TENDER DOCUMENT FOR

Construction of Chhat Ghats & Cremation Ghats in 600m Bund from Ch. 3200 to 3800m d/s Right side at Mohammadganj Barrage under North Koel Reservoir Project, Jharkhand and Bihar

Estimated Cost (Rs. 17.28 Lacs)

TENDER NO: WAP/INFRA./NK/Chhat Ghat/Cremation Ghat/2025

VOLUME -3

TECHNICAL SPECIFICATIONS

Issued to M/s

WAPCOS

(भारत सरकार का उपक्रम–जल शक्ति मंत्रालय)

(A Government of India Undertaking-Ministry of Jal Shakti)

Work reserved for Project Affected Families (PAFs) only

1.1 GENERAL

Materials to be used in the work shall conform to the specifications mentioned on the drawings, the requirements laid down in this section and specifications for relevant items of work covered under these specifications.

If any material, not covered in these specifications, is required to be used in the work, it shall conform to relevant Indian Standards, if there are any, or to the requirements specified by the Engineer-in-charge.

If any specification of work is not mentioned in this document then the contractor shall get the specification approved from the Engineer-in-charge before the start of the work.

1.2 SOURCES OF MATERIAL

The Contractor shall notify the Engineer-in-charge of his proposed sources of materials prior to delivery. If it is found after trial that sources of supply previously approved do not produce uniform and satisfactory products, or if the product from any other source proves unacceptable at any time, the Contractor shall furnish acceptable material from other sources at his own expense.

1.3 BRICKS

Burnt clay bricks shall conform to the requirements of IS:1077, except that the minimum compressive strength when tested flat shall not be less than 8.4 MPa for individual bricks and 10.5 MPa for average of 5 specimens. They shall be free from cracks and flaws and nodules of free lime. The brick shall have smooth rectangular faces with sharp corners and emit a clear ringing sound when struck. The size may be according to local practice with a tolerance of ± 5 per cent.

1.4 STONES

Stones shall be of the type specified. It shall be hard, sound, free from cracks, decay and weathering and shall be freshly quarried from an approved quarry. Stone with round surface shall not be used.

The stones, when immersed in water for 24 hours, shall not absorb water by more than 5 per cent of their dry weight when tested in accordance with IS:1124.

The length of stones shall not exceed 3 times its height nor shall they be less than twice its height plus one joint. No stone shall be less in width than the height and width on the base shall not be greater than three-fourth of the thickness of the wall nor less than 150 mm.

1.5 CAST IRON

Cast iron shall conform to IS:210, The grade number of the material shall not be less than 14.

1.6 CEMENT

Cement to be used in the works shall be any of the following types with the prior approval of the Engineer-in-charge:

a) Ordinary Portland Cement, 33 Grade, conforming to IS:269.
b) Rapid Hardening g Portland Cement, conforming to IS:8041.
c) Ordinary Portland Cement, 43 Grade, conforming to IS:8112.
d) Ordinary Portland Cement, 53 Grade, conforming to IS:12269.
e) Sulphate Resistant Portland Cement, conforming to IS:12330.

Cement conforming to IS:269 shall be used only after ensuring that the minimum required design strength can be achieved without exceeding the maximum permissible cement content of 540 kg/cu,m. of concrete.

Cement conforming to IS:8112 and IS:12269 may be used provided the minimum cement content mentioned elsewhere from durability considerations is not reduced. From strength considerations, these cements shall be used with a certain caution as high early strengths of cement in the 1 to 28-day range can be achieved by finer grinding and higher Constituent ratio of C_3S/C_2S, where C_3S is Tricalcium Silicate and C_2S is Dicalcium Silicate. In such cements, the further growth of strength beyond say 4 weeks may be much lower than that traditionally expected. Therefore, further strength tests shall be carried out for 56 and 90 days to fine tune the mix design from strength considerations.

Cement conforming to IS:12330 shall be used when sodium sulphate and magnesium sulphate are present in large enough concentration to be aggressive to concrete. The recommended threshold values as per IS:456 are sulphate concentration in excess of 0.2 per cent in soil substrata or 300 ppm (0.03per cent) in ground water. Tests to confirm actual values of sulphate concentration are essential when the structure is located near the sea coast, chemical factories, agricultural land using chemical fertilizers and sites where there are effluent discharges or where soluble sulphate bearing ground water level is high. Cement conforming to IS:12330 shall be carefully selected from strength considerations to ensure that the minimum required design strength can be achieved without exceeding the maximum permissible cement content of 540 kg/ cum. of concrete.

Cement conforming to IS:8041 shall be used only for precast concrete products after specific approval of the Engineer-in-charge.

Total chloride content in cement shall in no case exceed 0.05 per cent by mass of cement. Also, total sulphur content calculated as sulphuric anhydride (SO3) shall in no case exceed 2.5 per cent and 3.0 per cent when tri-calcium aluminate per cent by mass is upto 5 or greater than 5 respectively.

1.7 COARSE AGGREGATES

For plain and reinforced cement concrete (PCC and RCC) or prestressed concrete (PSC) works, coarse aggregate shall consist of clean, hard, strong, dense, non-porous and durable pieces of crushed stone, crushed gravel, natural gravel or a suitable combination thereof or other approved inert material. They shall not consist pieces of disintegrated stones, soft, flaky, elongated particles, salt, alkali, vegetable matter or other deleterious materials in such quantities as to reduce the strength and durability of the concrete, or to attack the steel reinforcement. Coarse aggregate having positive alkali- silica reaction shall not be used. All coarse aggregates shall conform to IS:383 and tests for conformity shall be carried out as per 15:2386, Parts I to VIII.

The contractor shall submit for the approval of the Engineer-in-charge, the entire information indicated in Appendix A of IS:383.

Maximum nominal size of coarse aggregate for various structural components in PCC, RCC or PSC, shall conform to Section 1700.

The maximum value for flakiness index for coarse aggregate shall not exceed 35 per cent. The coarse aggregate shall satisfy the following requirements of grading:

TABLE 1.1 REQUIREMENTS OF COARSE AGGREGATE

IS Sieve Size	Per cent by Weight Passing the Sieve		
	40 mm	**20mm**	**12.5mm**
63 mm	100	—	—
40 mm	95-100	100	—
20 mm	30-70	95-100	100
12.5 mm	—	—	90-100
10 mm	10-35	25-55	40-85
4.75 mm	0-5	0-10	0-10

1.8 SAND/FINE AGGREGATES

For masonry work, sand shall conform to the requirements of IS:2116. For plain and reinforced cement concrete (PCC and RCC) or prestressed concrete (PSC) works, fine aggregate shall consist of clean, hard, strong and durable pieces of crushed stone, crushed gravel, or a suitable combination of natural sand, crushed stone or gravel. They shall not contain dust, lumps, soft or flaky, materials, mica or other deleterious materials in such quantities as to reduce the strength and durability of the concrete, or to attack the embedded steel. Motorised sand washing machines should be used to remove impurities from sand. Fine aggregate having positive alkali-silica reaction shall not be used. All fine aggregates shall conform to IS:383 and tests for conformity shall be carried out as per IS:2386, (Parts I to VIII). The Contractor shall submit to the Engineer-in-charge the entire information indicated in Appendix A of IS:383. The fineness modulus of fine aggregate shall neither be less than
2.0 nor greater than 3.5.

Sand/fine aggregate for structural concrete shall conform to the following grading

requirements:

TABLE 1.2

IS Sieve Size	Per cent by Weight Passing the Sieve		
	Zone 1	Zone II	Zone 111
10 mm	100	100	100
4.75 mm	90-100	90-100	90-100
2.36 mm	60-95	75-100	85-100
1.18 mm	30-70	55-90	75-100
600 micron	15-34	35-59	60-79
300 micron	5-20	S-30	12-40
150 micron	0-10	0-10	0-10

1.9 STEEL

1.9.1. Cast Steel

The use of cast steel shall be limited to bearings and other similar parts. Steel for castings shall conform to Grade 280-520N of IS:1030. In case where subsequent welding is unavoidable in the relevant cast steel components, the letter N at the end of the grade designation of the steel casting shall be replaced by letter W. 0.3 per cent to 0.5 percent copper may be added to increase the corrosion resistance properties.

1.9.2. Steel for Prestressing

The prestressing steel shall conform to either of the following:

(a) Plain hard drawn steel wire conforming to IS:1785 (Part I) and IS:1785 (Part II).
(b) Cold drawn indented wire conforming to IS.6003
(c) High tensile steel bar conforming to IS:2090
(d) Uncoated stress relieved strands conforming to IS:6006.

1.9.3. Reinforcement / Untensioned Steel

For plain and reinforced cement concrete (PCC and RCC) or prestressed concrete (PSC) works, the reinforcement / untensioned steel as the case may be shall consist of the following grades of reinforcing bars.

TABLE 1.3

Grade Designation	Bar Type conforming to governing IS	Characteristic Strength fy MPa	Elastic Modulus GPa
	Specification		
S 240	IS:432 Part I Mild Steel Bar	240	200
S 415	IS:17B6 High Yield Strength Deformed Bars (I1YSD)	415	200

Other grades of bars conforming to IS:432 and IS:1786 shall not be permitted.

All steel shall be procured from original producers, no re-rolled steel shall be incorporated

in the work.

Only new steel shall be delivered to the site. Every bar shall be inspected before assembling on the work and defective, brittle or burnt bar shall be discarded. Cracked ends of bars shall be discarded.

Fusion-bonded epoxy coated reinforcing bars shall meet the requirements of IS: 13620, Additional requirements for the use of such reinforcement bars have been given below:

(i) Patch up materials shall be procured in sealed containers with certificates from the agency who has supplied the fusion bonded epoxy bars.

(ii) PVC coated G.I. binding wires of 18G shall only be used in conjunction with fusion bonded epoxy bars.

(iii) Chain for supporting the reinforcement shall also be of fusion bonded epoxy coated bars.

(iv) The cut ends and damaged portions shall be touched up repair patch up material.

(v) The bars shall be cut by saw-cutting rather than flame cutting.

(vi) While bending the bars, the pins of work benches shall be provided with PVC or plastic sleeves.

(vii) The coated steel shall not be directly exposed to sun rays or rains and shall be protected with opaque polyethelene sheets or such other approved materials.

(viii) While concreting, the workmen or trolleys shall not directly move on coated bars but can move on wooden planks placed on the bars.

When specified in the contract, protective coating prescribed by CECRI shall be provided in conformance to specifications given in *Appendix 1000.1*. The CECRI coating process shall be allowed to be implemented at the site of works provided a representative of the Institute is present throughout the duration of the coating process who shall certify that the materials and workmanship are in accordance with prescribed specifications developed by the Institute.

1.9.4. Grey Iron Castings

Grey Iron castings to be used for bearings shall have the following minimum properties:

Minimum ultimate tensile strength	370 MPa
Modulus of Elasticity	147000 MPa
Bnnell Hardness	230 MPa
Shear Strength	370 MPa
Compressive Strength	1370 MPa

The testing shall be as specified in IS:210.

1.9.5. Steel Forgings

Forged steel pins shall comply with clause 3, 3A or 4 of IS: 1875 and steel forgings shall comply with clause 3, 3A or 4 of IS:2004. Raw materials of the forging will be taken as per IS: 1875 with minimum reduction ratio of 1.8:1. Alternatively, if forging is made from ingot, a minimum reduction ratio between the ingot and forging will be 4:1. Forging shall be normalised.

1.9.6. Structural Steel

Unless otherwise permitted herein, all structural steel shall before fabrication comply with the requirements of the following Indian Standards:

IS: 226 : Structural Steel (Standard Quality)
15:961 : Structural Steel (High Tensile) IS: 2062 : Weld able Structural Steel

1S:8500 : Weld able Structural Steel (medium & high strength qualities)

IS:1148 : Hoi rolled rivet bars (upto 40mm dia) for structural purposes

IS:1149 : High tensile rivet bars for structural purposes

IS:1161 : Steel tubes for structural purposes

IS:4923 : Hollow Steel sections for structural use

IS:11587 : Structural weather resistant steel

IS:808 : Specifications for Rolled Steel Beam, Channel and Angle Sections

IS:1239 : Mild Steel Tubes

IS:1730 : Dimension for Steel Plate, sheet and strip for structural and general Engineering purposes

IS: 1731 : Dimension for Steel flats for structural and general Engineer-in-charge purposes

IS:1732 : Dimension for round and square steel bars for structural and general Engineering purposes

IS:1852 : Rolling and cutting tolerances for hot rolled steel products

The use of structural steel not covered by the above standards may be permitted with the specific approval of the authority. Refer to Section 1900 for further details.

1.9.7. Stainless Steel

Stainless steel shall be austenitic chromium- nickel steel, possessing rust, acid and heat resistant properties conforming to IS:66Q3 and IS:6911. Mechanical properties/grade for such stainless steel shall be as specified by the accepting authority, but in no case be inferior to mild steel. Generally, stainless steel is available as per AIS1 grades. A1SI 304 which is equivalent to grade 04Cr18Ni10 of IS:6911 satisfies the requirements of mechanical properties of structural steel. Other grades of stainless steel for specific purposes may be provided as per specific requirements. For application in adverse/ corrosive environment, stainless steel shall conform to A1SI 316L or 02G17 Ni Mo2 of 13:6911.

1.10 WATER

Water used for mixing and curing shall be clean and free from injurious amounts of oils, acids, alkalis, salts, sugar, organic materials or other substances that may be deleterious to concrete or steel. Potable water is generally considered satisfactory for mixing concrete. Mixing and curing with sea water shall not be permitted. As a guide, the following concentrations represent the maximum permissible values:

(a) To neutralize 200 ml sample of water using phenolphthalein as an indicator, it should not require more than 2 ml of 0.1 normal NaOH.

(b) To neutralize 200 ml sample of water, using methyl orange as an indicator, it should not require more than 10 ml of 0.1 normal HCl.

(c) The permissible limits for solids shall be as follows when tested in accordance with IS:3025 :

Permissible Limits (max)	
Organic	200 mg/lit
Inorganic	3000 mg/lit
Sulphates (SO4)	500 mg /lit
Chlorides (Cl)	500 mg/lit
Suspended matter	2000 mg/lit

* In case of structures of lengths 30m and below, the permissible limit of chlorides may be increased upto1000 mg/lit, All samples of water (including potable water) shall be tested and suitable measures taken where necessary to ensure conformity of the water to the requirements slated herein.

(d) The pH value shall not be less than 6.

1.11 TIMBER

The timber used for structural purposes shall conform to IS:883

1.12. CONCRETE ADMIXTURES

1.12.1. General

Admixtures are materials added to the concrete before or during mixing with a view to modify one or more of the properties of concrete in the plastic or hardened state.

Concrete admixtures are proprietary items of manufacture and shall be obtained only from established manufacturers with proven track record, quality assurance and full-fledged laboratory facilities for the manufacture and testing of concrete.

The contractor shall provide the following information concerning each admixture after obtaining the same from the manufacturer:

(a) Normal dosage and detrimental effects, if any, of tender dosage and over dosage.
(b) The chemical names of the main ingredients in the admixtures.
(c) The chloride content, if any, expressed as a percentage by the weight of the

admixture.

(d) Values of dry material content, ash content and relative density of the admixture which can be used for Uniformity Tests.

(e) Whether or not the admixture leads to the entertainment of air when used as per the manufacturer's recommended dosage, and if so to what extent

(f) Where two or more admixtures are proposed to be used in any one mix confirmation as to their compatibility.

(g) There would be no increase in risk of corrosion of the reinforcement or other embedment's as a result of using the admixture.

1.12.2. Physical and Chemical Requirements

Admixtures shall conform to the requirements of IS:9103. In addition, the following conditions shall be satisfied:

(a) "Plasticizers" and "Super-Plasticizers" shall meet the requirements indicated for "Water reducing Admixture".

(b) Except where resistance to freezing and thawing and to disruptive action of de- icing salts is necessary, the air content of freshly mixed concrete in accordance with the pressure method given in IS: 1199 shall not be more than 2 per cent higher than that of the corresponding control mix and in any case not more than per cent of the test mix.

(c) The chloride cement of the admixture shall not exceed 0.2 per cent when tested in accordance with IS: 6925. In addition, the maximum permissible limit of chloride content of all the constituents as indicated in Section 1700 shall also be observed.

(d) Uniformity tests on the admixtures are essential to compare qualitatively the com position of different samples taken from batch to batch or from the same batch at different times.

(e) The tests that shall be performed along with permissible variations in the same are indicated below:

i. Dry Material Content: to be within 3 per cent and 5 per cent of liquid and solid admixtures respectively of the value stated by the manufacturer.

ii. Ash content: to be within 1 per cent of the value stated by the manufacturer.

iii. Relative Density (for liquid admixtures): to be within 2 per cent of the value stated by the manufacturer.

iv. All tests relating to the concretes admixtures shall be conducted periodically at an independent laboratory and compared with the data given by the manufacturer.

1.13. REINFORCED CONCRETE PIPES

Reinforced concrete pipes for highway structures shall be of NP4 type conforming to the requirements of IS:458.

1.14. STORAGE OF MATERIALS

1.14.1. General

All materials may be stored at proper places so as to prevent their deterioration or intrusion by foreign matter and to ensure their satisfactory quality and fitness for the work. The

storage space must also permit easy inspection, removal and restorage of the materials. All such materials even though stored in approved godowns/places, must be subjected to acceptance test prior to their immediate use.

1.14.2. Brick

Bricks shall not be dumped at site. They shall be stacked in regular tiers as they are unloaded, to minimize breakage and defacement. The supply of bricks shall be available at site at any time. Bricks selected for use in different situations shall be stacked separately.

1.14.3. Aggregates

Aggregate stockpiles may be made on ground that is denuded of vegetation, is hard and well drained. If necessary, the ground shall be covered with 50 mm plank.

Coarse aggregates, unless otherwise agreed by the Engineer-in-charge in writing, shall be delivered to the site in separate sizes (2 sizes when nominal size is 25 mm or less and 3 sizes when the nominal size is 32 mm or more). Aggregates placed directly on the ground shall not be removed from the stockpile within 30 cm of the ground until the final cleaning up of the work, and then only the clean aggregate will be permitted to be used.

In the case of fine aggregates, these shall be deposited at the mixing site not less than 8 hours before use and shall have been tested and approved by the Engineer-in-charge.

1.14.4. Cement

Cement shall be transported, handled and stored on the site in such a manner as to avoid deterioration or contamination. Cement shall be stored above ground level in perfectly dry and water-tight sheds and shall be stacked not more than eight bags high. Wherever bulk storage containers are used their capacity should be sufficient to cater to the requirement at site and should be cleaned at least once every 3 to 4 months.

Each consignment shall be stored separately so that it may be readily identified and inspected and cement shall be used in the sequence in which it is delivered at site. Any consignment or pan of a consignment of cement which had deteriorated in any way, during storage, shall not be used in the works and shall be removed from the site by the Contractor without charge to the Employer.

The Contractor shall prepare and maintain proper records on site in respect of delivery, handling, storage and use of cement and these records shall be available for inspection by the Engineer-in-charge at all times.

The Contractor shall make a monthly return to the Engineer-in-charge on the date corresponding to the interim certificate date, showing the quantities of cement received and issued during the month and in stock at the end of the month.

1.14.5. Reinforcement /Untensioned Steel

The reinforcement bars, when delivered on the job, shall be stored above the surface of the ground upon platforms skids, or other supports, and shall be protected from mechanical injury "and from deterioration by exposure.

1.14.6. Prestressing Materials

All prestressing steel, sheathing, anchorages and sleeves or coupling must be protected during transportation, handling and storage. The prestressing steel, sheathing and other accessories must be stored under cover from rain or damp ground and protected from the ambient atmosphere if it is likely to be aggressive. Storage at site must be kept to the absolute minimum.

(a) Tendon: Wire strand and bar from which tendons are to be fabricated shall be stored about 300mm above the ground in a suitably covered and closed space so as to avoid direct climatic influences and to protect them from splashes from my other materials and from the cutting operation of an oxy -acetylene torch or arc welding process in the vicinity. Under no circumstances, tendon material shall be subjected to any welding operation or on site heal treatment or metallic coaling such as galvanising. Storage facilities and the procedures for transporting material into or out of store, shall be such that the material does not become kinked or notched. Wire or strand shall be stored in large diameter coils which enable the tendons to be laid out straight. As a guide, for wires above 5mm dia, coils of about 2m dia without breaks or joints shall be obtained from manufacturer and stored. Protective wrapping for tendons shall be chemically neutral. All prestressing steel must be provided with temporary protection during storage.

(b) Anchorage Components; The handling and storing procedures shall maintain the anchorage components in a condition in which they can subsequently perform their function to an adequate degree. Components shall be handled and stored so that mechanical damage and detrimental corrosion are prevented. The corrosion of the gripping and securing system shall be prevented. The use of correctly formulated oils and greases or of other corrosion preventing material is recommended where prolonged storage is required. Such protective material shall be guaranteed by the producer to be non-aggressive and non-degrading.

(c) Prestressing steel shall be stored in a closed store having single door with double locking arrangements and no windows. Also the air inside the store shall be kept dry as far as possible by using various means to the satisfaction of the Engineer-in-charge. Also instrument measuring the air humidity shall be installed inside the store. This is with a view to eliminating the possibility of initial rusting of prestressing steel during storage. The prestressing steel shall be coated with water solvable- grease. The prestressing steel should be absolutely clean and without any signs of rust.

(d) All prestressing steel shall be stored at least 30 cm above ground level and it shall be invariably wrapped by protective cover of tar paper or polythene or any other approved material.

(e) The Contractor should see that prestressing steel shall be used within 3 months of its manufacture. He should chalk out his programme in this respect precisely, so as to avoid initial corrosion before placing in position.

1.14.7. Water

Water shall be stored in containers/tanks covered at top and cleaned at regular intervals in order to prevent intrusion by foreign matter or growth of organic matter. Water from shallow, muddy or marshy surface shall not be permitted. The intake pipe shall be enclosed to exclude silt, mud, grass and other solid materials and there shall be a minimum depth of 0.60 m of water below the intake at all times.

1.15. TESTS AND STANDARD OF ACCEPTANCE

All materials, even though stored in an approved manner shall be subjected to an acceptance test prior to their immediate use.

Independent testing of cement for every consignment shall be done by the Contractor at site in the laboratory approved by the Engineer-in-charge before use. Any cement with lower quality than those shown in manufacturer's certificate shall be debarred from use. In case of imported cement, the same series of tests shall be carried out before acceptance.

1.15.1. Testing and Approval of Material

The Contractor shall furnish test certificates from the manufacturer/ supplier of materials along with each batch of material(s) delivered to site.

The Contractor shall set up a field laboratory with necessary equipment for testing of all materials, finished products used in the construction as per requirements of conditions of contract and the relevant specifications. The testing of all the materials shall be carried out by the Engineer-in-charge or his representative for which the Contractor shall make all the necessary arrangements and bear the entire cost.

Tests which cannot be carried out in the field laboratory have to be got done at the Contractor's cost at any recognised laboratory / testing establishments approved by the Engineer-in-charge.

1.15.2. Sampling of Materials

Samples provided to the Engineer-in-charge or his representative for their retention are to be in labelled boxes suitable for storage.

Samples required for approval and testing must be supplied well in advance by at least 48 hours or minimum period required for carrying out relevant tests to allow for testing and approval. Delay to works arising from the late submission of samples will not be acceptable as a reason for delay in the completion of the works.

If materials are brought from abroad, the cost of sampling/testing whether in India or abroad shall be borne by the Contractor.

1.15.3. Rejection of Materials not Conforming to the Specifications

Any stack or batch of material(s) of which sample(s) does not conform to the prescribed tests and quality shall be rejected by the Engineer-in-charge or his representative and such materials shall be removed from site by the Contractor at his own cost. Such rejected materials shall not be made acceptable by any modifications.

1.15.4. Testing and Approval of Plant and Equipment

All plants and equipment used for preparing, testing and production of materials for incorporation into the permanent works shall be in accordance with manufacturer's specifications and shall be got approved by the Engineer-in-charge before use.

CHAPTER-2- FORMWORK

2.1. Description

Formwork shall include all temporary or permanent forms required for forming the concrete of the shape, dimensions and surface finish as shown on the drawing or as directed by the Engineer-in-charge, together with all props, staging, centering, scaffolding and temporary Construction required for their support. The design, erection and removal of formwork shall conform to IRC:87 "Guidelines for Design and Erection of False work for Road Bridges" and these specifications.

2.2. MATERIALS

All materials shall comply with the requirements of IRC87. Materials and components used for formwork shall be examined for damage or excessive deterioration before use / re- use and shall be used only if found suitable after necessary repairs. In case of timber formwork, the inspection shall not only cover physical damages but also signs of attacks by decay, rot or insect attack or the development of splits.

Forms shall be constructed with metal or timber. The metal used for forms shall be of such thickness that the forms remain true to shape. All bolts should be countersunk. The use of approved internal steel ties or steel or plastic spacers shall be permitted. Structural steel tubes used as support for forms shall have a minimum wall thickness of 4 mm. Other materials conforming to the requirements of IRC:87 may also be used if approved by the Engineer-in-charge.

2.3. DESIGN OF FORMWORK

2.3.1. The Contractor shall furnish the design and drawing of complete formwork (i.e. the forms as well as their supports) for approval of the Engineer-in-charge before any erection is taken up. If proprietary system of formwork is used, the Contractor shall furnish detailed information as per *Appendix. 150011* to the Engineer-in-charge for approval. Notwithstanding any approval or review of drawing and design by the Engineer-in-charge, the Contractor shall be entirely responsible for the adequacy and safety for formwork.

2.3.2. The design of the formwork shall conform to provisions of IRC:87. It shall ensure that the forms can be conveniently removed without disturbing the concrete. The design shall facilitate proper and safe access to all parts of formwork for inspection.

2.3.3. In the case of prestressed concrete superstructure, careful consideration shall be given to redistribution of loads on props due to prestressing.

2.4. WORKMANSHIP

2.4.1. The formwork shall be robust and strong and the joints shall be leak-proof. Balli shall not be used as staging. Staging must have cross bracings and diagonal bracings in both directions. Staging shall be provided with an appropriately designed base plate resting on firm strata.

2.4.2. The number of joints in the formwork shall be kept to a minimum by using large size panels. The design shall provide for proper "soldiers" to facilitate alignment. All joints shall be leak proof and must be properly sealed. Use of PVC JOINT sealing tapes, foam rubber or PVC T-section is essential to prevent leakage of grout.

2.4.3. As far as practicable, clamps shall be used to hold the forms together. Where use of nails is unavoidable minimum number of nails shall be used and these shall be left projecting so that they can be withdrawn easily. Use of double headed nails shall be preferred.

2.4.4. Use of ties shall be restricted, as far as practicable. Wherever ties are used they shall be used with HOPE sheathing so that the ties can easily be removed. No parts prone to corrosion shall be left projecting or near the surface. The sheathing shall be grouted with cement mortar of the same strength as that of the structure.

2.4.5. Unless otherwise specified, or directed, chamfers or fillets of sizes 25 mm x 25 mm shall be provided at all angles of the formwork to avoid sharp corners. The chamfers, beveled edges and mouldings shall be made in the formwork itself. Opening for fixtures and other fittings shall be provided in the shuttering as directed by the Engineer-in-charge.

2.4.6. Shuttering for walls, sloping members and thin sections of considerable height shall be provided with temporary openings to permit inspection and cleaning out before placing of concrete.

2.4.7. The formwork shall be constructed with precamber to the soffit to allow for deflection of the formwork. Pre-camber to allow for deflection of formwork shall be in addition to that indicated for the permanent structure in the drawings.

2.4.8. Where centering trusses or launching trusses are adopted for casting of superstructure, the joints of the centering trusses, whether welded, riveted or bolted should be thoroughly checked periodically. Also, various members of the centering trusses should be periodically examined for proper alignment and unintended deformation before proceeding with the concreting. They shall also be periodically checked for any deterioration in quality due to steel corrosion.

2.4.9. The formwork shall be so made as to produce a finished concrete true to shape, line and levels and dimensions as shown on the drawings, subject to the tolerances specified in respective sections of these specifications, or as directed by the Engineer-in-charge.

2.4.10. Where metal forms are used, all bolts and rivets shall be countersunk and well ground to provide a smooth, plane surface. Where timber is used it shall be well seasoned, free from loose knots, projecting nails, splits or other defects that may mar the surface of concrete.

2.4.11. Forms shall be made sufficiently rigid by the use of ties and bracings to prevent any displacement or sagging between supports. They shall be strong enough to withstand all pressure, ramming and vibration during and after placing the concrete. Screw jacks or hardwood wedges where required shall be provided to make up any settlement in the formwork either before or during the placing of concrete.

2.4.12. The formwork shall take due account of the calculated amount of positive or negative camber so as to ensure the correct final shape of the structures, having regard to the deformation of false work, scaffolding or propping and the instantaneous or deferred deformation due to various causes affecting prestressed structures.

2.4.13. Suitable camber shall be provided to horizontal members of structure, specially in long spans to counteract the effects of deflection. The formwork shall be so fixed as to provide for such camber.

2.4.14. The formwork shall be coaled with an approved release agent that will effectively prevent sticking and will not stain the concrete surface. Lubricating (machine oils) shall be prohibited for use as coating.

2.5. FORMED SURFACE AND FINISH

The formwork shall be lined with a material approved by the Engineer-in-Charge to ensure a smooth finish with uniform texture and appearance. The lining material shall not stain the concrete and shall be securely fixed to its backing to prevent any blemishes or surface imperfections. A single type of lining material shall be used consistently throughout the construction of any one structure and shall be sourced from the same approved supplier.

The contractor shall rectify, to the satisfaction of the Engineer-in-Charge, any imperfections or defects in the finished concrete surface.

The design and installation of internal ties and embedded metal parts shall be carefully detailed and shall be subject to the prior approval of the Engineer-in-Charge.

2.6. PRECAUTIONS

(i) Special measures in the design of formwork shall be taken to ensure that it does not hinder the shrinkage of concrete. The soffit of the formwork shall be so designed as to ensure that the formwork does not restrain the shortening and or hogging of beams during prestressing. The forms may be removed at the earliest opportunity subject to the minimum time for removal of forms with props retained in position.

(ii) Where necessary, formwork shall be so arranged that the soffit from, properly supported on props only can be retained in position for such period as may be required by maturing conditions.

(ii) Any cut-outs or openings provided in any structural member to facilitate erection of formwork shall be closed with the same grade of concrete as the adjoining structure immediately after removal of formwork ensuring watertight joints.

(iii) Provision shall be made for safe access about the formwork at the levels as required.

(iv) Close watch shall be maintained to check for settlement of formwork during concreting. Any settlement of formwork during concreting shall be promptly rectified.

(v) Water used for curing should not be allowed to stagnate near the base plates supporting the staging and should be properly drained.

2.7. PREPARATION OF FORMWORK BEFORE CONCRETING

The inside surfaces of forms shall, except in the case of permanent form work or where
otherwise agreed to by the Engineer-in-charge be coated with a release agent supplied by approved manufacturer or of an approved material to prevent adhesion of concrete to the formwork. Release agents shall be applied strictly in accordance with the manufacturer's instructions and shall not be allowed to come into contact with any reinforcement or prestressing tendons and anchorages. Different release agents shall not be used in formwork for exposed concrete. Before re-use of forms, the following actions shall be taken:

(i) The contact surfaces of the forms shall be cleaned carefully and dried before applying a release agent.

(ii) It should be ensured that the release agent is appropriate to the surface to be coaled. The same type and make of release agent shall be used throughout on similar formwork materials and different types should not be mixed.

(iii) The form surfaces shall be evenly and thinly coaled with release agent. The vertical surface shall be treated before horizontal surface and any excess wiped out.

(iv) The release agent shall not come in contact with reinforcement or the hardened concrete. (v) All forms shall be thoroughly cleaned immediately before concreting.

The Contractor shall give the Engineer-in-charge due notice before placing any concrete in the forms to permit him to inspect and approve the formwork, but such inspection shall not relieve the contractor of his responsibility for safety of formwork, men, machinery, materials and finish or tolerances of concrete.

2.8. REMOVAL OF FORMWORK

The scheme for removal of formwork {i.e. de-shuttering and de- centering) shall be planned
in advance and furnished to the Engineer-in-charge for scrutiny and approval. No formwork or any part thereof shall be removed without prior approval of the Engineer-in-charge.

The formwork shall be removed so as not to cause any damage to concrete. Centering shall be gradually and uniformly lowered in such a manner as to permit the concrete to take stresses due to its own weight uniformly and gradually to avoid any shock or vibration.

Where not specifically approved, the time of removal of formwork (when ordinary Portland Cement is used without any admixtures at an ambient temperatures exceeding 10 degrees Celsius) shall be as under:

Walls, piers, abutments, columns and vertical faces of structural members as decided by the Engineer-in- charge	12 to 48 hours
Soffits of Slabs (with props left under)	3 days
Props (left under slabs)	14 days
Soffit of Gilders (with props left under)	7 days
Props (left under girders)	21 days

Where there are re-entrant-angles in the concrete sections, the formwork should be removed at these sections as soon as possible after the concrete has set, in order to avoid cracking due to shrinkage of concrete.

2.9. RE-USE OF FORMWORK

When formwork is dismantled, its individual components shall be examined for damage and damaged pieces shall be removed for rectification. Such examination shall always be carried out before being used again. Before re-use all components shall be cleaned of deposits of soil, concrete or other unwanted materials. Threaded parts shall be oiled after cleaning, All bent steel props shall be straightened before re-use. The maximum deviation from straightness is 1/600 of the length. The maximum permissible axial loads in used props shall be suitably reduced depending upon their condition. The condition of the timber components, plywood and steel shuttering plates shall be examined closely for distortion and defects before re-use.

2.10. SPECIALISED FORMWORK

Specialized formwork may be required in the case of slip form work, underwater concreting, segmental construction etc. Such specialized form- work shall be designed and detailed by competent agencies and a set of complete working drawings and installation instructions shall be supplied to the Engineer-in-charge. The site personnel shall be trained in the erection and dismantling as well as operation of such specialized formwork. In case proprietary equipment is used, the supplier shall supply drawings, details, installation instructions, etc., in the form of manuals along with the formwork. Where specialized formwork is used, close co-ordination with the design of permanent structure is necessary.
For slipform the rate of slipping the formwork shall be designed for each individual case taking into account various parameters including the grade of concrete, concrete strength, concrete temperature, ambient temperature, concrete admixtures, etc. In the case of

segmenlal construction, the concrete mix shall be normally designed for developing high early strength so that the formwork is released as early as possible.

In order to verify the time and sequence of striking/removal of specialized formwork, routine field tests for the consistency of concrete and strength development are mandatory and shall be carried out before adoption.

For specialized formwork, the form lining material may be either plywood or steel sheet of appropriate thickness. Plywood is preferred where superior quality of surface is desired, whereas steel sheeting is normally used where large number of repetitions is involved.

2.11. TESTS AND STANDARDS OF ACCEPTANCE

The materials shall be tested in accordance with these Specifications and shall meet the prescribed criteria.

The work shall conform to these Specifications and shall meet the prescribed standards of acceptance.

2.12. MEASUREMENTS FOR PAYMENT

Unless stated otherwise the rate for concrete in Plain Concrete or Reinforced Concrete or Prestressed Concrete shall be deemed to include all formwork required in accordance with this section and shall not be measured separately.

Where it is specifically stipulated in the Contract that the formwork shall be paid for separately, measurement of formwork shall be taken in square meters of the surface area of concrete which is in contact with formwork.

2.13. RATE

The unit rate of the Plain Concrete or Reinforced Concrete or Prestressed Concrete as defined in respective sections shall be deemed to cover the costs of all formwork, including cost of all materials, labour, tools and plant required for design, construction and removal of formwork and supervision as described in this section including properly supporting the members until the concrete *is* cured, set and hardened as required.

Where the contract unit rate for formwork is specifically provided as a separate item, it shall include the cost of all materials, labour, tools and plant required for design, construction and removal of formwork and supervision as described in this Section including properly supporting the members until the concrete is cured, set and hardened as required.

Chapter 3: Steel Reinforcement (Un-Tensioned)

3.1. DESCRIPTION

This work shall consist of furnishing and placing coated or uncoated mild steel or high strength deformed reinforcement bars (un tensioned) of the shape and dimensions shown on the drawings and conforming to these Specifications or as approved by the Engineer-in-charge.

3.2. GENERAL

Steel for reinforcement shall meet with the requirements of Section1000.Reinforcements may be either mild steel/medium tensile steel or high strength deformed bars. They may be uncoated or coated with epoxy or with approved protective coatings.

3.3. PROTECTION OF REINFORCEMENT

Uncoated reinforcing steel shall be protected from rusting or chloride contamination. Reinforcements shall be free from rust, mortar, loose mill scale, grease, oil or paints. This may be ensured either by using reinforcement fresh from the factory or thoroughly cleaning all reinforcement to remove rust using any suitable method such as sand blasting, mechanical wire brushing, etc., as directed by the Engineer-in-charge. Reinforcements shall be stored on blocks, racks or platforms and above the ground in a clean and dry condition and shall be suitably marked to facilitate inspection and identification.

Portions of uncoated reinforcing steel and dowels projecting from concrete shall be protected within one week after initial placing of concrete with a brush coat of neat cement mixed with water to consistency of thick paint. This coating shall be removed by lightly Tapping with a hammer or other tool not more than one week before placing of the adjacent pour of concrete. Coated reinforcing steel shall be protected against damage to the coating. If the coaling on the bars is damaged during transportation or handling and cannot be repaired, the same shall be rejected.

3.4. BENDING OF REINFORCEMENT

Bar bending schedule shall be furnished by the Contractor and got approved by the Engineer-in-charge before start of work.

Reinforcing steel shall conform to the dimensions and shapes given in the approved Bar Bending Schedules. Bars shall be bent cold to the specified shape and dimensions or as directed by the Engineer-in-charge using a proper bar bender, operated by hand or power to obtain the correct radii of bends and shape.

Bars snail not be bent or straightened in a manner that will damage the parent material or the coating.

Bars bent during transport or handling shall be straightened before being used on work and shall not be heated to facilitate straightening.

3.5. PLACING OF REINFORCEMENT

a) The reinforcement cage should generally be fabricated in the yard at ground level and then shifted and placed in position. The reinforcement shall be placed strictly in accordance with the drawings and shall be assembled in position only when the structure is otherwise ready for placing of concrete. Prolonged time gap between assembling of reinforcements and casting of concrete, which may result in rust formation on the surface, shall not be permitted.

b) Reinforcement bars shall be placed accurately in position as shown on the drawings. The bars, crossing one another shall be tied together at every intersection with binding wire (annealed), conforming to 1S:280 to make the skeleton of the reinforcement rigid such that the reinforcement does not get displaced during placing of concrete, or any other operation. The diameter of binding wire shall not be less than 1 mm.

c) Bars shall be kept in position usually by the following methods:

(i) In case of beam and slab construction, industrially produced polymer cover blocks of thickness equal to the specified cover shall be placed between the bars and formwork subject to satisfactory evidence that the polymer composition is not harmful to concrete and reinforcement. Cover blocks made of concrete may be permitted by the Engineer-in-charge, provided they have the same strength and specification as those of the member.

(ii) In case of dowels for columns and walls, the vertical reinforcement shall kept in position by means of timber templates with slots cut in them accurately, or with cover blocks tied to the reinforcement. Timber templates shall be removed alter the concreting has progressed up to a level just below their location.

(iii) Layers of reinforcements shall be separated by spacer bars at approximate tally one meter intervals. The minimum diameter of spacer bars shall be 12 mm or equal to maximum size of main reinforcement or maximum size of coarse aggregate, whichever is greater. Horizontal reinforcement shall not be allowed to sag between supports.

(iv) Necessary stays, blocks, metal chairs, spacers, metal hangers, supporting wires etc., or other subsidiary reinforcement shall be provided to fix the reinforcements firmly in its correct position.

(v) Use of pebbles, broken stone, metal pipe, brick, mortar or wooden blocks etc., as devices for positioning reinforcement shall not be permitted.

d) Bars coated with epoxy or any other approved protective coating shall be placed on supports that do not damage the coating. Supports shall be installed in a manner such that planes of weakness are not created in hardened concrete. The coated reinforcing steel shall be held in place by use of plastic or plastic coaled binding wires especially manufactured for the purpose. Reference shall be made to Section 1000 for other requirements.

e) Placing and fixing of reinforcement shall be inspected and approved by the Engineer-in-charge before concrete is deposited.

3.6. BAR SPLICES

3.6.1. Lapping

Bars shall be bent correctly and accurately to the size and shape as shown in the detailed drawing or as directed by Engineer- in-Charge. Preferably bars of full length shall be used. Necessary cutting and straightening is also included. Overlapping of bars, where necessary shall be done as directed by the Engineer-in-Charge. The overlapping bars shall not touch each other and these shall be kept apart with concrete between them by 25mm or 1.25 times the maximum size of the coarse aggregate whichever is greater. But where this is not possible, the overlapping bars shall be bound together at intervals not exceeding twice the dia. of such bars with two strands annealed steel wire of 0.90 mm to 1.6 mm twisted tight. The overlaps/ splices shall be staggered as per directions of the Engineer-in-Charge. But in no case the overlapping shall be provided in more than 50% of cross sectional area at one section.

3.6.2. Welding

Splicing by welding of reinforcement will be permitted only if detailed on the drawing or approved by the Engineer-in-charge. Weld shall develop an ultimate strength equal to or greater than that of the bars connected.

$$\mathbf{CE = C + } \frac{Mn}{6} + \frac{Cr+Mg+V}{5} + \frac{Ni+Cu}{15}$$

Is 0.4 or less.

3.6.2.1. The method of welding shall conform to IS:2751 and1S:9417 and to any supplemental specifications to the satisfaction of the Engineer-in-charge.

Welding may be carried out by metal arc welding process. Oxyacetelene welding shall not be permissible. Any other process may be used subject to the approval of the Engineer-in-charge and necessary additional requirements to ensure satisfactory joint performance. Precautions on overheating, choice of electrode, selection of correct current in arc welding etc., should be strictly observed.

All bars shall be butt welded except for smaller diameter bars (diameter of less than 20 mm) which may be lap welded; Single-V or Double-V butt joints may generally be used. For vertical bars single bevel or double bevel joints may be used.

Welded joints shall be located well away from bends and not less than twice the bar diameter away from a bend.

Generally, shop welding in controlled conditions is to be preferred, where feasible. Site welding where necessary shall, however, be permitted when the facilities, equipment, process, consumables, operators, welding procedure are adequate to produce and maintain uniform

quality at par with that attainable in shop welding to the satisfaction of the Engineer-in-charge.

Joint welding procedures which are to be employed shall invariably be established by a procedure specification. All welders and welding operators to be employed shall have to be qualified by tests prescribed in IS: 2751, Inspection of welds shall conform to IS: 822 and destructive or non-destructive testing may be undertaken when deemed necessary. Joints with weld defects detected by visual inspection or dimensional check inspection shall not be accepted.

Suitable means shall be provided for holding the bars securely in position during welding. It must be ensured that no voids are left in welding. When welding is done in 2 or 3 stages, previous surface shall be cleaned properly. Bars shall be cleaned of all loose scale, rust, grease, paint and other foreign matter before carrying out welding. Only competent and experienced welders shall be employed on the work with the approval of the Engineer-in-charge. No welding shall be done on coated bars.

M.S. electrodes used for welding shall conform to IS: 814.

3.6.2.2. Welded joints shall preferably be located at points where steel will not be subject to more than 75 per cent of the maximum permissible stresses and welds so staggered that at any one section, not more than 20 per cent of the bars are welded.

3.6.2.3. Welded pieces of reinforcement shall be tested. Specimens shall be taken from the site and the number and frequency of tests shall be as directed by the Engineer-in-charge.

3.6.3. Mechanical Coupling of Bars

Bars may be joined with approved patented mechanical devices as indicated on the drawing or as approved by the Engineer-in-charge e.g. by special grade steel sleeves swagged on to bars in end to end contact or by screwed couplers. Incase such devices are permitted by them Engineer-in-charge, they shall develop at least 125 per cent of the characteristic strength of the reinforcement bar.

3.7. TESTING AND ACCEPTANCE

The material shall be tested in accordance with relevant IS specifications and necessary test certificates shall be furnished. Additional tests, if required, will be got carried out by the Contractor at his own cost.

The fabrication, furnishing and placing of reinforcement shall be in accordance with these specifications and shall be checked and accepted by the Engineer-in-charge.

3.8. MEASUREMENTS FOR PAYMENT

Reinforcement shall be measured in length including hooks, if any, separately for different diameters as actually used in work, excluding overlaps. From the length so measured, the weight of reinforcement shall be calculated in tonnes on the basis of IS:1732. Wastage, overlaps, couplings, welded joints, spacer bars, chairs, stays, hangers and annealed steel wire or other methods for binding and placing shall not be measured and cost of these items shall be deemed to be included in the rates for reinforcement.

3.9. RATE

The contract unit rate for coated/uncoated reinforcement shall cover the cost of material, fabricating, transporting, storing, bending, placing, binding and fixing in position as shown on the drawings as per these specifications and as directed **by** the Engineer-in-charge, including all labour, equipment, supplies, incidentals, sampling, testing and supervision.

The unit rate for coated reinforcement shall be deemed to also include cost of all material, labour, tools and plant, royalty, transportation and expertise required to carry out the work. The rate shall alsocover sampling, testing and supervision required for the work,

Chapter 4: Open Foundations

4.1. DESCRIPTION

The work shall cover furnishing and providing plain or reinforced concrete foundation placed in open excavation, in accordance with the drawings and these specifications or as directed by the Engineer-in-charge.

4.2. MATERIALS

Materials shall conform to Section 1000 of these Specifications.

4.3. GENERAL

A method statement for construction indicating the following shall be submitted by the Contractor for approval of the Engineer-in-charge, well in advance of the commencement of open foundation:

i) Sources of Materials
ii) Design, erection and removal of formwork
iii) Production, transportation, laying and curing of concrete
iv) Personnel employed for execution and supervision
v) Tests and sampling procedures
vi) Equipment details
vii) Any other point

Necessary arrangements for execution under water wherever necessary, shall be included in method statement.

Dimensions, lines and levels shall be set out and checked with respect to permanent reference lines and permanent bench mark.

4.4. WORKMANSHIP

4.4.1. Preparation of Foundations

Excavation for laying the foundation shall be carried out in accordance with Section 300 of these specifications. The last 300 mm of excavation shall be done just before laying of lean concrete below foundation.

In the event of excavation having been made deeper than that shown on the drawing or as ordered by the Engineer-in-charge, the extra depth shall be made up with M15 concrete in case of foundation resting on soil and foundation grade concrete for foundations in rock, at the cost of the Contractor and shall be considered as incidental work. Special care shall be taken not to disturb the bearing surface. Open foundations shall be constructed in dry conditions and the Contractor shall provide for adequate dewatering arrangements to the satisfaction of the Engineer-in-charge.

4.4.2. Setting Out

The plan dimensions of the foundation shall be set out at the bottom of foundation trench and checked with respect to original reference line and axis. It shall be ensured that at no point the bearing surface is higher than the founding level shown on the drawing or as directed by the Engineer-in-charge.

4.4.3. Construction

Where the bearing surface is earth, a layer of M15 concrete shall be provided below foundation concrete. The thickness of lean concrete layer shall be 100 mm minimum unless otherwise specified.

No formwork is necessary for the lean concrete layer. For foundation concrete work, side formwork shall be used. Formwork arc for top of the foundation concrete shall also be provided, if its top has slopes steeper than 1 (vertical) to 3 (horizontal). When concrete is laid in slope without top formwork, the slump of the concrete shall be carefully maintained to ensure that compaction is possible without slippage down the slope of freshly placed concrete. In certain cases it may be necessary to build the top formwork progressively as the concreting proceeds up the slope. Reinforcement shall be laid as shown on the drawing.

Before lying of lean concrete layer, the earth surface shall be cleaned of all loose material and wetted. Care shall be taken to avoid muddy surface. If any portion of the surface has been spoiled by over- wetting, the same shall be removed. Concrete M15 shall be laid to the thickness as required. No construction joint shall be provided in the lean concrete.

Before laying foundation concrete, the lean concrete or hard rock surface shall be cleaned of all loose material and lightly moistened. Foundation concrete of required dimensions and shape shall be laid continuously up to the location of construction joint shown on the drawing or as directed by the Engineer-in-charge.

Formwork and concrete shall conform to Sections 1500 and 1700 respectively of these specifications. Furnishing and providing steel reinforcement shall conform to Section 1600. The concrete surface shall be finished smooth with a trowel. The location of construction joint and its treatment shall be done as per requirements of Section 1700. Formwork shall be removed not earlier than 24 hours after placing of concrete. Where formwork has been provided for top surface, the same shall be removed as soon as concrete has hardened. Curing of concrete shall be carried out by wetting of formwork before removal. After its removal, curing shall be done by laying not less than 10 cm of loose moistened sand, free from clod or gravel and shall be kept continuously moist for a period of 7 days.

Dewatering, where necessary for lying of concrete, shall be carried out adopting any one of the following procedures or any other method approved by the Engineer-in-charge;

i) A pit or trench deeper than the foundation level as necessary may be dug beyond the foundation pit during construction so that the water level is kept below the foundation level.
ii) Water table is depressed by well point system or other methods.
iii) Use of steel/concrete caissons or sheet piling for creating an enclosure for the foundations, which can subsequently be dewatered.

Before backfilling is commenced, loose sand laid on foundation shall be removed and dispersed as directed by the Engineer-in-charge.

All spaces excavated and not occupied by the foundation or other permanent works shall be refilled with earth up to surface of surrounding ground in accordance with Section:300. In case of excavation in rock, the annular space around foundation shall be filled with M15 concrete up to the top of rock.

The protective works, where provided shall be completed before the floods so that the foundation does net get undermined.

4.5. TESTS AND STANDARDS OF ACCEPTANCE

The materials shall be tested in accordance with these Specifications and shall meet the prescribed criteria.

The work shall conform to these Specifications and shall meet the prescribed standards of acceptance. No point of the surface of the lean concrete in the case of foundation on soil or the surface of hard rock in the case of foundation of hard rock, shall be higher than the founding level shown on the drawing or as ordered by the Engineer-in-charge. Levels of the surface shall be taken at intervals of not more than 3 meters center to center, subject to a minimum of nine levels on the surface.

4.6. TOLERANCES

a) Variation in dimensions : +50 min - 10 mm
b) Misplacement from specified position in plan: 15 mm
c) Surface irregularities measured with 3 m straight edge: *5* mm
d) Variation of levels at the top: +25 mm

4.7. MEASUREMENT FOR PAYMENT

Excavation in foundation shall be measured in accordance with Section 300 based on the quantity ordered or as shown on the drawing. Lean concrete shall be measured in cubic meters in accordance with Section 1700, based on the quantity ordered or as shown on the drawing.

Concrete in foundation shall be measured in cubic meters in accordance with Section 1700, based on the quantity ordered or as shown on the drawing. Reinforcement steel shall be measured in tones in accordance with Section 1600, based on the quantity ordered or as shown on the drawing.

4.8. RATE

The contract unit rates for excavation in foundation, lean concrete and concrete in foundation and reinforcement steel shall include all works as given in respective sections of these specifications and cover all incidental items for furnishing and providing open foundation as mentioned in this Section.

Chapter 5: sub-structure

5.1. DESCRIPTION

The work shall cover furnishing and providing of masonry or reinforced concrete sub-structure in accordance with the drawings and as per these specifications or as directed by the Engineer-in-charge.

5.2. MATERIALS

Materials shall conform to Section 1000 of these Specifications.

5.3. GENERAL

A method statement for construction indicating the following shall be submitted by the Contractor for approval of the Engineer-in-charge, well in advance of the commencement of sub- structure:

i) Sources of Materials
ii) Design, erection and removal of formwork
iii) Production, transportation, laying and curing of concrete
iv) Personnel employed for execution and supervision
v) Tests and sampling procedures vi) Equipment details
vi) Any other point

Arrangements for execution under water wherever necessary, shall be included in method statement.

Dimensions, lines and levels shall be set out and checked with respect to permanent reference lines and permanent bench mark.

5.4. PIERS AND ABUTMENTS

Masonry, formwork, concrete and reinforcement for piers and abutments shall conform to relevant sections of these specifications. In case of concrete piers, the number of horizontal construction joints shall be kept minimum. Construction joints shall be avoided in splash zones unless specifically permitted by the Engineer-in-charge and provided they are treated in accordance with special provisions. No vertical construction joint shall be provided. The work shall conform strictly to the drawings or as directed by the Engineer-in-charge.

In case of tall piers and abutments, use of slip form shall be preferred. The design, erection and raising of slip form shall be subject to special specifications which will be furnished by the Contractor. The concrete shall also be subject to additional specifications as necessary.

All specifications and arrangements shall be subject to the approval of the Engineer-in- charge.

The surface of foundation/well cap/pile cap shall be scrapped with wire brush and al! Loose materials removed. In case reinforcing bars projecting from foundations are coated with cement slurry, the same shall "be removed by tapping, hammering or wire brushing. Care shall be taken to remove all loose materials around reinforcements. Just before commencing masonry or concrete work, the surface shall be thoroughly welled.

In case of solid (non-spill through type) abutments, weep holes as shown on the drawings or as directed by the Engineer-in-charge, shall be provided in conformity with Section 2706.

The surface finish shall be smooth, except the earth face of abutments which shall be rough finished.

In case of abutments likely to experience considerable movement on account of backfill of approaches and settlement of foundations, the construction of the abutment shall be followed by filling up of embankment in layers to, the full height to allow for the anticipated movement during construction period before casting of superstructure.

5.5. PIER CAP AND ABUTMENT CAP

Formwork, reinforcement and concrete shall conform to relevant sections of these specifications.

The locations and levels of pier cap/abutment cap/pedestals and bolts for fixing bearings shall be checked carefully to ensure alignment in accordance with the drawings of the bridge.

The surface of cap shall be finished smooth and shall have a slope for draining of water as shown on the drawings or as directed by the Engineer-in-charge. For short span slab bridges with continuous support on pier caps, the surface shall be cast horizontal. The top surface of the pedestal on which bearings are to be placed shall also be cast horizontal.

The surface on which elastomeric bearings are to be placed shall be wood float finished to a level plane which shall not vary more than 1.5 mm from straight edge placed in any direction across the area. The surface on which other bearings (steel bearings, pot bearings) are to be placed shall be cast about 25 mm below the bottom level of bearings and as indicated on the drawings.

5.6. DIRT/ BALLAST WALL, RETURN WALL AND WING WALL

Masonry, concrete and reinforcement shall conform to relevant sections of these specifications.

In case of cantilever return walls, no construction joint shall generally be permitted. Wherever feasible, the concreting in cantilever return walls shall be carried out in continuation of the ballast wall.

For gravity type masonry and concrete return and wing wall, the surface of foundation shall be prepared in the same manner as prescribed for construction of abutment. No horizontal construction joint shall be provided. If shown on drawing or directed by the Engineer-in-charge, vertical construction joint may be provided. Vertical expansion gap of 20 mm shall be provided in return wall/wing wall at every 10 meter intervals or as directed by the

Engineer-in-charge. Weep holes shall be provided as prescribed for abutments or as shown on the drawings.

Formwork, reinforcement and concrete in dirt/ballast wall shall conform to relevant sections of these specifications.

The finish of the surface on the earth side shall be rough while the front face shall be smooth finished.

Architectural coping for wing wall/return wall in brick masonry shall conform to section 1300.

5.7. TESTS AND STANDARDS OF ACCEPTANCE

The materials shall be tested in accordance with these specifications and shall meet the prescribed criteria.

The work shall conform to these specifications and shall meet the prescribed standards of acceptance.

5.8. TOLERANCES IN CONCRETE ELEMENTS

(a)	Variation in cross-sectional dimensions	:	+10 mm, -5mm
(b)	Misplacement from specified position in plan	:	10 mm
(c)	Variation of levels at the top	:	±10 mm
(d)	Variations of reduced levels of bearing areas	:	± 5 mm
(e)	Variations from plumb over full height	:	±10 mm
(f)	Surface irregularities measured with 3 m straight edge		
	All surfaces except bearing areas	:	5 mm
	Bearing areas	:	3 mm

5.9. MEASUREMENTS FOR PAYMENT

Masonry in sub-structure shall be measured in cubic meters in accordance with Section 1300 or 1400, based on the quantities ordered or as shown on the drawing.

Concrete in sub-structure shall be measured in cubic meters in accordance with Section 1700, based on the quantity ordered or as shown on the drawing. No deduction shall be made for weep holes.

Steel in concrete of sub-structures shall be measured in tones, in accordance with Section 1600, based on the quantity ordered or as shown on the drawing.

Weep holes shall be measured as per Section 2700, based on the quantity ordered or as shown on the drawings.

5.10. RATE

The contract unit rates for masonry, concrete, reinforcement and weep holes shall include all works as given in respective sections of these specifications and cover all incidental items for furnishing and providing substructure as mentioned in this Section.

Chapter 6: Concrete Superstructure

6.1. DESCRIPTION

The work shall cover furnishing and providing of concrete superstructure in accordance with the drawings as per these specifications or as directed by the Engineer-in-charge.

6.2. MATERIALS

Materials shall conform to Section 1000 of these Specifications.

6.3. GENERAL

6.3.1. A method statement for construction, indicating the follow- in, shall be submitted by the Contractor for approval of the Engineer-in-charge, well in advance of the commencement of the construction of superstructure:

i) Sources of Materials
ii) Design, erection and removal of formwork
iii) Production, transportation, laying and curing of concrete
iv) Prestressing system, if applicable
v) Personnel employed for execution and supervision
vi) Tests and sampling procedure
vii) Equipment details
viii) viii) Any other point

6.3.2. Dimensions, lines and levels shall be set out and checked with respect to permanent reference tines and permanent bench mark so that the final product is in accordance with the drawings or as directed by the Engineer-in-charge.

6.3.3. The work shall conform to the following sections besides stipulations in this section with regard to specific type of construction:

i)	Formwork	Section 1500
ii)	Steel Reinforcement	Section 1600
iii)	Structural Concrete	Section 1700
iv)	Presiressing	Section 1800

Additionally, some of the common types of superstructure construction shall have features as discussed in this Section.

6.4. REINFORCED CONCRETE CONSTRUCTION

6.4.1. Solid Slabs

Where adjacent span of slab has already been cast, the expansion joint and filler board shall be placed abutting the already cast span which shall form the shutter on that side of the new span to be cast. The whole of the slab shall be cast with reinforcement embedded for the road kerb and railings. No other construction joint shall be allowed except with the express permission of the Engineer-in-charge.

Where wearing coat is required to be provided, after the deck slab has been cast, the surface of the slab shall be finished rough, but true to lines and levels as shown on the drawings, before the concrete has hardened. The areas of construction joints shall be treated in the prescribed manner. The top of the slab shall be covered with clean moist sand as soon as the top surface has hardened. Curing shall be carried out as per Section 1700. Where the slab is resting on bearings, the same shall be placed in position in accordance with the drawings, before casting of deck slab.

6.4.2. RCC T-Beam and Slab

Provision of construction joint shall conform to .the drawings or as per directions of the Engineer-in-charge. No construction joint shall be provided between the bottom bulb and the web. If not indicated on the drawing, construction joint may be provided at the junction of the web and the fillet between the web and the deck slab with the permission of the Engineer-in-charge.

The portions of deck slab near expansion joints shall be cast along with reinforcements and embedment's for expansion joints. For this purpose, the portion of deck slab near expansion joints may be cast in a subsequent stage, if permitted by the Engineer-in-charge.

The surface finish of the deck slab shall be finished rough but true to lines and levels as shown on the drawings before the concrete has hardened. Care shall be taken for setting of bearings as indicated on the drawings.

6.5. PRESTRESSED CONCRETE CONSTRUCTION

6.5.1. PSC Girder and Composite RCC Slab

PSC Girder may be precast or cast- in-situ as mentioned on the drawing or as directed by the Engineer-in-charge. Girders may be post-tensioned or pre-tensioned. Where precast construction is required to be adopted, selection of casting yard and details of methodology and of equipment for shifting and launching of girders shall be included in the method statement.

In case of cast- in-situ construction, the sequence of construction including side shifting of girders, if applicable, and placing on bearings shall be in accordance with the drawings.

The PSC girder constituting the top flange, web and the bottom flange shall be concreted in a single operation without any construction joint.

The portions of deck slab near expansion joints shall be cast along - with reinforcements and embedment's for expansion joints. For this purpose, the portion of deck slab near expansion joints may be cast in a subsequent stage, if permitted by the Engineer-in-charge.

The surface finish of the deck slab shall be finished rough but true to lines and levels as shown on the drawings before the concrete has hardened. Care shall be taken for setting of bearings as indicated on the drawings.

6.5.2. Box Girder

Box girders may be simply supported or continuous. Simply supported box girders shall have minimum construction joints as approved by the Engineer-in-charge. In the case of continuous box girders the sequence of construction and location of construction joints shall strictly follow the drawings.

The box section shall be constructed with a maximum of one construction joint located in the web below the fillet between the deck slab and web. If permitted by the Engineer-in-charge, one additional construction joint may be permitted and this construction joint shall be located in the web above the fillet between the soffit slab and web.

The portions of deck slab near expansion joints shall be cast along with reinforcements and embedments for expansion joints. For this purpose, the portion of deck slab near expansion joints may be casting a subsequent stage, if permitted by the Engineer-in-charge.

The surface finish of the deck slab shall be finished rough but true to lines and levels as shown on the drawings before the concrete has hardened. Care shall be taken for setting of bearings as indicated on the drawings.

6.5.3. Cantilever Construction

Continuity of untensioned reinforcement from one segment to the next must be ensured by providing full lap length as necessary.

The design of the superstructure shall take into account the following aspects which form an integral part of the construction operations:

a) Stability against over-turning for each statical condition through which the assembly passes, shall be checked.

b) Stresses at each preceding segment joint with the addition of every segment or change of statical conditions shall be checked. The load of equipment as well as construction live load shall be taken into account.

c) Precambering of the superstructure during construction shall be done in such a manner that the finally constructed structure under permanent load strains the final profile intended in the drawings.

6.6. TOLERANCES

6.6.1. Precast Concrete Superstructure

	Variation in cross-sectional dimensions:		
a)	up to and including 2m	:	+ 5 mm
	over 2m	:	± 5 mm
b)	Variation in length overall and length between bearings	:	shall not exceed +10 mm or ±0.1 per cent of the span length, whichever is lesser
c)	Permissible surface irregularities when measured with a 3 m straight edge or template	:	5 mm

6.6.2. Cast in Situ Superstructure

a)	Variations in thickness of top and bottom slab for box girders, top and bottom flange for T-girders or slabs	:	-5 mm to + 10 mm
b)	Variations in web thickness	:	-5 mm to +10 mm
c)	Variations in overall depth or width	:	±5 mm
d)	Variation in length overall and length between bearings	:	shall not exceed or ±0.1 per cent of the span length, whichever is lesser
e)	Permissible surface irregularities when measured with a 3 m straight edge or template	:	5 mm

6.7. TESTS AND STANDARDS OF ACCEPTANCE

The materials shall be tested in accordance with these specifications and shall meet the prescribed criteria. The work shall conform to these specifications and shall meet the prescribed standards of acceptance.

6.8. MEASUREMENTS FOR PAYMENT

Concrete in superstructure shall be measured in accordance with Section 1700, based on the quantity ordered or as shown on the drawings.

Steel reinforcement (untensioned) in superstructure shall be measured in accordance with Section 1600, based on the quantity ordered or as shown on the drawings.

High tensile steel (prestressing) in superstructure shall be measured in accordance with Section 1800, based on the quantity ordered or as shown on the drawings.

6.9. RATE

The contract unit rates for concrete, steel reinforcement (untentesioned) and high tensile steel (prestressing) shall include all works as given in respective sections of these specifications and cover all incidental items for furnishing and providing superstructure as mentioned in this section.

7. REPLACEMENT/RECTIFICATION OF BEARINGS

- The replacement/rectification of bearings shall be carried out in accordance. With approved repair plan or as approved by the Engineer-in-charge.

- Lifting of Superstructure spans may be carried out by jacking up from below or by lifting the span from top. Where jacks are employed, their location/number and size shall be selected in such a manner so that there are no undue stresses created in the structure. Jacks may be placed on piers/pier caps or specially erected trestles in accordance with the approved methodology for lifting of superstructure. All jacks shall be operated from one control panel by a single control lever. The system will have provision for manual over ride to control die loads of any particular jack. The jacks should be so synchronized that differential lift between individual jacks shall not exceed 1 mm.

- Necessary repair/replacement of bearings shall be carried out as indicated in the repair plan or as directed by the Engineer-in-charge. Care shall be taken to plan the execution of repair in the shortest possible period.

- Precautions during Lifting of Girders for Rectification of Bearings walkie talkies system or similar audio arrangements should be available for communicating instructions regarding lifting, stopping, starting etc. The operator shall have a clear view of the jacks and the lifting of each girder controlled by reading the dial gauges.

8. DISMANTLING OF CONCRETE WEARING COAT

8.1 Commencement of Dismantling

i) Before commencing dismantling, the nature and condition of concrete, the condition and position of reinforcement should be ascertained. The Contractor shall familiarize himself with the structural design and ensure that the overall stability of the bridge is not affected.

ii) The existing expansion joint assemblies shall be removed carefully along the entire width of the carriageway. The deck slab for a width of 400 mm on either side should be removed for placing of reinforcement, anchor rods, anchor bolts and other fixing assemblies for the new expansion joints and pouring of fresh concrete. The gap between the girders over the piers should be cleared of all debris a temporary platform in the gap at the end of girders shall be erected to collect the materials falling down during concreting and fixing of expansion joints.

iii) The service lines, if any, shall be disconnected/ diverted before the dismantling work starts.

8.2 Dismantling of concrete wearing coat shall be carried out using jack hammers or suitable manual methods as approved by the Engineer-in-charge. Care should be taken to avoid any damage to the existing structure including reinforcement or prestressing anchorages for cables, if any, located in the deck slab.

8.3 PRECAUTIONS DURING DISMANTLING WORK

Dismantling work shall not be carried out at night, or during storm or heavy rain. A warning device shall be installed in the area to be used to warn the workers in case of mishap/emergency.

Safety helmets conforming to IS:2925 shall be used by the workmen engaged in dismantling work. The sheds and tool boxes should be located away from the work site. Goggles preferably made up of celluloid's and gas masks shall be worn at the time of dismantling, especially where tools like jack hammers are deployed to protect eyes from injuries from flying pieces, dirt, dust etc. Leather or rubber gloves shall be worn by the workers during the demolition of RCC work. Screens made up of GI sheets shall be placed wherever necessary to prevent the flying pieces from injuring the workers.

Water should be sprayed to reduce the dust while removing concrete wearing course with jack hammer. No work shall be taken up under the span when dismantling work is in progress.

8.4 EXTERNAL PRESTRESSING

Various components constituting the system of external prestressing are as follows:

H.T. Strands/Wires, HDPE Sheathing, Deviator Blocks, Anchor Plates, Anchorages and grouting material.

8.4.1 Material

H.T. Strands / Wires:
H.T. Strands wires shall conform to Section 1000.

HDPE Sheathing:

HDPE Sheathing shall conform to IS:4984 suitable for a working pressure of 6 bars. Its density shall be 955 kg/cum, shore hardness D63, yield stress 24 MPa and ultimate tensile strength 35 MPa.

Deviator Blocks:
As necessitated by the profile of the external cable, suitable strand/ wire deviator block fabricated from M.S. Sections shall be provided. The deviator block shall be given a coat of suitable paint (preferably epoxy based) after sand blasting.

Anchorages: Depending upon the prestressing force, suitable anchorages and wedges shall be used conforming to relevant codes and section 1800.

8.4.2 Workmanship

a) Stressing of cables shall be carried out as per instructions given in the drawing, and conforming to Section 1800.

b) Care should be taken to avoid any damage to the existing structure by way of stress concentration or any other reason during fixing of the deviator blocks and after stressing of cable. The deviator blocks shall be so fined as not to allow any movement due to prestressing forces, Radius of curvature of the surface of the deviator block interfacing with the cable shall be minimum one meter.

c) The anchorages shall be sealed with suitable epoxy mortar system after the stressing of cables. A minimum cover of 50mm shall be provided for the anchor plates and anchorages.

d) Suitable grouting inlet points and vent points shall be provided by way of HDPE "T" vent connections to the sheathing.

e) Grouting of cables shall be carried out as per provisions made in Section 1800.

8.4.3 It shall be ensured that no part of the existing structure is damaged/distressed due to the external prestressing.

The behavior of the girder shall be monitored by measurement of deflection so that only required amount of external prestressing is imparted to the girder. Care shall be taken to avoid excess prestressing and impairment to the girders.

9. TESTS AND STANDARDS OF ACCEPTANCE

The materials shall be tested in accordance with these Specifications and shall meet the prescribed criteria.

The work shall conform to these Specifications and shall meet the prescribed standards of acceptance.