

- as initial load test value. The number of initial tests shall be determined by the Engineer taking into consideration the bore log and soil profile.
- iv) Lateral load tests shall be carried out for estimating the lateral load capacity of the piles. The test procedure shall be carried out as per IS 2911 part IV. However the permissible deflection shall be as per IRC:78.
 - v) In particular cases where upper part of pile is likely to be exposed later due to scour, then the capacity contributed by that portion of the pile during load test, shall be accounted for.

1113.2 Routine Load Tests

Routine load test shall be carried out at actual locations of foundations of bridges to re-confirm or modify the allowable loads. The lateral load test may be conducted on two adjacent piles. However, results of routine load tests shall not be used for upward revision of design capacity of piles. The minimum number of tests to be conducted for confirming the capacity shall be as per Table 1100-3.

Table 1100-3 : Minimum Number of Tests

Total Number of Piles for the Bridge	Minimum Number of Test Piles
Upto 50	2
50-150	3
Beyond 150	2% of total piles (fractional number rounded to next higher integer number)

Note: The number of tests may be judiciously increased depending upon the variability of foundation strata. For determining the number of piles to be tested for the routine test the total no. of piles under all structures of left and right carriageway and the service road shall be taken together provided length and diameters of the piles are the same.

1113.3 Permissible Overload

While conducting routine test on one of the piles belonging to a pile group, if the pile capacity is found to be deficient (based on the settlement criteria of 12 mm for piles of diameter up to and including 600 mm and 2 percent of the pile diameter for piles of diameter more than 600 mm at 1.5 times the design load) an overload up to 10 percent of the capacity may be allowed.

1113.4 For a quick assessment of pile capacity, strain dynamic tests may be conducted after establishing co-relation using the results of load tests. However, results of strain dynamic tests shall not be used for upward revision of design capacity of pile. Detailed guidelines and references are given in IRC:78. These methods can be followed.

To have a fairly good idea about the quality of concrete and construction defects like voids, discontinuities etc., pile integrity tests are extensively conducted. Detailed guidelines in this connection are given in IRC:78.

1114 PILE CAP

Casting of pile cap should be at a level higher than low water level unless functionally required to be below low water level. In such cases dewatering shall be resorted to allow concreting in dry conditions. Pile caps shall be of reinforced concrete. A minimum offset of 150 mm shall be provided beyond the outer faces of the outermost piles in the group. If the pile cap is in contact with earth at the bottom, a leveling course of minimum 80 mm thickness of M 15 nominal mix concrete shall be provided. In marine conditions or areas exposed to the action of harmful chemicals, the pile cap shall be protected with a coating such as bituminous based coaltar epoxy or epoxy based coating or with suitable anti corrosive paint. Concrete with high alumina cement, shall not be used in marine environment.

The attachment of the pile head to the cap shall be adequate for the transmission of loads and forces. A portion of pile top may be stripped of concrete and the reinforcement anchored into the cap. Manual chipping may be permitted three days after casting of pile, while pneumatic tools for chipping shall be permitted only seven days after casting of pile. The top of pile after stripping shall project at least 50 mm into the pile cap.

The top of concrete in a pile shall be brought above cut-off level to permit removal of all laitance and weak concrete before pile cap is laid. This will ensure good concrete at the cut-off level.

1115 IMPORTANT CONSIDERATIONS, INSPECTION/PRECAUTIONS FOR DIFFERENT TYPES OF PILES

1115.1 Driven Cast In-Situ Piles

1115.1.1 Specialist literature and the guidelines from the pile construction industry shall be consulted regarding the method of installation, equipment and accessories for pile driving and recording of data.

1115.1.2 During installation of piles, the final "set" of penetration of pile per blow of hammer shall be checked taking an average of last 10 blows.

1115.1.3 The pile shoes which may be of either cast iron conical type or mild steel flat type shall have double reams for proper seating of the removable casing tube inside the space between the reams.

1901 DESCRIPTION

This work shall include furnishing, fabricating, transporting, erecting and painting structural steel, rivet steel, cast steel, steel forgings, cast iron and other incidental metal construction of the kind, size and quantity in conformity with the drawings and these Specifications or as directed by the Engineer.

1902 GENERAL

General requirements relating to the supply of material shall conform to the Specifications of IS:1387, for the purpose of which the supplier shall be the Contractor and the purchaser shall be the Engineer.

Finished rolled material shall be free from cracks, flaws, injurious seams, laps, blisters, ragged and imperfect edges and other defects. It shall have a smooth and uniform finish, and shall be straightened in the mill before shipment. It shall also be free from loose mill scale, rust, pits or other defects affecting its strength and durability.

The acceptance of any material on inspection at the rolling mill, foundry or fabricating plant where material for the work is manufactured, shall not be a bar to its subsequent rejection, if found defective.

Unless otherwise specified, high tensile steel rivets conforming to IS:1149 shall be used only for members of high tensile steel conforming to IS:961 and shall not be used for members of mild steel.

Unless otherwise specified, bolted connection of structural joints using high tensile friction grip bolts shall comply with requirements of IS:4000.

Cast iron shall not be used in any part of the bridge structure, except where it is subject to direct compression.

1903 MATERIALS

1903.1 All materials shall conform to Section 1000 of these Specifications. Special requirements are given below:

Mild steel for bolts and nuts shall conform to IS:226 but have a minimum tensile strength of 44 kg/sq.mm and minimum percentage elongation of 14.

High tensile steel for bolts and nuts shall conform to IS:961 but with a minimum tensile strength of 58 kg/sq.mm.

Use of high strength friction grip bolts shall be permitted only on satisfactory evidence of performance to the requirements (not covered by these Specifications) specified by the Engineer or as laid down in special provisions.

For cast steel, the yield stress shall be determined and shall not be less than 50 percent of the minimum tensile strength.

Plain washers shall be of steel. Tapered or other specially shaped washers shall be of steel or malleable cast iron.

Parallel barrel drifts shall have a tensile strength not less than 55 kg/sq.mm with elongation of not less than 20 percent measured on a gauge length of $4 \sqrt{S_o}$.

(S_o = cross-sectional area).

1903.2 Materials for castings and forgings, fasteners, welding consumables and welding shall be as under :

1903.2.1 Castings and Forgings

Steel castings and forgings shall comply with the requirements of the following Indian Standards, as appropriate :

IS:1030	Carbon Steel Castings for General Engineering purposes
IS:1875	Carbon Steel Billets, blooms, slabs, bars for forgings
IS:2004	Carbon Steel Forgings for General Engineering purposes
IS:2644	High Tensile Steel Castings
IS:2708	1.5 Percent Manganese Steel Castings
IS:4367	Alloy and tool steel forgings for general industrial use

1903.2.2 Fasteners

Bolts, nuts washers and rivets shall comply with the following or relevant Indian Standards as appropriate :

IS:1148	Hot rolled rivet bars (up to 40 mm dia) for structural purposes
IS:1149	High tensile steel rivet bars for structural purposes
IS:1363	Hexagon head bolts, screw and nuts product grade C (Parts 1 to 3)
IS:1364	Hexagon head bolts, screw & nuts product grade A and B (Parts 1 to 3)

IS:1367	Technical supply conditions for threaded steel fastener (Parts 1 to 18)
IS:1929	Hot forged steel rivets for hot closing (12-36 mm dia)
IS:2155	Cold forged steel rivets for hot closing (6-16 mm dia)
IS:3640	Hexagon fit bolts
IS:3757	High strength structural bolts
IS:4000	High strength bolts in steel structures
IS:5369	Plain washers and lock washers – general requirements
IS:5370	Plain washers with outside dia = 3 X inside dia
IS:5372	Taper washers for channels (ISMC)
IS:5374	Taper Washers for I beams (ISMB)
IS:5624	Foundation bolts
IS:6610	Heavy washers for steel structures
IS:6623	High strength structural nuts
IS:6639	Hexagon bolts for steel structures
IS:6649	Hardened and tempered washers for high strength structural bolts and nuts.
IS:7002	Prevailing torque type steel hexagon nuts

1903.2.3 Welding Consumables

Welding consumables shall comply with the following Indian Standards as appropriate :

IS:814 (Part 1)	Covered Electrodes for Metal Arc Welding of Structural steel for welding other than sheets
IS:814 (Part 2)	For welding sheets
IS:1395	Low and medium alloy steel covered electrodes for manual Metal Arc Welding
IS:3613	Acceptance Tests for wire flux combinations for submerged arc welding of structural steel
IS:6419	Welding rods and bare electrodes for gas shielded arc welding of structural steel
IS:6560	Molybdenum and chromium-molybdenum low alloy steel welding rods and bare electrodes for gas shielded arc welding

IS:7280 Bare wire electrodes for gas shielded arc welding of structural steel

1903.2.4 Welding

IS:812 Glossary of terms relating to welding and cutting of metals

IS:816 Code of practice for use of metal arc welding for general construction in mild steel

IS:822 Code of procedure for inspection of welds

IS:1024 Code of practice for use of welding in bridges and structures subject to dynamic loading

IS:1182 Recommended practice for radiographic examination of fusion welded butt joints in steel plates

IS:4853 Recommended practice for radiographic inspection of fusion welded butt joints in steel pipes

IS:5334 Code of practice for magnetic particle flaw detection of welds

IS:7307 Approval tests for welding procedures : Part 1 fusion welding of steel

IS:7310 Approval tests for welders working to approved welding procedures : Part 1 fusion welding of steel

IS:7318 Approval tests for welders when welding procedure is not required : Part 1 Fusion welding of steel

IS:9595 Recommendations for metal arc welding of carbon and carbon manganese steels

1903.3 Corrosion resistant steel to be used in aggressive environment shall be low alloy steels containing a total of 1 percent to 2 percent alloys, in particular copper, chromium, nickel and phosphorous.

1903.4 Paints

All materials for paints and enamels shall conform to the requirements specified on the drawings or other special provisions laid down by the Engineer.

The type of paints which can be used shall be as follows :

- a) Ordinary i.e. paints based on drying oils, alkyd resin, modified alkyd resin, phenolic varnish epoxy

- b) Chemical Resistant – one pack type (ready for use) or two pack type (mixed before use).
- c) Vinyl
- d) Chlorinated rubber
- e) Bituminous - (IS:9862)
- f) Epoxy - (IS:14925)
- g) Polyurethane - (IS:13759)
- h) Zinc rich - (IS:14589)

Unless otherwise specified, paints shall conform to the relevant Indian Standards. Paints shall be tested for the following qualities as per Specifications given in the relevant IS codes:

- Weight (for 10 litres of paint, thoroughly mixed)
- Drying time
- Consistency
- Dry thickness and rate of consumption

1904 FABRICATION

1904.1 General

All work shall be in accordance with the drawings and as per these Specifications. Fabrication work shall be taken up only after receipt of approved fabrication/working drawings. It shall be ensured that all parts of an assembly fit accurately together. All members shall carry mark number and item number and, if required, serial number. Method of marking shall be commensurate with the process of manufacture and such as to ensure retention of identity at all stages.

Unless specifically required under the contract, corresponding parts need not be interchangeable, but the parts shall be match marked as required under Clause 1904.9.

Templates, jigs and other appliances used for ensuring the accuracy of the work shall be of mild steel; where specially required, these shall be bushed with hard steel. All measurements shall be made by means of steel tape or other device properly calibrated. Where bridge materials have been used as templates for drilling, these shall be inspected and passed by the Engineer before they are used in the finished structure.

All structural steel members and parts shall have straight edges and plane surfaces. They shall also be free from twist. If necessary, they shall be straightened or flattened by pressure

unless they are required to be of curvilinear forms. Adjacent surfaces or edges shall be in close contact or at uniform distance throughout.

The Contractor shall submit his programme of work to the Engineer for his approval at least 15 days before the commencement of fabrication, which shall include the proposed system of identification and erection marks together with complete details of fabrication and welding procedures. He shall also submit for approval of Engineer, a Quality Assurance Plan according to the nature of fabrication work (whether welded or riveted) which should clearly define the points of checking and inspection during the stages of fabrication as well as supply of materials.

The Contractor shall prepare shop drawings for fabrication of any member and obtain approval of the Engineer before the start of work. Complete information regarding the location, type, size and extent of all welds shall be clearly shown on the shop drawings. These drawings shall distinguish between shop and field welds.

1904.2 Laminations in Plates

The following areas of plates shall not have laminations:

- a) Steel plates and sections in which tension stresses are transmitted through thickness of plate or in region in which lamination could affect the buckling behavior and bending compression,
- b) On each side of welded bearing diaphragm, strip of flange and web plate for a length equal to 25 times their thickness.
- c) The strip of web plate for a length of 25 times its thickness on each side of single sided bearing stiffener welded to web.
- d) For welded cruciform joints transmitting tensile stress through the plate thickness, for a length 4 times the thickness of plate on each side of attachment.
- e) For edges of plates where corner welds are provided on the surface of such plates.
- f) Other areas of plates or sections as may be specified by the Engineer.

1904.3 Straightening and Bending

1904.3.1 The straightening of plates, angles and other shapes shall be done by methods not likely to produce fracture or any injury to the metal. Hammering shall not be permitted. Heating, if permitted by the Engineer in special cases, shall be followed by as slow cooling as possible. Following the straightening of a bend or buckle, the surface shall be carefully inspected for evidence of fracture. Sharp kinks and bends may lead to rejection of material.

1904.3.2 Straightening by heating shall be done under controlled procedure. Temperature of the steel shall not be more than 650°C. Heating and cooling rate shall be appropriate to the particular type of steel and shall be as agreed and approved by the Engineer. Accelerated cooling shall not be carried out without the approval of the Engineer.

1904.3.3 Bending and Curving

Steel having yield stress more than 360 MPa shall not be heat curved. Rolled beams and girders may be curved by either continuous or V-type heating as approved by Engineer.

- a) For the continuous method, a strip of sufficient length along the edge of top and bottom flange shall be heated simultaneously to desired temperature to obtain required curve.
- b) For V-type of heating, the top and bottom flanges shall be heated in truncated triangular or wedge-shaped areas having their base along the flange edge and spaced at regular intervals along each flange. The truncate triangular pattern shall have an angle 15 to 30 with base not more than 250 mm long. The spacing and temperature shall be as required to obtain the required curvature and heating shall be at approximately the same rate along the top and bottom flanges.

For flange thickness of 32 mm or more, both inside and outside surfaces shall be heated concurrently.

The heat bending shall be conducted so that the temperature of steel does not exceed 620°C. The girder shall not be artificially cooled until temperature comes down to 315°C by natural cooling. The method of artificial cooling shall be as approved by Engineer.

Camber for rolled beams may be obtained by heat curving methods approved by Engineer. For camber in plate girders, the web shall be cut to prescribed camber with suitable allowance for shrinkage due to cutting, welding and heat curving.

1904.4 Preparation of Edges and Ends

1904.4.1 All structural steel parts, where required, shall be sheared, cropped, sawn or flame cut and ground accurately to the required dimension and shape. Material shall be cleaned and any burrs, scales or abnormal irregularities shall be removed.

1904.4.2 End/edge planing and cutting shall be done by any one of the following prescribed methods or left as rolled:

- a) Shearing, cropping, sawing, machining, machine flame cutting.
- b) Hand flame cutting with subsequent grinding to a smooth edge.

Sheared edges of plate not more than 16 mm thick, which are for secondary use such as stiffeners and gussets, shall be subsequently ground to smooth profile.

If ends of stiffeners are required to be fitted, they shall be ground, so that the maximum gap over 60 percent of the contact area does not exceed 0.25 mm.

1904.4.3 Where flame cutting or shearing is done, at least one of the following requirements shall be satisfied.

- a) The cut edge is not subjected to applied stress.
- b) The edge is incorporated in weld.
- c) The hardness of cut edge does not exceed 350 HV 30.
- d) The material is removed from edge to the extent of 2 mm or minimum necessary, so that the hardness is less than 350 HV 30.
- e) Edge is suitably heat treated by approved method to the satisfaction of the Engineer and it is shown by dye penetrant or magnetic particle test that cracks have not developed.
- f) Thickness of plate is less than 40 mm for machine flame cutting of materials conforming to IS:2062 up to Grade E250 (Fe 410w). The requirement of hardness below 350 HV 30 of flame cut edges shall be specified by the Engineer.

The flame cut edges shall be ground or machined over and above the requirements in (a) to (f), wherever specified by the Engineer.

1904.4.4 Where machining for edge preparation in butt joint is specified, the ends shall be machined after the members have been fabricated.

Outside edges of plate and section, which are prone to corrosion shall be smoothed by grinding or filing.

In the case of high tensile steel at least 6 mm of the material from the flame cut edge shall be removed by machining.

Longitudinal edges of all plates and cover plates in plate girders and built-up members shall be machined except in the following cases:

- a) Rolled edges of single universal plates or flats
- b) Covers to single flange plates.
- c) Edges of single plates in compression and edges of single plates of thickness 25 mm or less, in tension, where machine flame cutting is acceptable.

- d) Edges of single shaped plates over 2 mm thick not capable of being machined by ordinary method, which may be machine flame cut and the end surface ground.
- e) Edges of universal plates or flats of the same nominal width used in tiers, if so authorized by the Engineer.

All edges of splice and gusset plates 12 mm thick and over, shall be machined and those less than 12 mm thick shall be sheared and ground.

The ends of plates and sections forming the main components of plate girders or of built-up members shall be machined, machine flame cut, sawn or hand flame cut and ground.

Where ends of stiffeners are required to be fitted, they shall be machined, machine flame cut, sawn, sheared and ground or hand flame cut and ground.

The ends of lacing bar shall be rounded unless otherwise specified.

Other edges and ends of mild steel parts shall be sheared and any burrs at edges shall be removed.

1904.5 Preparation of Holes

1904.5.1 Drilling and Punching

Holes for rivets, black bolts, high strength bolts and countersunk bolts/rivets (excluding close tolerance and turn fitted bolts) shall be either punched or drilled. For bolts/rivets less than 25 mm dia, the diameter of holes shall be 1.5 mm larger while for those of 25 mm dia or more, the diameter of holes shall be 2 mm larger than the diameter of the bolt/rivet.

All holes shall be drilled except those for secondary members such as floor plates, hand rails etc. Members which do not carry the main load can be punched subject to the thickness of member not exceeding 12 mm for material conforming to IS:2062 up to Grade E250 (Fe 410w).

Holes through material of more than one thickness or through main material thickness exceeding 20 mm for steel conforming to IS:2062 up to Grade E250 (Fe 410w) or 16 mm for steel conforming to IS:2062 up to Grade E300 (Fe 440w) and above, shall either be sub-drilled or sub-punched to a diameter of 3 mm less than the required size and then reamed to the required size. The reaming of material more than one thickness shall be done after assembly.

Where several plates or sections form a compound member, they shall, where practicable, be firmly connected together by clamps or tacking bolts and the holes shall be drilled through

the group in one operation. Alternatively, and in the case of repetition work, the plates and sections may be drilled separately from jigs and templates. Jigs and templates shall be checked at least once after every 25 operations. All burrs shall be removed.

In the case of repetition of spans, the erection of every span shall not be insisted upon, except where close tolerance or turned bolts are used, provided that methods are adopted to ensure strict interchangeability. In such cases, one span in ten or any number less than ten of each type shall be erected from pieces selected at random by the Engineer and should there be any failure of the pieces to fit, all similar spans shall be erected complete. In the event of spans being proved completely interchangeable, all corresponding parts shall carry the same mark so that sorting of the materials at site is facilitated.

1904.5.2 Block Drilling

Where the number of plates to be riveted exceeds three or the total thickness is 90 mm or more, the rivet holes, unless they have been drilled through steel bushed jigs, shall be drilled out in place 3 mm all round after assembling. In such cases, the work shall be tightly bolted together.

1904.5.3 Size of Holes

The diameters of rivet holes in millimetres are given in Table 1900-1.

Table 1900-1 : Diameters of Holes for Rivets

Nominal dia of Rivets (mm)	Dia of Holes (mm)
12	13.5
14	15.5
16	17.5
18	19.5
20	21.5
22	23.5
24	25.5
27	29.0
30	32.0
33	35.0

1904.5.4 Close Tolerance Bolts and Barrel Bolts

For close tolerance or turn fitted bolts, the diameter of the holes shall be equal to the nominal diameter of the bolt shank + 0.15 mm to - 0.0 mm.

The members to be connected with close tolerance or turn fitted bolts shall be firmly held together by service bolts or clamped and drilled through all thicknesses in one operation and subsequently reamed to required size within specified limit of accuracy as specified in IS:919 tolerance grade H8.

The holes not drilled through all thicknesses in one operation shall be drilled to smaller size and reamed after assembly.

1904.5.5 Holes for High Strength Friction Grip Bolts

All holes shall be drilled after removal of burrs. Where the number of plies in the grip does not exceed three, the diameters of holes shall be 1.5 mm larger than those of bolts. Where the number of plies in the grip exceeds three, the diameters of holes shall be as follows, unless otherwise specified by the Engineer:

- in outer plies 1.5 mm larger than diameter of bolts
- in inner plies not less than 1.5 mm and not more than 3.0 mm
larger than diameter of bolts

1904.5.6 Removal of Burrs

The work shall be taken apart after drilling and all burrs left by drilling and the sharp edges of all rivet holes completely removed.

1904.6 Rivets and Riveting

1904.6.1 The riveting shall be done by hydraulic or pneumatic machine unless otherwise specified by Engineer. The driving pressure shall be maintained on the rivets for a short time after the upsetting is completed.

1904.6.2 The diameter of rivets shown on the drawings shall be the size before heating. Each rivet shall be of sufficient length to form a head of the standard dimensions as given in IS handbook on Steel Sections, Part-I. The underside of the head shall be free from burrs.

1904.6.3 The tolerance on the diameter of rivets shall be in accordance with IS:1148 for mild steel rivets and IS:1149 for high tensile steel rivets. Unless otherwise specified, the tolerance shall be minus.

1904.6.4 When countersunk head is required, the head shall fill the countersunk hole and projection after countersinking shall be ground off wherever necessary. The included angle of the head shall be as follows:

- | | | |
|----|---|------------|
| a) | For plates over 14 mm thickness | 90 degree |
| b) | For plates upto and including 14 mm thickness | 120 degree |

1904.6.5 Mild steel rivets shall be heated uniformly to a light cherry red colour between 650°C to 700°C for hydraulic riveting and orange colour for pneumatic riveting. High tensile steel rivets shall be heated up to 1100°C. The rivets shall be red hot from head to the point when inserted and shall be upset in its entire length so as to fill the hole as completely as possible when hot. After being heated and before being inserted in the hole, the rivet shall be made free from scale by striking it on a hard surface. Any rivet whose point is heated more than the prescribed limit, shall not be driven.

Where flush surface is required, any projecting metal shall be chipped or ground off.

1904.6.6 Before riveting is commenced, the parts/members to be riveted shall be firmly drawn together with bolts, clamps or tack welds so that the various sections and plates are in close contact throughout. Every third hole of the joint shall have assembly bolts till riveted. Drifts shall only be used for drawing the work into position and shall not be used to such an extent as to distort the holes. Drifts of a larger size than the nominal diameter of the hole shall not be used.

1904.6.7 Driven rivets, when struck sharply on the head by a quarter pound rivet testing hammer, shall be free from movement and vibrations. Assembled riveted joint surfaces, including those adjacent to the rivet heads, shall be free from, dirt, loose scale, burrs, other foreign materials and defects that would prevent solid seating of parts.

1904.6.8 All loose or burnt rivets, rivets with cracked or badly formed defective heads or rivets with heads which are unduly eccentric with the shanks, shall be removed and replaced. In removing rivets, the head shall be sheared off and the rivet punched out so as not to damage the adjacent metal. If necessary, the rivets shall be drilled out. Re-cupping or re-caulking shall not be permitted. The parts not completely riveted in the shop shall be secured by bolts to prevent damage during transport and handling.

1904.7 Bolts, Nuts and Washers

1904.7.1 Black Bolts (Black All Over)

Black bolts are forged bolts in which the shanks, heads and nuts do not receive any further treatment except cutting of screw threads. They shall be true to shape and size and shall have the standard dimensions as shown on the drawings.

1904.7.2 Close Tolerance Bolts

Close tolerance bolts shall be faced under the head and turned on the shank.

1904.7.3 Turned Barrel Bolts

The diameter of the screwed portion of turned barrel bolts shall be 1.5 mm smaller than the diameter of the barrel unless otherwise specified by the Engineer. The diameter of the bolts as given on the drawing shall be the nominal diameter of the barrel. The length of the barrel shall be such that it bears fully on all the parts connected. The threaded portion of each bolt shall project through the nut by at least one thread. Faces of heads and nuts bearing on steel work shall be machined.

1904.7.4 High Strength Friction Bolts and Bolted Connections

The general requirement shall be as per relevant IS Specifications mentioned in **Clause 1903.2.2**. Unless otherwise specified by the Engineer, bolted connections of structural joints using high tensile friction grip bolts shall comply with requirements mentioned in IS:4000.

1904.7.5 Washers

In all cases where the full bearing area of the bolt is to be developed, the bolt shall be provided with a steel washer under the nut of sufficient thickness to avoid any threaded portion of the bolt being within the thickness of the parts bolted together and to prevent the nut when screwed up, from bearing on the bolt.

For close tolerance or turned barrel bolts, steel washers whose faces give a true bearing shall be provided under the nut. The washer shall have a hole diameter not less than 1.5 mm larger than the barrel and thickness not less than 6 mm so that the nut, when screwed up, will not bear on the shoulder of the bolt.

Taper washer, with correct angle of taper, shall be provided under all heads and nuts bearing on bevelled surfaces.

Spring washers may be used under nuts to prevent slackening of the nuts when excessive vibrations occur.

Where the heads or nuts bear on timber, square washers having a length of each side not less than three times the diameter of bolts or round washers having a diameter of $3\frac{1}{2}$ times the diameter of bolts and with a thickness not less than one quarter of diameter, shall be provided.

1904.7.6 Studs

Ordinary studs may be used for holding parts together, the holes in one of the parts being tapped to take the thread of the stud. Countersunk studs may be used for making connections

where the surfaces are required to be clear of all obstruction, such as protruding heads of bolts or rivets. Studs may also be welded on the steel work in the positions required.

1904.7.7 Service Bolts

Service bolts shall have the same clearance as black bolts and where it is required that there should be no movement prior to final riveting, sufficient drifts or close tolerance bolts shall be used to locate the work.

1904.7.8 Tightening Bolts

Bolted connection joints with black bolts and high strength bolts shall be inspected for compliance of code requirements.

All joint surfaces for bolted connection including bolts, nuts and washers shall be free of scale, dirt, burrs, other foreign material and other defects that would prevent solid seating of parts. The slope of surface of bolted parts in contact with bolt head and nuts shall not exceed 1:20 plane normal to bolt axis; otherwise suitable tapered washer shall be used.

All fasteners shall have a washer under nut or bolt head, whichever is turned in tightening.

Each fastener of joint shall be tightened to specified value or to 70 percent of specified minimum tensile strength by hand wrenches (turn of nut method) or calibrated wrenches, manual torque wrenches, impact wrench or any other method specified by the Engineer.

When 'turn of nut' method is used for tightening the bolts in a joint, all bolts shall be first brought to snug-tight condition i.e. tightening by full manual effort using ordinary wrench or by a few impacts of any impact wrench. All bolts in the joint shall then be tightened additionally by applicable amount of nut rotation as specified in IS:4000.

The Engineer shall observe the installation and tightening of bolts to ensure that correct tightening procedure is used and all bolts are tightened. Regardless of tightening method used, tightening of bolts in a joint should commence at the most rigidly fixed or stiffest point and progress towards the free edges, both in initial snugging and in final tightening.

The tightness of bolts in connection shall be checked by inspection wrench, which can be torque wrench, power wrench or calibrated wrench.

Tightness of 10 percent bolts, but not less than two bolts, selected at random in each connection shall be checked by applying inspection torque. If no nut or bolt head is turned by this application, connection can be accepted as properly tightened, but if any nut or head has turned, all bolts shall be checked and, if necessary, re-tightened.

1904.7.9 Drifts

The barrel shall be drawn or machined to the required diameter for a length of not less than one diameter over the combined thickness of the metal through which the drifts have to pass. The diameter of the parallel barrel shall be equal to the nominal diameter of the hole subject to a tolerance of +0 mm and - 0.125 mm. Both ends of the drift for a length equal to $1\frac{1}{2}$ times the diameter of the parallel portion of the bar, shall be turned down with a taper to a diameter at the end equal to one-half that of parallel portion.

1904.8 Pins and Pin Holes**1904.8.1 Pins**

The pins shall be parallel throughout and shall have a smooth surface free from flaws. They shall be of sufficient length to ensure that all parts that they connect, shall have a full bearing on them. Where the ends are threaded, they shall be turned to a smaller diameter at the ends for the thread and shall be provided with a pilot nut, where necessary, to protect the thread when being drawn to place. To facilitate insertion and extraction, pins may be chamfered beyond the required length and provided with suitable holes in the chamfered portion.

Pins more than 175 mm in length or diameter shall be forged and annealed.

1904.8.2 Pin Holes

Pin holes shall be bored smooth, straight and true to gauge at right angles to the axis of the member and parallel with each other, unless otherwise required. The tolerance in the length of tension members from outside to outside of pin holes and of compression members from inside to inside of pin holes shall be 1 mm. In built-up members, the boring shall be done only after the members have been finally riveted, welded or bolted unless otherwise approved by Engineer.

The specified diameter of the pin hole shall be its minimum diameter. The resulting clearance between the pin and the hole shall not be less than 0.5 mm and not more than 1 mm.

1904.9 Shop Erection and Match Marking

Before being dispatched, the steel work shall be temporarily erected in the fabrication shop for inspection by the Engineer either wholly or in such portion as the Engineer may require, so that he may be satisfied in respect of both the alignment and fit of all connections. For this purpose, sufficient number of parallel drifts and service bolts tightly screwed up, shall be employed. All parts shall fit accurately and be in accordance with drawings and specifications.

The steel work shall be temporarily assembled at place of fabrication. Assembly shall be of full truss or girder, unless progressive truss or girder assembly, full chord assembly, progressive chord assembly or special complete structure assembly, is specified by the Engineer.

The camber diagram showing camber at each panel point, method of shop assembly and any other relevant detail, shall be submitted to Engineer for approval.

The field connections of main members of trusses, arches, continuous beams, spans, bends, plate girders and rigid frame shall be assembled, aligned and accuracy of holes and camber checked by the Engineer. Only thereafter shall reaming of sub-sized holes to specified size, be taken up.

The assembly shall be dismantled only after final drilling of holes has been completed and the work has been passed by the Engineer. Before dismantling, each part shall be carefully marked for re-erection with distinguishing marks and stamped with durable markings. Drawings showing these markings correctly shall be supplied to the Engineer.

Unloading, handling and storage of steel work as per these Specifications shall be the responsibility of the Contractor. The cost of repairs, removal of rejected material, and transportation of replacement material to the site, shall be borne by the Contractor.

In cases where close tolerance or turned barrel bolts are used and interchangeability is not insisted upon, each span shall be erected and its members marked distinctly.

1904.10 Welding

1904.10.1 All welding shall be done with the prior approval of the Engineer and the workmanship shall conform to the specifications of the relevant Indian Standards as appropriate.

When material thickness is 20 mm or more, special precautions like pre-heating shall be taken as laid down in IS:9595. Surfaces and edges to be welded shall be smooth, uniform and free from fins, tears, cracks and other discontinuities. Surface shall also be free from loose or thick scale, slag rust, moisture, oil and other foreign materials. Surfaces within 50 mm of any weld location shall be free from any paint or other material that may prevent proper welding or cause objectionable fumes during welding.

The general welding procedures including particulars of the preparation of fusion faces for metal arc welding, shall be carried out in accordance with IS:9595.

The welding procedures for shop and site welds including edge preparation of fusion faces shall be as per details shown on the drawings and shall be submitted in writing for the approval of the Engineer, in accordance with Clause 22 of IS:9595, before commencing fabrication.

Any deviation from this procedure has to be approved by the Engineer. Preparation of edges shall, wherever practicable, be done by machine methods.

Machine flame cut edges shall be substantially as smooth and regular as those produced by edge planing and shall be left free of slag. Manual flame cutting shall be permitted by the Engineer only where machine cutting is not practicable.

Electrodes to be used for metal arc welding shall comply with relevant Indian Standards mentioned in Clause 1903.2.3. Procedure test shall be carried out as per IS:3613 to find out suitable wire-flux combination for welded joint.

Assembly of parts for welding shall be in accordance with provisions of Clauses 14 to 16 of IS:9595.

Welded temporary attachment should be avoided as far as possible. If unavoidable, the method of making any temporary attachment shall be as approved by the Engineer. Any scars from temporary attachment shall be removed by cutting and chipping and surface shall be finished smooth by grinding to the satisfaction of the Engineer.

Welding shall not be carried out when the air temperature is less than 10°C, when the surfaces are wet, during periods of strong winds and in snowy weather, unless the work and the welding operators are adequately protected.

1904.10.2 For welding of any particular type of joint, welders shall undergo the appropriate welders qualification test as prescribed in any of the relevant Indian Standards IS:817, IS:1966, IS:1393, IS:7307 (Part I), IS:7310 (Part I) and IS:7318 (Part I) to the satisfaction of the Engineer.

1904.10.3 In assembling and joining parts of a structure or of built-up members, the procedure and sequence of welding shall be such as to avoid distortion and minimize shrinkage stress.

All requirements regarding pre-heating of parent material and interpass temperature shall be in accordance with provisions of IS:9595.

1904.10.4 Peening of weld shall be carried out wherever specified by the Engineer :

- a) If specified, peening may be employed to be effective on each weld layer except the first filling layer.
- b) After weld has cooled, the peening should be carried out by light blows from a power hammer using a round nosed tool. Care shall be taken to prevent scaling or flaking of weld and base metal from over peening.

1904.10.5 Where the Engineer has specified that the butt welds are to be ground flush, the loss of parent metal shall not be greater than that allowed for minor surface defects. The ends of butt joints shall be welded so as to provide full throat thickness. This may be done by use of extension pieces, cross runs or other means approved by the Engineer. Extension pieces shall be removed after the joint has cooled and the ends of the weld shall be finished smooth and flush with the faces of the abutting parts.

1904.10.6 The following joints and welds which do not perform well under cyclic loading, are prohibited.

- a) Butt joints not fully welded throughout their cross-section
- b) Groove welds made from one side only without any backing grip
- c) Intermittent groove welds
- d) Intermittent fillet welds
- e) Bevel-grooves and J-grooves in butt joints for other than horizontal position
- f) Plug and slot welds

1904.10.7 The run-on and run-off plate extension shall be used for providing full throat thickness at the end of butt welded joints. These plates shall comply with the following requirements.

- i) One pair of run-on and one pair of run-off plates prepared from same thickness and profile as the parent metal shall be attached to start and finish of all butt welds, preferably by clamps.
- ii) When run-on and run-off plates are removed by flame cutting, they shall be cut at more than 3 mm away from the parent metal and the remaining metal of the plates shall be removed by grinding or by any other method approved by the Engineer.

1904.10.8 Welding of Stud Shear Connectors

The stud shear connectors shall be welded in accordance with the manufacturer's instructions including those relating to pre-heating.

The stud and the surface to which it is to be welded shall be free from scale, moisture, rust and other foreign material. The stud base shall not be painted, galvanised or cadmium plated prior to welding.

The welds shall be visually free from cracks and shall be capable of developing at least the nominal ultimate strength of studs.

The procedural trial for welding the stud shall be carried out when specified by the Engineer.

1904.11 Tolerances

Tolerances in dimensions of components of fabricated structural steel work shall be specified on the drawings and shall be subject to the approval of the Engineer before fabrication. Unless otherwise specified, all parts of an assembly shall fit together accurately within tolerances specified in Table 1900-2.

A machined bearing surface, where specified by the Engineer, shall be machined within a deviation of 0.25 mm for surfaces that can be inscribed within a square of side 0.5 m.

Table 1900-2 : Fabrication Tolerances - Individual Components

1)	Length		
	a)	Member with both ends finished for contact bearing	± 1 mm
	b)	Individual components of members with end plate connection	+ 0 mm - 2 mm
	c)	Other members of length i) Upto and including 12 M ii) Over 12 M	± 2 mm ± 3.5 mm
2)	Width		
	a)	Width of built-up girders	± 3 mm
	b)	Deviation in the width of members required to be inserted in other members	+ 0 mm - 3 mm
3)	Depth		
	Deviation in the depths of solid web and open web girders		+ 3 mm - 2 mm
4)	Straightness		
	a)	Deviation from straightness of columns	L/3000 subject to maximum of 15 mm where L is length of member
		i) in elevation ii) In plan	+ 5 mm - 0 mm L/1000 subject to a maximum of 10 mm
5)	Deviation of centre line of web from centre line of flanges in built-up members at contact surface		3 mm
6)	Deviation from flatness of plate of webs of built-up members in a length equal to the depth of the members		0.005 d to a maximum of 2 mm where d is depth of the member

7)	Tilt of flange of plate girders		
	a)	At splices and stiffeners, at supports, at the top flanges of plate girders and at bearings	0.005 b to a minimum of 2 mm where b is width of the member
	b)	at other places	0.015 b to a maximum of 4 mm where b is width of the member
8)	Deviation from squareness of flange to web of columns and box girders		$L/1000$, where L is nominal length of the diagonal
9)	Deviation from squareness of fixed base plate (not machined) to axis of columns. This dimension shall be measured parallel to the longitudinal axis of the column at points where the outer surfaces of the column sections make contact with the base plate		$D/500$, where D is the distance from the column axis to the point under consideration on the base plate
10)	Deviation from squareness of machined ends to axes of columns		$D/1000$, where D is as defined in 9 above
11)	Deviation from squareness of machined ends to axes of beams		$D/1000$, where D is as defined in 9 above
12)	Ends of members abutting at joints through cleats or end plates, permissible deviation from squareness of ends		$1/600$ of depth of member subject to a maximum of 1.5 mm

1904.12 Annealing and Stress Relieving

The members to be annealed or stress relieved as indicated in the contract or specified by Engineer, shall have finish machining, boring, etc., done subsequent to heat treatment. The stress relief treatment shall conform to the following unless otherwise specified by Engineer:

- a) The temperature of the furnace shall not be more than 300°C at the time welded assembly is placed in it.
- b) The rate of heating shall not be more than 220°C per hour divided by maximum metal thickness, subject to maximum of 220°C per hour.
- c) After maximum temperature of 600°C is reached, the assembly shall be held within specified limit of time based on weld thickness. The temperature shall be maintained uniformly throughout the furnace during holding period such that temperature at no two points on the member will differ by more than 80°C.
- d) The cooling shall be done in closed furnace when temperature is 300°C, at the maximum rate of 260°C per hour divided by maximum metal thickness. The local stress relieving shall be carried out if specified and procedure approved by Engineer.

1904.13 Rectification of Surface Defects

The surface defects revealed during fabrication or cleaning shall be repaired as specified. The repair by welding on any surface defect or exposed edge lamination shall be carried out only with approval of Engineer.

1904.14 Alignment at Splice and Butt Joints

Bolted splice shall be provided with steel packing plates where necessary, to ensure that the sum of any unintended steps between adjacent surfaces does not exceed 1 mm for HSFG bolted joints and 2 mm for other joints.

In welded butt joints, misalignment of parts to be joined shall not exceed the lesser of 0.15 times the thickness of thinner part or 3 mm. However, if due either to different thicknesses arising from rolling tolerances or a combination of rolling tolerances with above permitted misalignment, this deviation is more than 3 mm, it shall be smoothened by a slope not steeper than 1:4.

1905 ERECTION**1905.1 General**

These provisions shall apply to erection of steel bridge superstructures or steel main members of bridge superstructures, which span between supports.

If the substructure and the superstructure are built under separate contracts, the Employer will provide the substructure, constructed to correct lines, dimensions and elevations properly finished and will establish the lines and the elevation required for erection purposes.

The Contractor shall erect the structural steel, remove the temporary construction and do all work required to complete the construction included in the contract, in accordance with the drawings and the specifications and to the entire satisfaction of the Engineer.

1905.2 Organisation and Equipment

The Contractor shall submit erection plans prepared by the fabricator showing the method and procedure of erection, compatible with the details of fabrication.

A detailed scheme shall be prepared showing stage-wise activities, with complete drawings and working instructions. This should be based on detailed stage-wise calculations taking into account specifications and capacity of erection equipment machinery, tools and tackles to be used and temporary working loads as per codal provisions.

The scheme shall also take into account site conditions such as hydrology, rainfall, flood timings and intensity, soil and subsoil conditions in the river bed and banks, maximum water depth, temperature and climatic conditions and available working space.

The scheme shall indicate details of materials required with specifications, quantities, type of storage, etc. It shall also indicate precisely the type of temporary fasteners to be used as also the minimum percentage of permanent fasteners to be fitted during the stage erection. The working drawings should indicate clearly the temporary jigs, fixtures, clamps, spacer supports, etc.

All components of the bridge shall be got checked for their adequacy to take care of temporary forces to which they are subjected during erection so as to ensure safety of the structure at all stages of erection.

Unless otherwise provided in the contract, the Contractor shall supply and erect all necessary falsework and staging and shall supply all labour, tools, erection plant and other materials necessary to carry out the work complete in all respects.

The Contractor shall supply all rivets, bolts, nuts, washers, etc. required to complete erection at site with an allowance for wastage of 12½ percent of the net number of field rivets, bolts, washers required, or a minimum of five numbers of each item.

Service bolts and nuts, washers and drifts for use in erection shall be supplied at 60 percent (45 percent bolts and 15 percent drifts) of the number of field rivets per span in each size (this includes wastage). A reduction in the numbers of service bolts, etc., may however, be specified by the Engineer if more than one span of each type is ordered.

Prior to actual commencement of erection, all equipment, machinery, tools, tackles, ropes, etc. need to be tested to ensure their efficient working. Frequent visual inspection of vulnerable areas is essential to detect displacements, distress, damages, etc.

Deflection and vibratory tests shall be conducted on supporting structures, launching truss and also the structure under erection. Any unusual deviation or looseness of fittings, is to be noted and reviewed.

For welded structures, welders' qualifications and skills are to be checked as per standard norms. Non-destructive tests of joints are to be carried out as per designer's directives.

Precision non-destructive testing instruments should be used for frequent checking of various important parameters of the structures and systematic records should be maintained.

Safety requirements shall conform to IS:7205, IS:7273 and IS:7269 as applicable and all aspects of safety commensurate with economy and speed of construction, shall be considered.

Erection work should start with complete resources mobilized as per latest approved drawings and after a thorough survey of foundations and other related structural work. For works of large magnitude, mechanization is to be adopted to the maximum extent possible.

The structure should be divided into erectable modules as per the scheme. The module should be pre-assembled in a suitable yard / platform and its matching with members of the adjacent module checked by trial assembly before erection.

The structure shall be set out to the required lines and levels. The steelwork should be erected, adjusted and completed in the required position to the specified lines and levels with sufficient drifts and bolts. Packing materials shall be available to maintain this condition. Quality surveillance checks need to be carried out frequently.

Before starting work, the Contractor shall obtain necessary approval of the Engineer for the methodology/procedure of erection, drawings of temporary works, use of erection equipments and the number and character of tools and plant. The approval of the Engineer shall not relieve the Contractor of his responsibility for the safety of his methodology and equipment or from carrying out the work fully in accordance with the drawings and specifications.

During execution, the Contractor shall have a competent engineer or foreman in charge of the work, who has adequate experience in steel erection and is acceptable to the Engineer.

1905.3 Handling and Storing of Materials

Suitable area for storage of structures and components shall be located near the site of work. The access road should be free from water logging during the working period and the storage area should be on firm levelled ground.

The store should be provided with adequate handling equipment viz. mobile crane, gantries, derricks, chain pulley blocks, winch etc., of capacity as required. Stacking area should be planned and have racks, stands sleepers, access tracks etc. and proper lighting.

Storage should be planned to suit erection work sequence and avoid damage or distortion of material. Excessively rusted, bent or damaged steel shall be rejected. Methods of storage and handling steel, whether fabricated or not, shall be subject to the approval of the Engineer.

Fabricated materials are to be stored with erection marks visible. They should not come into contact with earth surface or water and should be accessible to handling equipment.

All materials, consumables, including raw steel or fabricated material shall be stored specification-wise and size-wise above the ground upon platforms, skids or other supports. They shall be kept free from dirt and other foreign matter and shall be protected as far as possible from corrosion and distortion. Electrodes shall be stored specification-wise and shall

be kept in dry warm condition in properly designed racks. The bolts, nuts, washers and other fasteners shall be stored in gunny bags on racks above the ground with protective oil coating. Paint shall be stored under cover in air-tight containers. Small hand tools shall be kept in containers in covered stores.

IS:7293 and IS:7969 dealing with handling of materials and equipment for safe working should be followed. Safety nuts and bolts as directed are to be used while working. The Contractor shall be held responsible for loss or damage to any material paid for by the Employer while in his care or for any damage to such material resulting from his work.

1905.4 Formwork

The formwork shall be properly designed, substantially built and maintained for all anticipated loads. The Contractor, if required, shall submit plans for approval to the Engineer. Approval of the plans, however, shall not relieve the Contractor of his responsibility for adequacy and effective performance of the formwork.

1905.5 Assembling Steel

The parts shall be accurately assembled as shown on the drawings and match marks shall be followed. The material shall be carefully handled so that no parts will be bent, broken or otherwise damaged.

Hammering which will injure or distort the members shall not be done. Bearing surface or surfaces to be in permanent contact shall be cleaned, before the members are assembled. The truss spans shall be erected on blocking, so placed as to give the proper camber. The blocking shall be left in place until the tendon chord splices are fully riveted and all other truss connections pinned and bolted. Rivets in splices of butt joints of compression members and rivets in railings, shall not be driven until the span has been swung.

All joint surface for bolted connections including bolts, nuts, washers shall be free from scale, dirt, burrs, other foreign materials and defects that would prevent solid seating of parts. The slope of surface of bolted parts in contact with bolt head and nut shall not exceed 1 in 20, in a plane normal to bolt axis; in case it does, suitable tapered washer shall be used.

All fasteners shall have a washer under nut or bolt head, whichever is turned in tightening.

Any connection to be riveted or bolted shall be secured in close contact with service bolts or with a sufficient number of permanent bolts before the rivets are driven or before the connections are finally bolted. Joints shall normally be made by filling not less than 50 percent of holes with service bolts and barrel drifts in the ratio 4:1. The service bolts are to be fully tightened as soon as the joint is assembled. Connections to be made by close tolerance or barrel bolts shall be completed as soon as practicable after assembly.

Any connection to be site welded shall be securely held in position by approved methods to ensure accurate alignment, camber and elevation before welding is commenced.

Field riveting, welding, bolting and pin connections shall conform to the requirements of Clause 1904 as appropriate.

The correction of minor misfits involving harmless amounts of reaming, cutting and chipping will be considered a legitimate part of erection. However, any error in the shop fabrication or deformation resulting from handling and transportation which prevents proper assembling and fitting up of parts by moderate use of drifts or by a moderate amount of reaming and slight chipping or cutting, shall be reported immediately to the Engineer. In such cases, the method of correction shall be approved by the Engineer and carried out in his presence.

1905.6 Field Inspection

1905.6.1 General

All materials equipment and work of erection shall be subject to the inspection of the Engineer who shall be provided with all facilities required for this purpose, including labour and tools, at all reasonable times. Any work found defective is liable to be rejected.

1905.6.2 No protective treatment shall be applied to the work until the appropriate inspection and testing have been carried out. The stage inspection shall be carried out for all operations so as to ensure correctness of fabrication and good quality. Girder dimensions and camber shall not be finally checked until all welding and heating operations are completed and the member has cooled to a uniform temperature.

1905.6.3 Testing of Material

Structural steel shall be tested for mechanical and chemical properties as per appropriate Indian Standards as may be applicable and shall conform to requirements specified in IS:226, IS:2062, IS:11587, IS:1977, IS:8500 and IS:961.

Rivets, bolts, nuts, washers, welding consumables, steel forging, casting and stainless steel shall be tested for mechanical and chemical properties in accordance with the appropriate Indian Standards.

Rolling and cutting tolerance shall be as per IS:1852. The thickness tolerance check measurements for plates and rolled sections shall be taken at not less than 15 mm from edge.

Check for laminations in plates shall be carried out for areas specified in Clause 1904.2, by ultrasonic testing or any other specified method. Flame cut edges without visual signs of

laminations need not be tested for compliance with Clause 1904.2, unless otherwise specified by Engineer.

Steel work shall be inspected for surface defects and exposed edge laminations during fabrication and blast cleaning. Significant edge laminations found shall be reported to the Engineer for his decision.

Chipping, grinding, machining or ultrasonic testing shall be used to determine depth of imperfection.

1905.6.4 Testing of Connections

1905.6.4.1 Bolted Connections

Bolts and bolted connection joints with high strength friction grip bolts, shall be inspected and tested according to IS:4000.

Bolted connection joints with black bolts and high strength bolts shall be inspected and tested for compliance or requirements mentioned in Clause 1904.7.8.

1905.6.4.2 Riveted Connections

Rivets and riveted connection shall be inspected as per Clause 1904.6 and tested for compliance of codal requirements.

The firmness of joint shall be checked by 0.2 mm filler gauge, which shall not go inside under the rivet head by more than 3 mm. There shall not be any gap between members to be riveted.

Driven rivets shall be checked with rivet testing hammer. When struck sharply on the head with the hammer, the rivet shall be free from movement and vibration. All loose rivets and rivets with cracks, badly formed or deficient heads or with heads which are eccentric with shanks, shall be cut out and replaced.

The alignment of plates at all bolted splice joints and welded butt joints shall be checked for compliance with codal requirements.

Testing of flame cut and sheared edges is to be done, where the hardness criteria given in the code are adopted. Hardness testing shall be carried out on six specimens.

1905.6.4.3 Welded Connections

Welding procedure, welded connections and testing shall be in compliance with codal requirements.

Welders qualification test shall be carried out as per requirements laid down in IS:7318 (Part 1). For approved welding procedures, the approval tests shall be as per requirements of IS:7310 (Part 1).

All facilities necessary for stage inspection during welding and on completion shall be provided to the Engineer or his inspecting authority by fabricator.

Adequate means of identification either by identification mark or other record shall be provided to enable each weld to be traced to the welder(s) by whom its welding was carried out.

All metal arc welding shall be in compliance with IS:9595 provisions.

The method of inspection shall be in accordance with IS:822 and extent of inspection and testing shall be in accordance with the relevant standards or as agreed with the Engineer.

1905.7 Procedure tests for Welds

The destructive and non-destructive test of weld shall be carried out according to IS:7307 (Part I).

1905.7.1 Non-Destructive Testing of Welds

One or more of the following methods may be applied for inspection or testing of weld :

- i) **Visual Inspection** : All welds shall be visually inspected, to cover all defects of weld such as size, porosity, crack in the weld or in the HAZ (Heat Affected Zone) etc. Suitable magnifying glass may be used for visual inspection. A weld shall be acceptable by visual inspection if it is seen that :
 - a) The weld has no cracks.
 - b) Thorough fusion exists between weld and base metal and between adjacent layers of weld metal.
 - c) Weld profiles are in accordance with relevant Clauses of IS:9595 or as agreed with the Engineer.
 - d) The weld is of full cross section, except for the ends of intermittent fillet welds outside their effective length.
 - e) When weld is transverse to the primary stress, undercut shall not be more than 0.25 mm deep in the part that is undercut. When the weld is parallel to the primary stress, undercut shall not be more than 0.8 mm deep in the part that is undercut.
 - f) The fillet weld in any single continuous weld shall be permitted to under run the nominal fillet weld size specified by 1.6 mm without

correction, provided that the undersized portion of the weld does not exceed 10 percent of the length of the weld. On the web-to-flange welds of girders, no under-run is permitted at the ends for a length equal to twice the width of the flange.

- g) The piping porosity in fillet welds shall not exceed one in each 100 mm of weld length and the maximum diameter shall not exceed 2.4 mm, except for fillet welds connecting stiffeners to web, where the sum of diameters of piping porosity shall not exceed 9.5 mm in any 25 mm length of weld and shall not exceed 19 mm in any 300 mm length of weld.
- h) The full penetration groove weld in butt joints transverse to the direction of computed tensile stress, shall have no piping porosity. For all other groove welds, the piping porosity shall not exceed one in 100 mm of length and the maximum diameter shall not exceed 2.4 mm.
- ii) **Magnetic Particle and Radiographic Inspection :** Welds that are subject to radiographic or magnetic particle testing in addition to visual inspection, shall have no crack.

Magnetic particle test shall be carried out according to IS:5334 for detection of crack and other discontinuity in the weld.

Radiographic test shall be carried out for detection of internal flaws in the weld such as crack, piping porosity inclusion, lack of fusion, incomplete penetration, etc. This test may be carried out as per IS:1182 and IS:4853.
- iii) **Ultrasonic Inspection :** Ultrasonic testing, in addition to visual inspection, shall be carried out for detection of internal flaws in the weld such as cracks, piping porosity inclusion, lack of fusion, incomplete penetration, etc. Acceptance criteria shall be as per IS:4260 or any other relevant IS Specification and as agreed to by the Engineer.

Bearing stiffeners or bearing diaphragms adjacent to welds, flange plates adjacent to web/flange welds, plates at cruciform welds, plates in box girder construction adjacent to corner welds or other details where specified by the Engineer, shall be ultrasonically tested after fabrication.
- iv) **Liquid Penetration Inspection :** The liquid penetrant test in addition to visual inspection, shall be carried out for detection of surface defect in the weld, as per IS:3658.
- v) Non-destructive testing of the following welds shall be carried out using any of the methods described at (ii), (iii) and (iv) above, as may be agreed to by the Engineer.

- a) All transverse butt welds in tension flanges
- b) 10 percent of the length of longitudinal and transverse butt welds in tension flanges.
- c) 5 percent of the length of longitudinal and transverse butt welds in compression flanges.
- d) All transverse butt welds in webs adjacent to tension flanges as specified by the Engineer.

The particular length of welds in webs to be tested shall be agreed with the Engineer, in case (b) or (c).

Any lamination, lamellar tearing or other defect found shall be recorded and reported to the Engineer for his decision.

1905.7.2 Testing of Welds for Cast Steel

The testing of weld for cast steel shall be carried out as agreed to and directed by the Engineer.

1905.7.3 Stud Shear Connectors

Stud shear connectors shall be subjected to the following tests:

- a) The fixing of studs after being welded in position shall be tested by striking the side of the head of the stud with a 2 kg hammer to the satisfaction of the Engineer.
- b) The selected stud head shall not show displacement of more than 0.25 times the height of the stud, from its original position, if struck once with a 6 kg hammer. The stud weld shall not show any sign of a crack or lack of fusion.

The studs whose welds have failed the tests given in (a) and (b) shall be replaced.

1905.7.4 Inspection of Members

1905.7.4.1 Inspection Requirement

The fabricated member/component made out of rolled and built-up section shall be checked for compliance of the tolerances given in Table 1900-2. Inspection of member/components for compliance with tolerances, and the check for deviations shall be made over the full length.

During checking, the inspection requirement shall be indicated in such a manner that local surface irregularities do not influence the results.

For plate, out-of-plane deviation shall be checked at right angle to the surface over the full area of plate.

The cross girder or cross frame deviation shall be checked over the middle third of its length between each pair of webs and at the end of member for cantilever.

The web of rolled beam or channel section shall be checked for out-of-plane deviation in a longitudinal direction over a length equal to the depth of the section.

During inspection, the component/member shall not have any load or external restraint.

1905.7.4.2 Inspection Stages

The stages of inspection to be carried out for compliance of tolerances shall include, but not be limited to, the following :

- a) For completed parts, component/members - on completion of fabrication and before any subsequent operation such as surface preparation, painting, transportation, erection.
- b) For webs of plate and box girder, longitudinal compression flange stiffeners in box girders and orthotropic decks and all web stiffeners at site joints - on completion of site joint.
- c) For cross girders and frames, cantilevers in orthotropic decks and other parts in which deviations have apparently increased - on completion of site assembly.

Where, on checking member/component for out-of-plane or out-of-straightness at right angles to the plate surface, and any other instances, the deviation exceeds the tolerance, the maximum deviation shall be measured and recorded. The record shall be submitted to the Engineer who will determine whether the component/member may be accepted without rectification, accepted with rectification or rejected.

1906 PAINTING

1906.1 General

Unless otherwise specified, all metal work shall be given approved shop coats as well as field coats of painting. The item of work shall include preparation of metal surfaces, application of protective covering and drying of the paint coatings along with all tools, scaffolding, labour and materials necessary.

Coatings shall be applied only to dry surfaces and the coated surfaces shall not be exposed to rain or frost before they are dry. The coatings shall be applied to all surfaces excluding shear connectors and inner surfaces of fully sealed hollow sections. While coating adjacent surfaces, care shall be taken to ensure that primer is not applied on the shear connectors.

1906.1.1 Types of Paints**i) Ordinary Paints**

These include paints based on drying oils, alkyd resin, modified alkyd resin, phenolic varnish epoxy, etc.

Ordinary painting can generally be sub-divided into two types:

a) Primary Coats :

This shall be applied immediately after the surface preparation and should have the properties of adhesion, corrosion inhibition and imperviousness to water and air.

b) Finishing Coats :

This shall be applied over the primary coat and should have the properties of durability, abrasion resistance, aesthetic appearance and smooth finish.

ii) Chemical Resistant Paints

The more highly corrosion resistant paints can be divided into two main groups :

a) One pack paints (ready for use)**b) Two pack paints (mixed before use)**

The two pack paints shall be mixed together just before use since they remain workable thereafter only for a restricted period of time.

iii) Other types of paints as mentioned in Clause 1903.4 of this Section may also be used, subject to approval by the Engineer.

All paints shall conform to relevant IS Standards as appropriate.

1906.1.2 Surfaces which are inaccessible for cleaning and painting after fabrication shall be painted as specified before being assembled for riveting.

All rivets, bolts, nuts, washers etc., are to be thoroughly cleaned and dipped into boiling linseed oil conforming to IS:77.

All machined surfaces are to be well coated with a mixture of white lead conforming to IS:34 and mutton tallow conforming to IS:887.

In site painting, the whole of the steel work shall be given the second cover coat after final passing and after touching up the primer and cover coats, if damaged in transit.

1906.1.3 Quality of Paint

Only paints which have been tested for the following qualities as per the specifications given in the relevant IS codes, should be used :

- Weight test (weight per 10 litre of paint thoroughly mixed)

- Drying time
- Flexibility and adhesion
- Consistency
- Dry thickness and rate of consumption

1906.1.4 Unless otherwise specified, all painting and protective coating work shall be done in accordance with IS:1477 (Part I).

1906.2 Surface Preparation

Steel surface to be painted either at the fabricating shop or at the site of work shall be prepared in a thorough manner with a view to ensuring complete removal of mill scale by one of the following processes as agreed to between the fabricator and the Engineer :

- a) Dry or wet grit/sand blasting
- b) Pickling which should be restricted to single plates, bars and sections
- c) Flame cleaning

Primary coat shall be applied as soon as practicable after cleaning and in case of flame cleaning, while the metal is still warm.

All slag from welds shall be removed before painting. Surfaces shall be maintained dry and free from dirt and oil. Work out of doors in frosty or humid weather shall be avoided.

1906.3 Coatings

Prime coat to be used shall conform to the specification of primers approved by the Engineer. Metal coatings shall be considered as prime coats. Primer shall be applied to the blast cleaned surface before any deterioration of the surface is visible. In any case, the surface shall receive one coat of primer within 4 hours of abrasive blast cleaning.

All coats shall be compatible with each other. When metal based coatings are used, the undercoat shall be compatible with the concerned metal base. The undercoat and finishing coat shall preferably be from the same manufacturer. Successive coats of paints shall be of different shades or colours and each shall be allowed to dry thoroughly before the next is applied. Particular care shall be taken with the priming and painting of edges, corners, welds and rivets. Typical guidelines for epoxy based paints and the conventional painting system for bridge girders as given below, may be complied with :

- a) **Epoxy Based Painting**
 - i) Surface preparation : Remove oil/grease by use of petroleum hydrocarbon solution (IS:1745) and grit blasting to near white metal surface.
 - ii) Paint system : 2 coats of epoxy zinc phosphate primer = 60 micron:
Total 5 coats = 200 micron

b) **Conventional Painting System for areas where corrosion is not severe Priming Coat :**

One coat of ready mixed, red lead primer conforming to IS:102

or

One coat of ready mixed zinc chrome primer conforming to IS:104 followed by one coat of ready mixed red oxide zinc chrome primer conforming to IS:2074

or

Two coats of red oxide zinc chrome primer conforming to IS:2074.

Finishing Coats :

Two cover coats of red oxide paint conforming to IS:123 or any other approved paint shall be applied over the primer coat. One coat shall be applied before the fabricated steel work leaves the shop. After the steel work is erected at site, the second coat shall be given after touching up the primer and the cover coats, if damaged in transit.

c) **Conventional Painting System for areas where corrosion is severe Priming Coat :**

Two coats of ready mixed red lead primer conforming to IS:102

or

One coat of ready mixed zinc chrome primer conforming to IS:104 followed by one coat of ready mixed zinc chrome primer conforming to IS:2074.

Finishing Coats :

Two coats of aluminium paint conforming to IS:2339 shall be applied over the primer coat. One coat shall be applied before the fabricated steel work leaves the shop. After the steel work is erected at site, the second coat shall be given after touching up the primer and the cover coats, if damaged in transit.

1906.4 Painting in the Shop

All fabricated steel shall be painted in the shop after inspection and acceptance with at least one priming coat, unless the exposed surfaces are subsequently to be cleaned at site or are metal coated. No primer shall be applied to galvanised surfaces.

Shop contact surfaces, if specifically required to be painted, shall be brought together while the paint is still wet.

Field contact surfaces and surfaces to be in contact with cement, shall be painted with primer only. No paint shall be applied within 50 mm of design location of field welds. Paint shall be completely dry before loading and transporting of the fabricated steel work to site.

Surfaces not in contact but inaccessible after shop assembly shall receive the full specified protective treatment before assembly.

Where surfaces are to be welded, the steel shall not be painted or metal coated within a suitable distance from any edges to be welded, if the specified paint or metal coating would be harmful to welders or is likely to impair the quality of site welds.

Exposed machined surfaces shall be adequately protected.

1906.5 Painting at Site

Surfaces which will be inaccessible after site assembly shall receive the full specified protective treatment before assembly.

Surfaces which will be in contact after site assembly shall receive a coat of paint (in addition to any shop priming) and shall be brought together while the paint is still wet.

Damaged or deteriorated paint surfaces shall be first made good with the same type of coat as the shop coat.

Where steel has received a metal coating in the shop, this coating shall be completed on site so as to be continuous over any welds, bolts and site rivets.

Specified protective treatment shall be completed after erection.

1906.6 Methods of Application

The methods of application of all paint coatings shall be in accordance with the manufacturer's written recommendation and shall be as approved by the Engineer. Spray painting may be permitted provided it will not cause inconvenience to the public and is appropriate to the type of structure being coated. Areas inaccessible for painting and areas shaded for spray application, shall be coated first by brushing.

Oil based red lead primers must be applied by brush only, taking care to work into all corners and crevices.

The primer, intermediate and finishing coats shall all be applied so as to provide smooth coatings of uniform thickness. Wrinkled or blistered coatings or coatings with pinholes, sags, lumps or other blemishes shall not be accepted. Where the Engineer so directs, the coating shall be removed by abrasive blast cleaning and replaced by the Contractor at his own cost.

1906.7 Protective Coatings in Different Environments

Since the severity of corrosion depends upon atmospheric conditions and these vary enormously, there is no single protective system or method of application that is suitable for every situation.

Table 1900-3 gives guidelines for various types of coatings to be used in various environmental conditions. Approximate life to first maintenance is also indicated.

1907 TESTS AND STANDARDS OF ACCEPTANCE

The materials shall be tested in accordance with relevant IS Specifications and necessary

test certificates shall be furnished. Additional tests, if required, shall be got carried out by the Contractor at his own cost.

The fabrication, furnishing, erection and painting of structural steel work shall be in accordance with these Specifications and shall be checked and accepted by the Engineer.

Table 1900-3 : Guidelines for Selection of Types of Protective Coatings

	Type of Coating	Exposure Condition
i)	Wire brush to remove all loose rust and scale; 2 coats drying oil type primer, and 1 under coat alkyd type paint; 1 finishing coat alkyd type. Total dry thickness = 150 μm	Moderate
ii)	Wire brush to remove all loose rust and scale; 2 coats drying oil type primer; 2 under coats micaceous iron oxide (MXO) pigmented phenolic modified drying oil. Total dry film thickness = 170 μm (life up to 5 years)	Polluted inland environment
iii)	Blast clean the surface; 2 coats of quick drying primer; undercoat alkyd type paint; 1 finishing coat alkyd type. Total dry film thickness : 130 – 150 μm	Moderate
iv)	Blast clean the surface; 2 coats of drying type oil primer; 1 under coat micaceous iron oxide pigmented drying oil type paint. Total dry film thickness : 165–190 μm	Polluted inland environments
v)	Blast clean the surface; 2 coats of metallic lead pigmented chlorinated rubber primer, 1 undercoat of high build chlorinated rubber primer, 1 under coat of high build chlorinated rubber; 1 finishing coat of chlorinated rubber. Total dry film thickness : 200 μm	Severe coastal and non-coastal interior situations
vi)	Blast clean the surface; 350 – 450 μm thickness coal tar epoxy.	Severe
vii)	Pickle; hot dip galvanised (Zinc). Total thickness : 85 μm (life up to 15-20 years)	Moderate
viii)	Grit blast, hot dip galvanised. (Zinc). Total thickness = 140 μm (life more than 20 years)	Moderate
ix)	Grit blast; 1 coat of sprayed zinc/aluminum followed by suitable sealer Total thickness = 150 μm (life up to 15-20 years)	Severe

1908 MEASUREMENTS FOR PAYMENT

The measurements of this item shall be in tonnes based on the net weight of metal in the fabricated structure, computed on the basis of nominal weight of materials.

The weight of rolled and cast steel and cast iron shall be determined from the dimensions shown on the drawings on the following basis :

- Rolled or cast steel : 7.84×10^{-3} kg/cu.cm.
- Cast Iron : 7.21×10^{-3} kg/cu.cm.

Weight of structural sections shall be nominal weight.

Weight of castings shall be computed from the dimensions shown on the drawings with an addition of 5 percent for fillets and over-runs.

Weight of rivet heads shall be computed by taking the weight of 100 snap heads as given in Table 1900-4.

When specially agreed upon, allowance for snap heads may be taken as a flat 2.5 percent of the total weight.

Table 1900-4 : Weight of Rivet Heads

Dia of Rivet as Manufactured-mm	Weight of 100 Snap Heads - kg
12	1.3
14	2.1
16	3.4
18	4.45
20	6.1
22	8.1
24	10.5
27	15.0
30	20.5
33	27.2

The Contractor shall supply detailed calculation sheets for the weight of the metal in the fabricated structure.

No additions shall be made for the weight of protective coatings, weld fillets, bolts, nuts and washers.

Where computed weight forms the basis for payment, the weight shall be calculated for exact cut sizes of members used in the structure, deductions being made for all cuts, except for rivet holes. Additions shall be made for the rivet heads as mentioned above.

When specially agreed upon, the basis for payment may be the bridge weight complete, according to specifications included in special provisions of the contract.

1909 RATE

The contract unit rate for the completed structural steel work shall include the cost of all materials, labour, tools, plant and equipment required for fabrication, connections, oiling, painting, temporary erection, inspection, tests and complete final erection as shown on the drawings or as directed by the Engineer and as specified in these Specifications.

from the bank, thus lowering and sliding out the tilted platform under the crate, gradually placing the crate on the slopes while the tilted platform rotates around its hinges.

2504 PITCHING/REVETMENT ON SLOPES

2504.1 Description

The work shall consist of covering the river side slopes of guide bunds, training works and road embankments with stone, boulders, cement concrete blocks or stones in wire crates over a layer of granular material which will act as a filter. The rear slopes, not subjected to direct attack of the river, may be protected by 300 mm - 600 mm thick cover of clayey or silty earth and turfing.

2504.2 Pitching and Filter Medium

2504.2.1 Pitching

The pitching shall be provided with stones of thickness and shape as indicated on the drawings.

The stones shall be obtained from quarries and shall be sound, hard, durable and fairly regular in shape. Round boulders shall not be allowed. Stones showing marked deterioration by water or weather shall not be accepted.

The size and weight of stone shall conform to Clause 5.3.5.1 of IRC: 89. No stone, shall weigh less than 40 kg. The size of spalls shall be a minimum of 25 mm and shall be suitable to fill the voids in the pitching.

Where the stones of required size are not economically available, cement concrete blocks in minimum M15 grade concrete conforming to Section 1700 of these Specifications or stones in wire crates, shall be used.

Geosynthetics, if used in pitching, shall conform to Section 700 of these Specifications.

2504.2.2 Filter Medium

The material for the filter shall consist of coarse sand, gravel or stone. One or more layers of graded materials, to act as a filter medium, shall be provided underneath the pitching, to prevent loss of the embankment material and build up of uplift head on the pitching.

The gradation of the filter material shall satisfy the following requirements:

$$\frac{D_{15} \text{ (Filter)}}{D_{85} \text{ (Base)}} < 5$$

$$4 < \frac{D_{15} \text{ (Filter)}}{D_{15} \text{ (Base)}} < 20$$

$$\frac{D_{50} \text{ (Filter)}}{D_{50} \text{ (Base)}} < 25$$

Notes :

- 1) Filter design may not be required if embankment consists of CH or CL soils with liquid limit greater than 30, resistant to surface erosion. In this case, if a layer of material is used as bedding for pitching, it shall be well graded and its D 85 size shall be at least twice the maximum void size in pitching
- 2) In the foregoing, D 15 means the size of that sieve which allows 15 percent by weight of the filter material to pass through it and similar is the meaning of D 50 and D 85 (15 being replaced with 50 and 85 respectively).
- 3) If more than one filter layer is required, the same requirement as above shall be followed for each layer. The finer filter shall be considered as base material for selection of coarser filter.
- 4) The filter shall be compacted to a firm condition. The thickness of filter is generally of the order of 200 mm to 300 mm. Where filter is provided in two layers, thickness of each layer shall be 150 mm.

2504.3 Construction Operations

Before laying the pitching, the side of banks shall be trimmed to the required slope and profiles by means of lines and pegs at intervals of 3 m. Depressions shall be filled and thoroughly compacted.

The filter granular material shall be laid over the prepared base and compacted to the thickness specified on the drawings by means of suitable equipment.

The lowest course of pitching shall be started from the toe wall and built up in courses upwards. The toe wall shall be in dry rubble masonry (uncoursed) conforming to Clause 1405.3, of these Specifications in case of dry rubble pitching. It shall be in nominal mix cement concrete (M 15) conforming to Clause 1704.3, of these Specifications in case of cement concrete block pitching.

The stone pitching shall commence in a trench below the toe of the slope. Stone shall be placed by derrick or by hand to the required length, thickness and depth conforming to the drawings. Stones shall be set normal to the slope, and placed so that the largest dimension is perpendicular to the face of the slope, unless such dimension is greater than the specified thickness of pitching.

The largest stones shall be placed in the bottom courses and for use as headers for subsequent courses.

In hand placed pitching, the stone of flat stratified nature should be placed with the principal bedding plane normal to the slope. The pattern of laying shall be such that the joints are broken and voids are minimum by packing with spalls, wherever necessary, and the top surface is as smooth as possible.

When full depth of pitching can be formed with a single stone, the stones shall be laid breaking joints and all interstices between adjacent stones shall be filled in with spalls of the proper size wedged in with hammers to ensure tight packing.

When two or more layers of stones must be laid to obtain the design thickness of pitching, dry masonry shall be used and stones shall be well bonded. To ensure regular and orderly disposition of the full intended quantity of stone as shown, template cross walls in dry masonry shall be built about a metre wide and to the full height of the specified thickness at suitable intervals all along the length and width of the pitching. Within these walls the stones shall be hand packed as specified.

2504.4 Toe Protection

A toe wall shall be provided at the junction of slope pitching and launching apron of a guide bund so as to prevent the slope pitching from sliding down. The toe wall shall be in dry rubble masonry (uncoursed) conforming to Section 1400 of these Specifications or in cement concrete of M15 grade. The pitching/revetment shall be of stones in wire crates or cement concrete blocks in M15 grade. For protection of ties of bank slopes terminating either in short aprons at bed levels or anchored in flooring/rocky bed, the provision of Clause 8.2.2 of IRC:89 may be complied with.

2505 RUBBLE STONE/CEMENT CONCRETE BLOCK FLOORING OVER CEMENT CONCRETE BEDDING

2505.1 The work shall consist of constructing rubble stone/cement concrete block flooring laid over a bedding of cement concrete (M15).

sealant trimmed to receive the wearing coat. After the wearing coat is completed, similar sealant shall be provided to cover at least 50 mm on the wearing coat surface all round the drainage assembly.

2706 WEEP HOLES

Weep holes shall be provided on all plain concrete, reinforced concrete, brick masonry and stone masonry structures such as, abutment, wing wall and return walls as shown on the drawings or as directed by the Engineer to permit water to flow out without building up pressure in the back fill. Weep holes shall be provided with 100 mm diameter AC/PVC/HDPE pipe for structures in plain/reinforced concrete or brick masonry. In case of stone masonry, weep holes shall be of rectangular shape 80 mm wide, 150 mm high or circular with 150 mm diameter. Weep holes shall extend through the full width of concrete/masonry with slope of about 1 vertical: 20 horizontal towards the draining face. The spacing of weep holes shall be 1 m in either direction or as shown in the drawings with the lowest at 150 mm above the low water level or ground level whichever is higher or as directed by the Engineer.

2707 TESTS AND STANDARDS OF ACCEPTANCE

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

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

2708 MEASUREMENTS FOR PAYMENT

The measurement for payment for wearing coat, railing/crash barrier, approach slab, drainage spout and weep holes shall be made as under:

- i) Bituminous and cement concrete wearing coat shall be measured in cubic metres. Steel reinforcement in wearing coat shall be measured in tonnes.
- ii) Railing and metal beam crash barriers shall be measured in running metres.
- iii) For concrete crash barriers concrete shall be measured in cubic metres and steel shall be measured in tonnes.
- iv) Approach slab and its base shall be measured separately in cubic metres.
- v) Drainage spouts shall be measured in numbers.

2901 SCOPE

This work shall consist of furnishing and installing reinforced cement concrete pipes, of the type, diameter and length as per design and details and at locations shown on the drawings or as ordered by the Engineer and in accordance with the requirements of these Specifications.

2902 MATERIALS

All materials used in the construction of pipe culverts shall conform to the requirements of **Section 1000**.

Each consignment of cement concrete pipes shall be inspected, tested, if necessary, and approved by the Engineer either at the place of manufacture or at the site before their incorporation in the works.

2903 EXCAVATION FOR PIPE

The foundation bed for pipe culverts shall be excavated true to the lines and grades shown on the drawings or as directed by the Engineer. The pipes shall be placed in shallow excavation of the natural ground or in open trenches cut in existing embankments, taken down to levels as shown on the drawings. In case of high embankments where the height of fill is more than three times the external diameter of the pipe, the embankment shall first be built to an elevation above the top of the pipe equal to the external diameter of the pipe, and to width on each side of the pipe of not less than five times the diameter of pipe, after which a trench shall be excavated and the pipe shall be laid.

Where trenching is involved, its width on either side of the pipe shall be a minimum of 150 mm or one-fourth of the diameter of the pipe whichever is more and shall not be more than one-third the diameter of the pipe. The sides of the trench shall be as nearly vertical as possible.

The pipe shall be placed where the ground for the foundation is reasonably firm. Installation of pipes under existing bridges or culverts shall be avoided as far as possible. When during excavation the material encountered is soft, spongy or other unstable soil, and unless other special construction methods are called for on the drawings or in special provisions, such unsuitable material shall be removed to such depth, width and length as directed by the Engineer. The excavation shall then be backfilled with approved granular material which shall be properly shaped and thoroughly compacted upto the specified level.

Where bed-rock or boulder strata are encountered, excavation shall be taken down to atleast 200 mm below the bottom level of the pipe with prior permission of the Engineer and all rock/ boulders in this area be removed and the space filled with approved earth, free from stone or fragmented material, shaped to the requirements and thoroughly compacted to provide adequate support for the pipe.

Trenches shall be kept free from water until the pipes are installed and the joints have hardened.

2904 BEDDING FOR PIPE

The bedding surface shall provide a firm foundation of uniform density throughout the length of the culvert, shall conform to the specified levels and grade, and shall be of one of the following two types as specified on the drawings :

- i) **First Class Bedding** : Under first class bedding, the pipe shall be evenly bedded on a continuous layer of well compacted approved granular material, shaped concentrically to fit the lower part of the pipe exterior for atleast ten percent of its overall height or as otherwise shown on the drawings. The bedding material shall be well graded sand or another granular material passing 5.6 mm sieve suitably compacted/rammed. The compacted thickness of the bedding layer shall be as shown on the drawings and in no case shall it be less than 75 mm.
- ii) **Concrete Cradle Bedding** : When indicated on the drawings or directed by the Engineer, the pipe shall be bedded in a cradle constructed of concrete having a mix not leaner than M 15 conforming to Section 1700. The shape and dimensions of the cradle shall be as indicated on the drawings. The pipes shall be laid on the concrete bedding before the concrete has set.

2905 LAYING OF PIPE

No pipe shall be laid in position until the foundation has been approved by the Engineer. Where two or more pipes are to be laid adjacent to each other, they shall be separated by a distance equal to at least half the diameter of the pipe subject to a minimum of 450 mm.

The arrangement for lifting, loading and unloading concrete pipes from factory/yard and at site shall be such that the pipes do not suffer any undue structural strain, any damage due to fall or impact. The arrangement may be got approved by the Engineer.

Similarly, the arrangement for lowering the pipe in the bed shall be got approved by the Engineer. It may be with tripod-pulley arrangement or simply by manual labour in a manner that the pipe is placed in the proper position without damage.

The laying of pipes on the prepared foundation shall start from the outlet and proceed towards the inlet and be completed to the specified lines and grades. In case of use of pipes with bell-mouth, the belled end shall face upstream. The pipes shall be fitted and matched so that when laid in work, they form a culvert with a smooth uniform invert.

Any pipe found defective or damaged during laying shall be removed at the cost of the Contractor.

2906 JOINTING

The pipes shall be jointed either by collar joint or by flush joint. In the former case, the collars shall be of RCC 150 to 200 mm wide and having the same strength as the pipes to be jointed. Caulking space shall be between 13 and 20 mm according to the diameter of the pipe. Caulking material shall be slightly wet mix of cement and sand in the ratio of 1:2 rammed with caulking irons. Before caulking, the collar shall be so placed that its center coincides with the joint and an even annular space is left between the collar and the pipe.

Flush joint may be internal flush joint or external flush joint. In either case, the ends of the pipes shall be specially shaped to form a self centering joint with a jointing space 13 mm wide. The jointing space shall be filled with cement mortar, 1 cement to 2 sand, mixed sufficiently dry to remain in position when forced with a trowel or rammer. Care shall be taken to fill all voids and excess mortar shall be removed.

For jointing pipe lines under light hydraulic pressure, the recess at the end of the pipe shall be filled with jute braiding dipped in hot bitumen or other suitable approved compound. Pipes shall be so jointed that the bitumen ring of one pipe shall set into the recess of the next pipe. The ring shall be thoroughly compressed by jacking or by any other suitable method.

All joints shall be made with care so that their interior surface is smooth and consistent with the interior surface of the pipes. After finishing, the joint shall be kept covered and damp for at least four days.

2907 BACKFILLING

Trenches shall be backfilled immediately after the pipes have been laid and the jointing material has hardened. The backfill soil shall be clean, free from boulders, large roots, excessive amounts of sods or other vegetable matter, and lumps and shall be approved by the Engineer. Backfilling upto 300 mm above the top of the pipe shall be carefully done and the soil thoroughly rammed, tamped or vibrated in layers not exceeding 150 mm, particular care being taken to thoroughly consolidate the materials under the haunches of the pipe. Approved pneumatic or light mechanical tamping equipment can be used.

Filling of the trench shall be carried out simultaneously on both sides of the pipe in such a manner that unequal pressures do not occur.

In case of high embankment, after filling the trench upto the top of the pipe in the above said manner, a loose fill of a depth equal to external diameter of the pipe shall be placed over the pipe before further layers are added and compacted.

2908 HEADWALLS AND OTHER ANCILLARY WORKS

Headwalls, wing walls, aprons and other ancillary works shall be constructed in accordance with the details shown on the drawings or as directed by the Engineer. Masonry for the walls shall conform to Sections 1300, 1400 or 1700 as applicable. Aprons shall conform to Section 2500.

2909 OPENING TO TRAFFIC

No traffic shall be permitted to cross the pipes unless height of filling above the top of the pipes is atleast 600 mm.

2910 MEASUREMENTS FOR PAYMENT

RCC pipe culvert shall be measured as complete work in linear metres along its length between the inlet and outlet ends. Culverts with multiple rows of pipes shall be measured as one unit, irrespective of the number of rows.

2911 RATE

The Contract unit rate for the pipe culvert shall include the cost of pipes including loading, unloading, hauling, handling, storing, laying in position and jointing and all ancillary works such as excavation, bedding for pipes, backfilling, concrete, masonry and aprons and incidental costs to complete the work as per these Specifications.

3101 SCOPE

The work covers construction of reinforced soil structures together with the construction of earthwork in layers, assembly and placing of reinforcing elements and fascia elements during the construction process and all associated works.

The work shall include the design and construction of the reinforced soil structure and ground improvement measures required, if any.

The reinforced soil retaining structures can be used as, (i) Reinforced soil retaining wall, (ii) Reinforced soil abutment, (iii) Reinforced soil slope

Reinforced soil structures with slope face angles steeper than 70° are categorized as reinforced soil walls and those with slope face angle less than 70° are considered as reinforced soil slopes.

3102 DESIGN

Guidelines for design are given in Annexure-1.

3103 REINFORCING ELEMENT

3103.1 The reinforcing element shall be metallic in the form of strips (aluminum alloy strip, copper strip, carbon steel strip, galvanised steel strip, stainless steel strip, ladder) or mats of metal (steel grids, woven and welded steel wire meshes) or synthetic (PET, HDPE, PVA, PP) reinforcement in the form of grid or strip or strap or combination of metallic or synthetic or any other proprietary material which may be approved by the Engineer and shown on the drawings

3103.2 Aluminum alloy strip shall comply with BS:1470 quality 5454 in the H 24 condition.

3103.3 Copper strip shall comply with BS:2870 quality C 101 or C 102 in the ½ H condition and shall have 0.2 percent proof stress of not less than 180 N/mm².

3103.4 Carbon steel strip shall comply with BS EN 10025 or IS:2062 and have a silicon content of not more than 0.55 percent. The fabricated element shall be galvanized in accordance with IS:4759 and IS:2629 and the minimum zinc coating weight shall not be less than 1000gm/sq.m

The steel strips with minimum bearing and shear strength of 490N/mm² shall comply with the requirements of BS EN 10025, Grade S 355 JR, or IS:2062 grade Fe 490, except the elongation (on base metal) for which minimum 22 percent is acceptable.

The panel lugs shall be manufactured from hot-rolled steel strips with the same steel quality and grades as specified above, except that the minimum zinc coating weight not less than 600 gm/sq.m.

All permanent metallic connectors (exposed to soil), tie strips and lugs shall be hot dip galvanized. Nuts/ bolts (fasteners) shall be galvanized as per requirements of IS: 1367-Part 3. Nuts/ bolts (fasteners) shall be of grade 10.9.

For all metallic components, where holes or penetrations are made through the reinforcing elements to accommodate connection such as bolts, pins, or other, the cross section thickness and/or width of metallic component shall be increased to account for section loss caused by the hole or penetration.

3103.5 Stainless steel strip shall comply with BS: 1449 (Part 2) quality 315 S 31 or 316 S 33 except that the material shall be cold rolled to provide a 0.2 percent proof stress of not less than 400 N/mm² and the tensile strength shall not be less than 540 N/mm².

3103.6 All metallic components buried in soil shall be of electrolytically compatible materials.

3103.7 Geotextile, Geogrids and other Geosynthetic Materials used as Reinforcing Elements

3103.7.1 Geotextile

High strength high tenacity geotextile fabrics used as reinforcement in the construction of reinforced slopes or in the base of reinforced soil structure as reinforcement, shall be considered as reinforcing element and shall satisfy all the requirements stipulated for geosynthetic reinforcing elements, in Clause 3103.7.2.

Geotextile fabric used for separation, filtration and/ or drainage shall satisfy the requirements given in relevant Clauses of Section 700 Geosynthetics.

3103.7.2 Geogrids

The manufacturer of geogrids, geotextiles, geostrips, polymeric strips or straps, polymeric ties or any other geosynthetic material, including any proprietary geosynthetic material, for use as reinforcing element shall fulfill the following requirements:

- a) Shall have ISO (ISO-9001) or CE Certification for manufacturing process and quality control, and
- b) The product shall have certification for use as soil reinforcing material from an agency accredited for certifying geosynthetic reinforcement products.

- c) The manufacturer shall provide test reports from an independent laboratory with valid accreditation, for all the tests needed to establish all the reduction factors listed below

RF_{CR} -	Reduction factor for creep.
RF_{ID} -	Reduction factor for installation damage
RF_W -	Reduction factor for weathering
RF_{CH} -	Reduction factor for chemical/ environmental effects.
f_e -	Factor for the extrapolation of data

All the above factors shall be determined in accordance with the provisions of ISO/TR 20432- "Guide to the determination of long-term strength of geosynthetics for soil reinforcement."

Project Specific Tests/Data

Test for the ultimate tensile strength shall be carried out on a random sample for each grade of reinforcement as per ISO-10319. The test results shall be accompanied by stress-strain curves showing strength at 2% and 5% strain and strain/elongation at failure.

The manufacturer shall also provide the results of ultimate tensile strength for each lot and all grades of reinforcement proposed for use in the project.

Annual Average Daily Temperatures (AADT)/design temperature of the project site shall be worked out and values of reduction factor for creep RF_{CR} and for RF_{CH} shall be provided as per procedures given in ISO/TR-20432.

Tests shall be carried out to provide values of

- i) Pull-out coefficient as per ASTM D 6706 "Standard Test Method for Measuring Geosynthetic Pullout Resistance in Soil" and
- ii) Coefficient of interaction between reinforced fill soil and geogrids as per ASTM D 5321-"Standard Test method for Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by the Direct Shear method" or as per IS: 13326: Part 1-1992 "Method of test for the evaluation of interface friction between geosynthetics and soil: Part 1 Modified direct shear technique" for all types of geogrids.

One set of project specific tests shall be conducted at third party accredited laboratory or at a reputed institute.

Each roll shall have at least one identification label with roll number and product type.

3104 EARTH FILL

The fill material in the reinforced soil zone shall have drained or effective angle of friction not less than 30°, measured in accordance with IS:2720 (Part 13), by conducting a drained direct shear test. In case the fill material has 25 percent or more particles of 4.75 mm or larger, drained shear test using large shear box may be conducted (IS:2720:Part 39:Section 1). The gradation of fill soil shall be as per following limits.

Sieve Size	Percentage Passing
75 mm	100%
425 micron	0-60%
75 micron	less than 15
PI ≤6	

Materials with more than 15 percent passing 75 micron sieve, but less than 10 percent of particles smaller than 15 microns are acceptable provided PI is less than 6 and angle of friction is not less than 30°.

Fly ash may be used as fill material in reinforced soil walls provided its angle of internal friction is not less than 30° and PI is less than 6. Gradation requirements need not be completely satisfied. Reference may be made to IRC Guide lines on Use of Flyash in Road Embankments (IRC:SP-58). Fly ash shall also satisfy requirements concerning pH and environmental conditions of the fill vis-à-vis the reinforcement type as specified in Clause 3014.1.

The fill material used in the reinforced soil zone shall be free from organic or other deleterious materials and shall not react adversely (chemically, electrically or biologically) with the reinforcement material and/or facing material.

Properties of fill soil in the reinforced zone, unreinforced zone (or retained/back fill) soil and the foundation soil shall be determined accurately during the construction phase, as per quality assurance plans and directions of Engineer so as to ensure that these are the same as those considered in the design phase.

The fill soil in the unreinforced zone shall conform to the requirements specified in the design.

3104.1 Environmental Conditions of Fill**3104.1.1 Steel Reinforcement**

Where galvanized steel reinforcement is used, the fill material shall be free draining granular material and shall meet the following requirements as per Table 3100.1.

Table 3100.1 : Recommended Limits of Electrochemical Properties for Reinforced Fills with Steel Reinforcement

Property	Criteria	Test Method
Resistivity	> 3000 ohm-cm	AASHTO T-288
pH	> 5 and < 10	AASHTO T-289
Chlorides	< 100 PPM	ASTM D 4327
Sulphates	< 200 PPM	ASTM D 4327

3104.1.2 Geosynthetic Reinforcement

Where geosynthetic reinforcement is used for reinforcing elements manufactured from polyester yarn, pH value of the fill material shall be between 3 and 9, and for reinforcing elements manufactured from PVA, PP and HDPE, the pH value shall be greater than 3.

3105 FACIA MATERIAL

3105.1 The facing system shall be one of the following

- a) Precast reinforced concrete panels
- b) Precast concrete blocks and precast concrete hollow blocks.
- c) Gabion facing
- d) Wrap around facing using geosynthetics
- e) Metallic facing, prefabricated in different shapes including welded wire grid and woven steel wire mesh
- f) Other proprietary and proven systems

Facing shall be sufficiently flexible to withstand any deformation of the fill and foundations.

The facia units to be adopted in the project shall be shown in the drawings and shall be approved by the Engineer.

3105.1.1 Precast Reinforced Concrete Panels

The minimum thickness of precast concrete panels shall be 180 mm including facing textures, logos and embellishments. The grade of concrete shall be minimum M35. The concrete shall conform to the requirements of Section 1700 of these Specifications.

Facia panel systems shall have provision of both horizontal and vertical gaps to prevent concrete to concrete contact. The horizontal gap between the facing elements shall be maintained by provision of Ethylene Propylene Diene Monomer (EPDM) pad. Bedding

SPECIFICATIONS FOR BRIDGE WORKS

Name of Work _____

_____ Department

_____ Circle

_____ Division

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3.	***	***	***
4.	***	***	***
5.	***	***	***
6.	***	***	***
7.	***	***	***
8.	***	***	***
9.	***	***	***
10.	***	***	***
11.	***	***	***
12.	***	***	***
13.	***	***	***
14.	***	***	***
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16.	***	***	***
17.	***	***	***
18.	***	***	***
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22.	***	***	***
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30.	***	***	***
31.	***	***	***
32.	***	***	***
33.	***	***	***
34.	***	***	***
35.	***	***	***

GENERAL TECHNICAL SPECIFICATIONS

1. General:

All measurements shall be made in the metric system. Different items of work shall be measured in accordance with the procedures set forth in the relevant specifications read in conjunction with General Conditions of Contract. The same shall not, however, apply in the case of lump-sum items. All measurements and computations, unless otherwise indicated, shall be carried nearest to the following limits :

- | | |
|--|-----------------|
| (i) Length and breadth | 10mm |
| (ii) height, depth or thickness of earthwork, sub-base, bases, surfacings and structural members | 05 mm |
| (iii) areas | 0.01 Sq.Mtrs. |
| (iv) cubic contents | 0.01 Cubic Mtr. |

In recording dimensions of work the sequence of length, width and height or depth or thickness shall be followed.

2. Measurements of lead for materials

Where lead is specified in the contract, the same shall be deemed to mean as described hereunder.

Lead shall be determined on the bases of the shortest practicable route and not the one actually taken and the decision of the Engineer-in-charge in this regard shall be taken as final. Distances upto and including 100 metres shall be measured in units of 50 metres exceeding 100 metres but not exceeding 1 km, in units of 100 metres, and exceeding 1 km, in units of 500 metres. The half and greater than half of the units shall be reckoned as one and less than half of the units ignored. In this regard, the source of the material shall be divided into suitable blocks and for each block the distance from the centre of the block to the centre of placing pertaining to that block shall be taken as the lead distance. Where no lead is specified, it shall mean all lead.

3. Surface Regularity

The surface regularity of completed wearing surfaces in the longitudinal and transverse directions shall be within the tolerances indicated in Table below. The longitudinal profile shall be checked with a 3 metre long straight edge, at the middle of each traffic lane along a line parallel to the centre of the road. The transverse profile shall be checked with a set of three camber boards at intervals of ten metres.

PERMITTED TOLERANCES OF SURFACE REGULARITY FOR PAVEMENT COURSES				
Sr. No.	Type of Construction	Longitudinal profile with 3 metre No. straight edge		Cross Profile
		Maximum Permissible undulations mm.	Maximum number of Undulations permitted in any 300 metres length exceeding 6 mm.	Maximum Permissible variation from specified profile under camber template mm.
1.	Bituminous wearing coat	15	20@	6

Notes. 1. @ These are for machine laid surfaces. If laid manually, tolerance upto 50 percent above these values in this column may be permitted. However this relaxation does not apply to the value of maximum undulation for longitudinal and cross profiles mentioned in columns 3 and 4 on the table.

2. Surface evenness requirements in respect of both the longitudinal and cross profiles should be simultaneously satisfied.

3.1 Rectification :

Where the surface irregularity fall outside the specified tolerances, the contractor shall be liable to rectify these in the manner described below and to the satisfaction of the Engineer-in-charge at his own cost.

3.2 Bituminous Constructions :

For bituminous constructions, for wearing course, where the surface is high or low, the full depth of the layer shall be removed and replaced with fresh material and compacted to specifications. In all cases where the removal and replacement of a bituminous layer is involved, the area treated shall not be less than 5 metres long and less than 1 lane wide.

4. Quality control tests during Construction :

The materials supplied and the works carried out by the Contractor shall conform to the enclosed relevant specifications. For ensuring the requisite quality of construction, the materials and works shall be subjected to quality control tests, as described here in after, by the Engineer-in-charge. Test procedures for the various quality control test are indicated in the respective sections of the Specifications or for certain tests within this section. Where no specific testing procedure is mentioned, the test shall be carried out as per the prevalent accepted Engineering practice to the directions of the Engineer-in-charge.

5. Following materials shall conform to the Indian Standards shown "Against Them":

(1) Cement	IS : 269
(2) Sand for Masonary	IS : 2116
(3) Sand for Concrete	IS : 383
(4) Coarse aggregate	IS : 383
(5) Mild Steel	IS : 432
(6) High yield strength deformed bars-	
(a) Hot Rolled	IS : 1139
(b) Cold Twisted	IS : 1786
(7) Cast Steel	IS : 1030
(8) Cast Iron	IS : 210
(9) Structural Steel-	
(a) Mild Steel	IS : 226
(b) H. T. Steel	IS : 961
(c) Fusion welding quality steel	IS : 2062
(d) Rivet steel	IS : 1148 or
	IS : 1149 as applicable.
(10) H.T. Steel	IS : 1785
(11) Greese	IS : 1002
(12) Electrodes for metal or welding of N.J.	IS : 814

Item 1 - Dismantling (Road and Bridge items)

1. This work shall consist of removing, as here in after set forth, existing culverts, bridges, pavements, kerbes and other structures like guard- rails, fences utility poles, manholes, catch basins, inlets, etc. Which are in place but interfere with the new construction or are not suitable to remain in place, and of salvaging and disposing of the resulting materials and back filling the resulting trenches and pits.

2. Existing culverts, bridges, pavements and other structures which are within the highway and which are designated to be removed shall be removed upto the limits and extent specified in the drawings or as indicated by the Engineer-in-charge.

3. Dismantling and removal operations shall be carried out with such equipment and in such a manner as to leave undisturbed, adjacent pavement, structures and any other work to be left in place.

4. All operations necessary for the removal of any existing structure which might endanger new construction shall be completed prior to the start of new work.

5. The structures shall be dismantled carefully and the resulting materials so removed as not to cause any damage to the serviceable materials to be salvaged, the part of the structure to be retained and any other properties or structures nearby.

6. Unless otherwise specified, the superstructure portion of culverts/bridges shall be entirely removed and other parts removed to below the ground level or as necessary depending upon the interference they cause to the new construction. Removal of overlying or adjacent material if required in connection with the dismantling of the structures, shall be incidental to this item.

7. Where existing culverts/bridges are to be extended or otherwise incorporated in the new work, only such part of the existing structure shall be removed as are necessary to provide a proper connection to the new work. The connecting edges shall be cut chipped and trimmed to the required lines and grades without weakening or damaging any part of the structure to be retained. Reinforcing bars which are to be left in place so as to project into new work as dowels or ties shall not be injured during removal of concrete.

8. Pipe culverts shall be carefully removed in such a manner to avoid damage to the pipes..

9. Steel structures shall unless otherwise provided be carefully dismantled in such a manner as to avoid damage to members thereof. If specified in the drawing or directed by the Engineer-in-charge that structure is to be removed in a condition suitable for re-erection, all members shall be match marked by the contractor with white lead paint before dismantling end pins, nuts, loose plates, etc. shall be similarly marked to indicate their proper location, all pins, pin holes and machined surfaces shall be painted with a mixture of white lead and tallow and all loose parts shall be securely wired to adjacent members or packed in boxes.

10 Timber structures shall be removed in such a manner as to avoid damage to such timber or lumber as is designated to be salvaged by the Engineer-in-charge.

11. In removing pavements, kerbs, gutters and other structures like guard rails, fences, manholes, catch basins, inlets, etc. where portions of the existing construction are to be left in the finished work the same shall be removed to an existing joint or cut and chipped to a true line with a face perpendicular to the surface of the existing strata. Sufficient removal shall be made to provide for proper grades and connections with the new work as directed by the Engineer-in-charge.

12. All concrete pavements, base course in carriage way and shoulders etc. designated for removal shall be broken to pieces whose volume shall not exceed 0.02 cubic metre and stockpiled at designated locations if the material is to be used later or otherwise arranged for disposal as directed.

13. Where directed by the Engineer-in-charge holes and depressions caused by dismantling operations shall be backfilled with excavated or other approved material and thoroughly compacted in line with surrounding area.

14. All materials obtained by dismantling shall be the property of Government. Unless otherwise specified, materials having any salvage value shall be placed in neat stacks of like material within the right-of-way as directed by the Engineer-in-charge, for which Contractor will remain responsible for its safe custody and preservation for 60 days after recording measurements of the salvaged material.

15. Pipe culverts that are removed shall be cleared and neatly piled on the right-of way at points designated by the Engineer-in-charge.

16. Structural steel removed from old structure shall, unless otherwise specified or directed, be stored in a neat and presentable manner. Structures or portions thereof which are specified in the contract for re-erections shall be stored in separate piles.

17. Timber or lumber from old structure which is designated by the Engineer-in charge us materials to be shall have all nails and bolts removed there from and shall be stored in neat piles locations suitable for loading.

18. All the products of dismantling operations which in the opinion of the Engineer-in-charge cannot be used or auctioned shall be disposed as directed, within 100 metres.

19. The work of dismantling structures shall be paid for in units indicated below by taking measurements before and after, as applicable :

(i) Dismantling brick/concrete (Plain and Reinforced) masonry	Cubic Metre
(ii) Dismantling flexible and cement concrete pavement.	Cubic Metre
(iii) Dismantling steel structure.	Tonne
(iv) Dismantling timber structure.	Cubic Metre
(v) Dismantling pipes, guard rails, kerbs, gutters and fencing.	Linear Metre
(vi) Utility poles.	Nos.

20. The contract unit rates for the various items of dismantling shall be payment in full for carrying out the required operations including full compensation for all labour, materials, tools, equipment, safeguards and incidentals necessary to complete the work. These will also include excavation and backfilling where necessary and for handling, salvaging, piling and disposing of the dismantles materials within all lifts and upto a lead of 100 metres.

Item-2 Painting flood Gauge Marks on Sub-structure

1. The width of the flood gauge shall be 60 cm and will have caneri yellow background colour. The flood gauge marking will be in 10 cm. thick strips of alternative black and white colour. The width of the strip shall be as under :-

(a) At every 10 cm.	15cm. width
(b) At every 1/2 m.	25 cm, width in black
(c) At every metre	35 cm. width in white

The lettering shall be in black colour and of 10 cm. height. The lettering shall show every metre and 1/2 m. level. The lettering shall show levels based on either GST B.M. or Arbitrary B.M. as furnished by Engineering-in-charge.

2. All the painting work shall be done in 3 coats. The paint shall be of approved make.

3. The measurement for payment shall be on running meter basis measured vertically in height.

4. The unit rate includes the cost of materials, labour, painting, equipment if any to complete the work.

Item-3 Providing Masonary Steps With Cement Pointing

1. Stones subject to mark deterioration will not be accepted. The stone shall be sound, hard, durable and fairly regular in shape and its thickness in any one direction shall not be less than 15 cm.

2. Before laying the stones, the slope of embankment shall be trimmed to the required profile put up by means of line and pages to receive the steps and kerb on it. Depression shall be filled and thoroughly compacted. The with of the tread shall be 30 cm. (clear) and shall extend further 15 cm. below next tread, thickness of the stone work of the tread shall depend upon the slop of the embankment as under :-

(a) Slope 1 to 2	15 cm.
(b) Slope 1 to 3	10cm.

The thickness of the stones work shall be uniform throughout and shall not be less than the height of the riser depending upon the slope of the embankment as stated above. There shall not be more than 3 stones in the total 45 cms. width of the tread.

3. Kerb of 15 cm. width & 25 cm. depth, flush with the embankment slope line shall be provided to prevent spilling of earth on the steps. Width of the steps between the kerbs shall be 90

cms. Unevenness and voids shall be filled with quarry spalls and exposed faces of the tread riser and kerb of the stones work shall be cement pointed in proportion as specified so that they are stable and remain in line and level. For cement pointing relevant specifications of that item shall apply.

4. The unit rate includes the cost of material, labour and tools including cement pointing to complete the work.

Item-4 Providing intermedia behind abutment etc.

1. Well graded pebbled or metal of 40 mm. to 63 mm. size shall be used. The grading and tolerances of metal of pebbles shall be as under:-

Sr. No.	No. of Size Range	Sieve designation	Percentage by weight passing through the sieve.
1.	63 mm. to 40 mm.	90 mm.	100-00
		63 mm	85-100
		50 mm.	35-70
		40 mm.	00-15
		20 mm.	00-05

The size shall be 40 mm. to 63 mm. where in tolerance limit for over size shall be upto 15% and that for lower size should be upto 15% and below 20 mm. it shall be allowable upto 5%. The filter Material shall be tightly placed to a thickness of not less than 600 mm. and provided over the entire surface behind abutments, wings or return walls to the full height.

2. Materials shall be first stacked in boxed of 2 m. x 1 ½ m. x 0.5m. size on fairly level ground and measured.

3. The measurement for payment shall be made on Cmt. basis of boxes. No deduction shall be made for voids.

4. The unit rate includes the cost of materials, scaffolding labour and tools to complete the work.

Item-5-A Filling rubbles between returns and behind abutment

1. Stone subject to marked deterioration by water or weather will not be accepted. The stone shall be sound, hard, durable and fairly regular in shape and its thickness in any one direction shall not be less than 15 cm. The largest stones procurable shall be supplied on site. The size of spauls shall be minimum 25 mm. and shall be suitable to fill voids.

2. Stones shall be filled in layers of 23 cms. to 30 cms. thickness and all interstics between adjacent stones shall be filled with 20 per cent spauls of proper size and wedged in with hammers to ensure tight packing.

3. Stones shall be first stacked in rectangular chattas on fairly level ground and measured. Artificial voids should not be left in side the chattas.

4. The measurement for payment shall be made on cmt. basis of chatta of rubbles only. No deduction shall be made for voids. Chattas for spauls shall be made separately and shall be measured for record purpose only and shall not be paid for.

5. The unit rate includes the cost of materials, labour & tools to complete the work,

Item 5-B-Providing rubble for apron

1. The work shall consist of laying boulders directly on the prepared surface for protection against scour.

2. The stones used in apron shall be sound, hard, durable & fairly regularly in shape. Stone subject to marked deterioration by water or weather shall not be used. The thickness and shape of apron shall be as indicated on the drawings or as directed by the Engineer-in-charge. The surface on which the apron is to be laid shall be levelled and prepared for the length and width as shown on

the drawings. The size of stone shall be as large as possible & weight shall be as specified in the item but in no case any fragment shall weight less than 40 Kg. The specific gravity of stone shall be as high as possible and it shall not be less than 2.50. To ensure regular and orderly disposition- of the full intended quantity of stone in the apron, template cross walls in dry masonry shall be built about a metre wide and to the full hight of the specified thickness of the apron at intervals of 30 metres and all along the length and width of the apron. Within these walls, the stone then shall be hand-packed.

3. Payment shall be made on CMT basis of chatta. The materials shall have to be stacked at site before laying. Preparation of base, or laying bedding shall be deemed incidental to the work. Nothing shall deducted for voids.

4. The rate shall include cost of materials, labour & tools to complete the job.

Item 6-Fhiling with sand (a) between returns,, (B) between top and bottom plug (C) below raft foundations.

1. The sand to be used for filling shall be coarse, granular, clean, free from dust and deleterious matters obtained from a source as approved by the Engineer-in-charge. Sand between returns shall confirm to I.S. : 383.

Coarse aggregate: 10 mm,12.5 mm,16 mm,20 mm,40 mm & 63 mm

2. After the bottom plug has been laid and tested for leakage the level of its top shall be ascertained and recorded and the well shall be filled with sand under water in suitable layers not exceeding 30 cm. at a time and each layer well compacted by rodding to maximum density upto the level of the underside of the plug as per detailed drawing or as directed by the Engineer-in-charge.

3. Sand between returns and below raft foundations shall be filled in suitable layers not exceeding 30 cms. at a time and each layer shall be well compacted.

4. Mode of measurement shall be the total cubical content (in cmt.) of the area covered by sand filling.

Item 7-Excavation for foundation in all sorts of soils and murrum including dewatering

1. Excavation for structures shall consist of the removal of material for the construction of foundations for bridges, culverts, retaining walls, headwalls, cut off walls, pipe culverts and other similar structures, in accordance with the requirements, of these specifications and the lines and dimensions shown on the drawings or as indicated by the Engineer-in-charge. The work shall be include all necessary sheeting, shoring, bracing, draining and pumping and the removal of all logs, stumps, shrubs, and other deleterious matter and obstruction necessary for the foundations, trimming bottoms of excavations; back filling and clearing up th3 site and the disposal of all surplus material.

2. After the site has been cleared the limits of excavation shall be sot out true to lines, curves, slopes, grades and sections as shown on the drawings or as directed by the Engineer-in-charge. The contractor shall provide all labour, survey instruments and materials such as strings, pegs nails bamboos, stones, lime, mortar, concrete, etc. required in connection with the siting out of works and the establishment of bench mark, centre line stones and other marks and stakes as long as in the opinion of the Engineer-in-charge, they are required for the work.

3. Excavation shall be taken to the with of the lowest step of the footing. The contractor at his own expense shall put up necessary shoring, strutting and planking or cut slopes to a safer angle or both with due regard to the safety of personal and works and to the satisfaction of the Engineer-in-charge.

4. The depth to which the excavation is to be carried out shall be is shown on the drawings, unless the type of material encountered is such as to require changes, in which case the depth shall be as ordered by the Engineer-in-charge.

5. Where water is met with in excavation due to stream flow, seepage, springs, rain or other reasons, the contractor shall take adequate measures such as bailing pumping, to keep the foundation trenches dry when so required and to protect the green concrete/masonry against

damage by erosion or sudden rising of water level. The methods to be adopted in this regard and other details thereof shall be left to the choice of the contractor but subject to approval of the Engineer-in-charge. Approval of the Engineer-in-charge shall, however not relieve the contractor of the responsibility for the adequacy of dewatering, and production arrangements and for the quality and safety of the works.

6. pumping from the interior of any foundation enclosure shall be done in such a manner as to preclude the possibility of movement of water through any fresh concrete. No. pumping shall be permitted during the placing of concrete or for any period of at least 24 hours thereafter, unless it is done from a suitable sump separated from the concrete work by a water tight wall or other similar means.

7. The bottom of the foundation shall be levelled both longitudinally and transeversely or stepped as directed by the Engineer-in-charge. Before footing is laid, the surface shall be slightly watered and rammed. In the event of excavation having been made deeper than that shown on the drawings or as otherwise ordered by the Engineer-in-charge, the extra depth shall be made up with concrete or masonry of the foundation grade at the cost of the contractor. Ordinary filling shall not be used for the purpose to bring the foundation to level. If there are any slips or blows in the excavation, these shall be removed by the contractor at his own cost.

8. Near towns, villages and all frequented places, trenches and foundation pits shall be securely fenced, provided with proper caution signs and marked with red lights at night to avoid accidents. The contractor shall take adequate protective measures to see that the excavation operations do not affect or damage adjoining structures.

9. Backfilling shall be done with approved materials after concrete or masonry is fully set and carried out in such a way as not to cause undue thrust on any part of the structure. All space between foundation masonry or concrete and the sides of excavation shall be refilled to the original surface, making due allowance for settlement in 250 mm. loose layers, which shall be watered and compacted.

10. All the excavated materials shall be the property of the Government. Where the excavated materials is to be used in the construction of embankment, it shall be directly deposited at the required location, within 100 metres lead.

11. All useful materials not intended for use in the bank, shall be stacked neatly on Government land as directed by the Engineer-in-charge within 100 metres lead. Unsuitable and surplus materials not intended for use shall be disposed off as directed by the Engineer-in-charge.

12. Excavation for structures shall be measured in cubic metres for each class of materials encountered, limited to the dimensions shown on the drawing or as directed by the Engineer-in-charge. Excavation over increased width cutting of slopes, shoring, shuttering and planking shall be deemed as convenience for the contractor in executing the work and shall not be measured and paid for separately.

13. The contract unit rate for the items of excavation for structures shall be paid in full for carrying out the required operations including :-

1. Setting out and fixing bench marks and centre lines stones.
2. Construction of necessary shoring and bracing and their subsequent removal.
3. Removal of all logs, stumps, Grubs and other deleterious matter and obstructions for placing the foundations including trimming of bottoms of excavations;
4. Foundation sealing, dewatering including pumping;
5. Backfilling, Clearing up the site and disposal, of all surplus material within all lifts and lead upto 100 metres;
6. All labour, materials, tools equipment, safeguards and incidentals necessary to complete the work to the specification.

14. Excavation shall be for ordinary soil such as vegetation or organic soil, turf, sand, silt, loam, clay, mud, black cotton soil, soft shale or soft murrum, a mixture of these and similar material which yields to the ordinary application of pick and shovel, or other ordinary digging equipment. Removal of gravel or any other nodular material having diameter in any one direction not exceeding 75 mm. occurring in such strata shall be deemed to be covered under this category. The classification

of excavation shall be decided by the Engineer-in-charge and his decision shall be final and binding on the contractor.

Item 8- Excavation for foundation in hard murrum and boulders including dewatering.

1 to 13. Para 1 to 13 of the item of excavation for foundation in all sorts of soil shall apply.

14. Excavation shall be in hard soil such as stiff heavy clay, hard shale or compact murrum requiring grouting tool or pick or both and shovel, closely applied and gravel and rubble stone having maximum diameter in any one direction between 75 and 300 mm. and soft conglomerate. The classification of excavation shall be decided by the Engineer in -charge and his decision shall be final and binding on the contractor.

Item 9- Excavation for foundations in large boulders and soft rock without blasting including dewatering.

1 to 13. Para 1 to 13 of the item of excavation for foundation in all sorts of soil shall apply.

14. Excavation shall be in soft rock or such as lime stone, sand stone, laterite, hard conglomerate or other soft or disintegrated rock which may be quarried or split with crow bars, boulders which do not require blasting having diameter in any direction of more than 300 mm. and any rock which in dry state may be hard, requiring blasting but which when wet become soft and manageable by means other than blasting. The classification of excavation shall be decided by the Engineer-in-charge and his decision shall be final and binding on the contractor.

Item 10 Excavation for foundation in hard rock including dewatering.

(A) Requiring blasting (B) Blasting prohibited

1 to 13. Para 1 to 13 of the item of excavation for foundation in all sorts of soil shall apply.

14. Excavation shall be in any rock or boulders having diameter in any one direction of more than 300 mm. for which the use of mechanical plant or blasting is required. The classification of excavation shall be decided by the Engineer-in-charge and his decision shall be final and binding on the contractor. Merely the use of explosive in excavation will not be considered as a reason for higher classification unless blasting is clearly necessary in the opinion of the Engineer-in-charge.

15. Where blasting is prohibited for any reason, excavation shall be carried out by chiseling, wedging or any other approved method.

16. Blasting shall be carried out only with the written permission of the Engineer-in-charge. All the statutory laws, regulations, rules, etc. pertaining to the acquisition, transport, storage, handling and use of explosives shall be strictly followed.

17. The contractor may adopt any method or methods of blasting consistent with the safety and job requirements, after approval from the Engineer-in-charge.

18. The magazine for the storage of explosives shall be built to the design and specifications of the Explosives Department concerned and located at the approved site. No unauthorized person shall be admitted into the magazine which when not use shall be kept securely locked. No matches or inflammable material shall be allowed in the magazine. The magazine shall have an effective lightning conductor. The following shall be hung in the lobby of magazine.

- (a) A copy of the relevant rules regarding safe storage both in English and in the language with which the workers concerned are familiar.
- (b) A statement of up-to-date stock in the magazine.
- (c) A certificate showing the last date of testing of the lightning conductor.
- (d) A notice that smoking is strictly prohibited.

19. In addition to these, the contractor shall also observe the following instructions and any further additional instructions which may be given by the Engineer-in-charge and shall be responsible for damage to property and any accident which may occur to workmen or the public on account of any operations connected with the storage handling or use of explosive and blasting. The Engineer-in-charge shall frequently check the contractor's compliance with these precautions.

20. All the materials, tools and equipment used for blasting operations shall be of approved type. The Engineer-in-charge may specify the type of explosive to be allowed in special cases. The fuse to be used in wet locations shall be sufficiently water-resistant as to be unaffected when

immersed in water for 30 minutes. The rate of burning of the fuse shall be uniform and definitely known to permit such a safe length being cut as will permit sufficient time to the firer to reach to place of safety before explosion takes place. Detonators shall be capable of giving effective blasting of the explosives. The blasting powder, explosive detonators, fuses, etc., shall be fresh and not damaged due to damp, moisture or, any other cause. They shall be inspected totally and removed immediately, if found unsuitable.

21 The blasting operation shall remain in charge of competent and experienced supervisory staff and workmen who are thoroughly acquainted with the details of handling explosives and blasting operations.

22. The Wasting shall be carried out during fixed hours of the day preferably during the mid-day luncheon hour or at the close of the work as ordered in writing by the Engineer-in-charge. The hours shall be made known to the people in the vicinity. All the charges shall be prepared by the man in charge only.

23. Red danger flags shall be displayed permanently in all directions during the blasting operations. People, except those who actually light the fuse, shall be prohibited from entering this area. The flags shall be planted 200 meters from the blasting site in all directions and all persons including workmen shall be excluded from the flagged area at least 10 minutes before the firing, a warning whistle being sounded for the purpose.

24. The charge holes shall be drilled in suitable places to required depths. Blasting should be as light as possible consistent with thorough breakage of the material necessary for economic loading and hauling. Any method of blasting which leads to over shooting shall be discontinued.

25. When blasting is done with powder, the fuse cut to the required length, shall be inserted into the hole and the powder dropped in. The powder shall be gently tamped with copper rods with rounded ends. The explosive powder shall then be covered with tamping materials which shall be tamped light but firmly.

26. When blasting is done with dynamite and other high explosives, dynamite, cartridges shall be prepared by inserting the square cut end of a fuse into the detonator and finishing it with nippers at the open end, the detonator gently pushed into the primer leaving 1/3rd of copper tube exposed outside. The paper of the cartridge shall then be closed up and securely bound with wire, or twine. The primer shall be housed into the explosive. Bore holes shall be of such size that the cartridge can easily go down. The holes shall be cleared of all debris and explosive inserted. The space of about 20 cm. above the charge shall then be gently filled with dry clay, passed home & the rest of the tamping formed of any convenient material gently packed with a wooden rammer.

27. At a time, not more than 10 such charges will be prepared and fired. The man in charge shall blow a whistle in a recognised manner or cautioning the people. All the people shall then be required to move to safe distance. The charge shall be lighted by the man in charge only. The man in charge shall count the number of explosions. He shall satisfy himself that all the charges have been exploded before allowing the workmen to go back to the work site.

28. In case of a misfire, the following procedure shall be observed :

(1) Sufficient time shall be allowed to account for the delayed blast. The man in charge shall inspect all the charges and determine the missed charges.

(2) If it is the blasting powder charge it shall be completely flooded with water. A new hole shall be drilled at about 45 cm. from the old hole and fired. This should be repeated till the old charge is blasted.

(3) In case of charges of gelatine, dynamite etc., the man in charge shall gently remove the tamping and the primer with the detonator. A fresh detonator and primer shall then be used to blast the charge.

Alternatively, the hole may be cleared of 30 cm. of tamping and the direction then ascertained by placing a stick in the hole. Another hole may then be drilled 15 cm. away and parallel to it. This hole shall then be charged and fired when the misfired hole should explode at the same time. The man in charge shall at once report to the contractor's Officer and Engineer-in-charge all cases of misfire, the cause of the same and what steps were taken in connection therewith.

29. If a misfire has been found to be due to defective detonator or dynamite, the whole quantity in the box from which defective article was taken must be sent to the authority directed by the Engineer-in-charge for inspection to ascertain whether all the remaining materials in the box be also defective.

30. A careful and day to day account of the explosive shall be maintained by the contractor in an approved manner in a register which shall be open to inspection by the Engineer-in-charge at all times.

31. Excavation shall be measured after removal of over burden by taking cross-sections at suitable intervals in the original position before the work starts and after its completion and computing the volumes in cubic metres by the method of average and areas. Where it is not feasible to compute volumes by this method because of erratic location of isolated deposits; the volumes shall be computed by other accepted methods. At the option of the Engineer-in-charge, the contractor shall leave depth indicators during excavations of such shape and size, and in such positions as directed so as to indicate the original ground level as accurately as possible. The contractor shall see that these remain intact till the final measurements are taken. Where cross-sectional measurements, could not be taken due to irregular configuration, or where the rock is admixed with other classes of materials, the volumes shall be computed on the basis of stacks of excavated rubble after making 40 per cent deduction therefrom.

Item 11- Diversion of water course, providing soffer dam, bund or island for foundations.

1. The item provides for the diversion of water course by suitable means such as by constructing ring bunds, coffer-dams, channeling, islanding or any other suitable means as may be necessary and approved by Engineer-in-charge. This item will not include dewatering of foundations, trenches, which will be covered in the item of open excavation. The contractor shall take all necessary protective measures against possible erosion due to tide variations if any and maintain the coffer dams, bund or island in proper manner during construction. He shall not be entitled for any payment or compensation in the event of washing of the coffer dam, bund or island at any time, either due to tidal waters if any or floods, or any other reasons whatsoever, and the contractor shall reconstruct the same. If required at his risk and cost. The size of the coffer dam, bund or island shall be such as would allow without obstruction and inconvenience, enough working free space all around the foundation works.

2. The contractor shall plan, construct and maintain satisfactorily necessary diversion channels and protective works so as to safely pass the stream flow and also satisfactorily meet with any sudden rise of flow due to tides, flood or any other reason, without damaging the foundation works. The cofferdam or bund shall be such as to give sufficient working space for construction, inspection and installations of pumping machinery inside the enclosed area. The coffer dam or bund shall be of adequate section and properly designed, constructed to prevent ingress of water as practically as possible in the foundation pits and to protect green concrete or masonry work.

3. Adequate pumping arrangement shall be made for dewatering the inside of coffer dam, bunds etc. Pumps of adequate capacity and in required number shall be provided to ensure adequate pumping.

4. The coffer dam, bund or island shall be completely removed and their materials shall be disposed of in the manner as directed by the Engineer-in-charge when no longer required.

5. The measurements for paying will be per number of pier or abutment for which diversion of water course etc. is required to be made. Unit of abutment will be inclusive of returns or wingwalls attached to it.

6. The unit cost includes all materials labour and equipment to complete the job. Diversion of channels etc. will have to be construed and maintained till all operations to complete the entire bridge structure are completed as may be necessary.

Item 12- Ordinary concrete with or without reinforcement

1. In case of ordinary concrete, mix is not required to be designed by preliminary tests and proportions of cement, fine aggregates and coars aggregates are specified by volume as given in table below for different grades of concrete designated as ordinary M. 100, M. 150, M.200 and M.250.

2. In the designation of a concrete mix, letter "M" refers to the mix and the number the specified 28 days works cube compressive strength of that mix on 150 mm. cubes expressed in kg./cm².

3. The ordinary concrete mix shall generally be specified by volume. For cement which normally comes in bags and is used by weight, volume shall be worked out taking 50 kg. of cement as 0.035 cubic metre in volume. While measuring aggregate by volume, shaking, ramming or hammering shall not be done. Proportioning of sand shall be as per its dry volume. In case it is dump, allowance for "bulking" shall be made as per IS : 2386 (Part-III).

4. Ingredients required for ordinary concrete containing one 50 Kg. bag of cement of different proportions of mix shall be as given in Table below.

TABLE

Grade of Concrete	Mix By Volume	Total quantity of dry aggregates by volume Per 50 Kg. of cement, to be taken as sum of the individual volumes of fine and coarse aggregates max.	Proportion of fine aggregate to coarse aggregate	Quantity of water per 50 Kg. of cement max.
1	2	3	4	5
(1 Cubic metre = 1000 Litres)				
Ordinary	Litres			Litres.
M. 100	1:3:6	300	General 1 : 2 for fine aggregate to coarse aggregate by volume but subject to a upper limit of 1:1, 1/2 & a lower limit of 1 : 3	34
M.150	1:2:4	220		32
M.200	1:1 1/2:3	160		30
M.250	1:1:2	100		27

NOTE - The proportions of the aggregates shall be adjusted from upper limit to lower limit progressively as the grading of the fine aggregates becomes finer & the maximum size of coarse aggregate becomes larger. Example - For an average grading of fine aggregate (that is Zone II of IS : 383-1963) the proportions shall be 1: 1 1/2, 1:2 and 1:3 for maximum size of aggregates 10 mm, 20 mm. and 40 mm. respectively (after carrying out sieve analysis).

Note-2 A mix leaner than M.100 (1:3:6) may be used for non- structural parts, if provided in the contract. In such case grading of aggregates shall be by volume. Other requirements for mixing, placing & curing shall be the same.

5. Following shall be the maximum nominal size of coarse aggregate for the different items of work:

Sr. No.	Item of construction	Maximum nominal size of coarse aggregate
(i)	R.C.C. well curb, R.C.C. well steining and R.C.C. Piles	40 mm.
(ii)	R.C.C. well steining	63mm.
(iii)	Well cap or pile cap; solid type piers, abutment and wing-walls, and their pier caps	40 mm.
(iv)	R.C.C. works in cross girders deck slab, wearing	20 mm.

	coars, kerb, light post,, blast walls, approach slab etc. and hollow type piers, abutments, wing-walls and their pier caps,	
(v)	R.C.C bparings.	20mm
(vi)	For any other item of construction not covered by items (i) to (v)	As specified on the drawing or as desired by the Engineer in-charge in case it is not specified on drawing.

For heavily reinforced concrete members as in the case of fibs of main beams nominate maximum size of aggregate shall usually be restricted to 5 mm. less than the minimum lateral clear distance between the main bars or 5 mm. less than the minimum cover to the reinforcement, whichever is the smaller.

6. Fine aggregate shall be clean, hard, coarse sand, it shall be free from dust and such other substances. The sand be got approved by the Engineer-in-charge.

7. All materials shall be stored as to prevent their deterioration or intrusion of their quality and fitness for the work. Any material which has deteriorated or has been damaged or is otherwise considered defective by the Engineer-in-charge shall not be used in the works.

8. Cement shall be stored above the ground level in perfectly dry and water tight sheds. Wherever bulk storage containers are used, their capacity should be sufficient to cater to thy requirements at site and should be cleaned at least once every 3 to 4 months. The aggregate shall be stored in such a way as to prevent admixture of foreign materials. Different size of fine or coarse aggregate shall be stored in separate stock-piles sufficiently away from the each other to prevent intermixing the material.

9. The water for mixing shall be potable water to satisfaction of the Engineer-in-charge. The quantity of water shall be just sufficient to produce a dense concrete of required workability for the job.

10. For all work concrete shall be mixed in a mechanical mixer which along with other accessories shall be kept in first class working condition and so maintained throughout the construction. Mixing shall be continued till materials are uniformly distributed and uniform colour of the entire mass is obtained and each individual particle of the coarse aggregate show complete coating of mortar containing its proportionate amount of cement. In no case shall the mixing be done for less than 2 minutes after all ingredients have been put into the mixer.

11. When hand mixing is permitted by the Engineer in-charge for small jobs or for certain other reasons. It shall be done en a smooth watertight platform large enough to allow efficient turning over of the ingredients of concrete before and after adding water. Mixing platform shall be so arranged that no foreign material shall get mixed with concrete nor does the mixing water flow out. Cement in required number of bags shall be placed in a uniform layer OP top of the measured quantity of fine and coarse aggregate, which shall also be spread in a layer of uniform thickness on the mixing platform. Dry coarse and fine aggregate and cement shall then be mixed thoroughly by turning over to get a mixture of uniform colour. Enough water shall then be added gradually through a rose can and the mass turned over till a mix of required consistency is obtained. In hand mixing quantity of cement shall be increased by 10 per cent above that specified.

12. Mixers which have been out of use for more than 30 minutes shall be thoroughly cleaned before putting in a new batch. Unless otherwise agreed to be the Engineer-in-charge, the first batch of concrete from the mixer shall contain only two thirds of normal quantity of coarse aggregate. Mixing plant shall be thoughtly cleaned before changing from one type of cement to another.

13. The method of transporting and placing concrete shall be approved by the Engineering-in-charge. Concrete shall be so transported and placed that no contamination, segregation or loss of its constituent material takes places. All form work and reinforcement contained in it shall be cleaned and made free from standing water, dust, snow or ice immediately before placing of concrete. No concrete shall be placed in any part of the structure until the approval of the Engineer-in-charge has been obtained.

14. If concreting is not started within 24 hours of the approval being given, it shall have to be obtained again from the Engineer-in-charge. Concreting being given it shall proceed continuously over the area between construction joints. Fresh concrete shall not be placed against concrete which has been in position for more than 30 minutes unless a proper construction joint is formed. Concrete shall be compacted in its final position within 30 minutes of its discharge from the mixer unless carried in properly design agitators, operating continuously, when this time shall be within 2 hours of the addition of cement to the mix and within 30 minutes of its discharge from the agitator. Except where otherwise agreed to be the Engineer-in-charge, concrete shall be deposited in horizontal layers to a compacted depth of not more than 0.45 metre when internal vibrators are used and not exceeding 0.30 metre in all other cases.

15. Unless otherwise agreed to by the Engineer-in-charge concrete shall not be dropped into place from a height exceeding 2 metres. When trunking or chutes are used they shall be kept clean and used in such a way as to avoid segregation. When concreting has to be resumed on a surface which has hardened, it shall be roughened, swept, clean, thoroughly wetted and covered with a 13mm thick layer of mortar composed of cement and sand in the same ratio as in the concrete mix itself. This 13 mm. layer of mortar shall be freshly mixed and placed immediately before placing of new concrete. Where concrete has not fully hardened, all laitance shall be removed by scrubbing the wet surface with wire or bristle brushes, care being taken to avoid dislodgement of any particles of coarse aggregate. The surface shall then be thoroughly wetted, all free water removed and then coated with neat cement grout. The first layer of concrete to be placed on this surface shall not exceed 150 mm. in thickness, and shall be well rammed against old work particular attention being given to corners and close spots.

16. All concrete shall be compacted to produce a dense homogeneous mass with the assistance of vibrators, unless otherwise permitted by the Engineer-in-charge for exceptional cases, such as concreting under water, where vibrators can not be used. Sufficient vibrators in serviceable condition shall be kept at site so that spare equipment is always available in the event of break downs.

17. Immediately after compaction, concrete shall be protected against harmful effects of weather, including rain, running water, shocks, vibration, traffic, rapid temperature changes, frost and driving out process. It shall be covered with wet sacking, hessian or other similar absorbent material approved by the Engineer-in-charge soon after the initial set, and shall be kept continuously wet for a period of not less than 14 days from the date of placement. Masonry work over the foundation may be started after 48 hours of its laying but the curing of concrete shall be continue for a period of 14 days.

18. Form work shall include all temporary or permanent forms required for forming the concrete, together with all temporary construction required for their support. Form work shall however be divided into following two distinct categories :-

(1) Shuttering i.e., form work required for forming the concrete.

(2) Scaffolding i.e., form-work required for supporting shuttering.

Forms for shuttering shall be constructed only in metal suitably lined. Forms for scaffolding shall be constructed of metal or timber. Both shuttering and scaffolding shall be of substantial -rigid construction and shuttering shall be true to shape and dimensions shown on the drawings. All bolts and rivets shall be counter-sunk and well ground to provide a smooth, plane surface.

19. Forms shall be mortar-tight and 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, without deflection from the prescribe lines occurring during and after placing the concrete. Screw jacks or hard wood wedges where required shall be provided to make up any settlement in the formwork either before or during the placing of concrete. Suitable camber shall be provided in horizontal members of structure, specially in long spans to counteract the effects of any fixed as to provide for such camber. Forms shall be so constructed as to be removable in sections in the desired sequence, without damaging the surface of concrete or disturbing other sections. Unless otherwise specified or directed, chambers or fillets of sizes 25 mm x 25 mm shall be provided at all angles of formwork to avoid sharp corners.

20- The inside surfaces of shuttering shall, except in the case of permanent form work or where otherwise agreed to by the Engineer-in-charge, be coated with an approved material to prevent adhesion of concrete to the form work. 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 form work for concrete which will be visible in the finished works.

21. Special measures shall be taken to ensure that the form work does not hinder the shrinkage of concrete because without these cracking could occur before the form work is removed. Wherever applicable arrangements must be made to ensure that the form work does not restrain the shortening and hogging of the beams or slabs during tensioning of the tendons. The form work should 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 a false work, scaffolding or propping and the instantaneous or deferred deformation due to various causes affecting prestressed structures. Where there are re-entrant angles in the concrete sections the form work should be removed at those sections as soon as possible after the concrete has set in order to avoid cracking due to shrinkage of concrete, formwork shall be tight enough to prevent any appreciable loss of cement during vibrations, suitable utterances should be provided in the formwork. Immediately before concreting all forms shall be thoroughly cleaned. Contractor shall give the Engineer-in-charge due notice before placing any concrete in the forms to permit him to inspect and accept the false work and forms as to their strength alignment and general fitness, but such inspection shall not relieve the contractor of his responsibility safety of men, machinery, materials and for results obtained.

22. The Engineer-in-charge shall be informed in advance by the contractor of his intention to strike any formwork. While fixing the time for removal of formwork, due consideration shall be given to local conditions, character of the structure, the weather and other conditions that influence the setting of concrete and of the materials used in the mix. Where field operations are controlled by strength tests of concrete, the removal of the load-supporting or soffit forms may commence when concrete has attained strength equal to at least twice the stress to which the concrete will be subjected at the time of striking props including the effect of any further addition of loads. When field operations are not controlled by strength tests of concrete the vertical forms of beams, columns and walls may be removed after 2 days. The props of slabs and beams may be removed after 21 days respectively. All formwork shall be removed without causing any damage to the 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. Where internal metal ties are permitted, they or their removable parts shall be extracted without causing any damage to the concrete and remaining holes filled with mortar. No permanently embedded metal part shall have less than 25 mm. cover to the finished concrete surface. Where it is intended to reuse the formwork, it shall be cleaned and made good to the satisfaction of the Engineer-in-charge.

23. Immediately after the removal of forms, all exposed bars or bolts passing through the Cement concrete member and used for shuttering or any other purpose shall be cut inside the cement concrete member to a depth of at least 25 mm, below the surface of the concrete and the resulting holes be filled by cement mortar. All fins caused by form joints, all cavities produced by the removal of form ties and all other holes and depressions, honeycomb spots, broken edges or corners and other defects, shall be thoroughly cleaned, saturated with water and carefully pointed and rendered true with mortar of cement and fine aggregate mixed in the proportions used in the grade of concrete that is being finished and of as dry as consistency as is possible to use. Considerable pressure shall be applied in filling and pointing to ensure thorough filling in all voids. Surfaces which have been pointed shall be kept moist for a period of twenty four hours. If rock pockets/honeycombs, in the opinion of the Engineer-in-charge are of such an extent or character as to affect the strength of the structure materially or to endanger the life of the steel reinforcement, he may declare the concrete defective and require the removal and replacement of the portions of the structure affected.

24. In the case of reinforced concrete work workability shall be such that the concrete surrounds and properly grips all reinforcement. The degree of consistency, which shall depend upon the nature of work and methods of vibration of concrete shall be determined by regular slump tests. Following slump shall be adopted for different types of works.

Type		Slump (mm) (at the Time of Placing of Concrete)
1)	a) Structure with exposed inclined surface requiring low slump concrete to allow proper compaction	25
	b) Plain cement concrete	25
2)	RCC structure with widely spaced reinforcements; e.g. solid columns, piers, abutments, footings, well steining	40 – 50
3)	RCC structure with fair degree of congestion of reinforcement; e.g. pier and abutment caps, box culverts, well curb, well cap, walls with thickness greater than 300 mm	50 – 75
4)	RCC and PSC structure with highly congested reinforcements e.g. deck slab girders, box girders, walls with thickness less than 300 mm	75 – 125
5)	Underwater concreting through tremie e.g. bottom plug, cast in-situ piling	150 – 200

25. Works strength tests shall be made in accordance with IS : 516. Each test shall be conducted on ten specimens/five of which shall be tested at seven days and the remaining five at 28 days. The samples of concrete shall be taken on each day of concreting and cubes shall be made at the rate of one for every 5 cubic metre of concrete or a part thereof. However, if concreting done in a day is less than 15 cubic meters, the minimum number of cubes can be reduced to 6 with the specific permission of the Engineer-in-charge. Similar works tests shall be carried out whenever the quality and grading of materials is changed irrespective of the quantity of concrete poured. The number of specimens may be suitably increased as deemed necessary by the Engineer-in-charge when procedure of tests given above reveal a poor quality of concrete and in other special cases.

26. The average strength of the group of cubes cast for each day shall not be less than the specified works cube-strength. 20 per cent of the cubes cast for each day may have values less than the specified strength, provided the lowest value is not less than 85 per cent of the specified strength.

27. R.C.C. work shall have exposed concrete surface. Centering design and its erection shall be approved by the Engineer-in-charge. One carpenter with helper will invariably be kept present throughout the period of concreting. Movement of labour and other persons shall be totally prohibited over reinforcement laid in position. For access to different parts, suitable mobile platforms shall be provided so that steel reinforcement in position is not disturbed. For ensuring proper cover, mortar blocks of suitable size shall be cast and tied to the reinforcement. Timber, kapchi or metal pieces shall not be used for this purpose. Concreting of important structural members shall always be done in the presence and under the supervision of departmental person not below the rank of Asst. Engineer/ Addl-Asst. Engineer Overseer or as instructed by the Engineer-in-charge. After removal of form work checks that concrete produced is of good quality. Plastering shall not be allowed to the exposed faces of concrete.

28. In reinforced concrete the volume occupied by reinforcement shall not be deducted. The slab shall be measured as running continuously through and the beam as the portion below the slab.

29. All necessary labour, materials, equipment, etc., for sampling, preparing test cubes, curing etc., shall be provided by the Contractor. Testing of the materials and concrete may be arranged by the Engineer-in-charge in an approved laboratory at the cost of the contractor.

30. The payment will be made on cmt. basis of the finished work.

31. The unit rate for concrete shall include the cost of all materials, labour, tools and plan required for mixing, placing in position, vibrating and compacting finishing as per directions of the Engineer-in-charge, curing and all other incidental expenses for producing concrete of specified strength to complete the structure or its components as shown on the drawings and according to these specifications. The rate shall also include the cost of making/fixing and removing of all centres and forms required for the work.

Item 13 - Controlled concrete

1. For controlled concrete, design of the mix shall be approved after preliminary tests and all necessary precautions shall be taken in its production to ensure that the required works cube strength is attained and maintained. The controlled concrete shall be eight grades designated as M. 100, M. 150, M. 200, M. 250, M.300, M. 350, M. 400 and M. 450 with the suffix 'controlled' added to it.

2. In the designation of a concrete mix, letter 'M' refers to the mix and the number to the specified 28 days works cube compressive strength of that mix on 150 mm cubes, expressed in kg/cm² where ordinary Portland cement conforming to IS : 269 or Portland blast furnace cement conforming to IS : 455 is used, the compressive strength requirements for various grades of concrete shall be as given below on The next page :-

Grade of Concrete	Compressive works test strength in kg/cm ² on 150 mm. cubes, conducted in accordance with IS '516	
	Min. at 7 days	Win. at 28 days
M100	70	100
M150	100	150
M200	135	200
M250	170	250
M300	200	300
M350	235	350
M400	270	400
M450	300	450

NOTE - In all cases, the 28 days compressive strength specified in the above Table shall alone be the criterion for acceptance or rejection of the concrete.

Where the strength of a concrete mix, as indicated by tests, lies in between the strength for any two grades specified in the above Table such concrete shall be classified for all purposes as a concrete belonging to the lower or the two grades between which its strength lies.

3. Concrete mix shall be designed on the basis of preliminary tests so as to attain a strength at least 33 per cent higher than that required on work tests. The proportions for ingredients chosen shall be such that concrete has adequate workability for conditions prevailing on the work in question and can be properly compacted with the means available. Except where it can be shown to the satisfaction of the Engineer-in-charge that supply of properly graded aggregate of uniform quality can be maintained till the completion of work, grading of aggregate should be controlled by obtaining the coarse aggregates in different sizes and blending them in the right proportions as required. Aggregates of different sizes shall be stocked in separate stock piles. Required quantity of material shall be stock piled several hours, preferably a day, before use. Grading of coarse and fine aggregate shall be checked as frequently as possible, frequency for a given Job being determined by the Engineer-in-charge to ensure that the suppliers are maintaining the uniform grading as approved for samples used in the preliminary tests.

4. In proportioning concrete, the quantity of both cement and aggregate shall be determined by weight. Where the weight of cement is determined by accepting the maker's weight per bag, a reasonable number of bags shall be weighed separately to check the net weight. Where cement is weighed from bulk stocks at site and not by bags, it shall be weighed separately from the aggregates. Water shall either be measured by volume in calibrated tanks or weighed. All measuring equipment shall be maintained in a clean, and serviceable condition. Their accuracy shall be periodically checked.

5. It is most important to keep the specified water-cement ratio constant and at its correct value. To this end, moisture content in both fine and coarse aggregates shall be determined by the Engineer-in-charge according to the weather conditions. The amount of mixing water shall then be adjusted to compensate for variations in the moisture content. For the determination of moisture content in the aggregates, IS : 2386 (Part -II) shall be referred to. Suitable adjustments shall also be made in the weights of aggregates to allow for the variation in weights of aggregates due to variation in their moisture content. Minimum quantity of cement to be used in controlled concrete shall not be less than 210 Kg. per cubic metre in plain concrete and not less than 300 kg/per cubic metre in reinforced concrete structural members. The minimum quantity of cement for prestressed concrete work shall not be less than 360 kg/per cubic metre of concrete nor shall it be more than 540 kg/per cubic metre of concrete.

6. Following shall be the maximum nominal size of coarse aggregate for the different items of work :

Sr. No.	Item of construction	Maximum nominal size of Coarse aggregate
(i)	R.C.C. well curb, R.C.C. well steining and R.C.C piles.	40mm.
(ii)	P.C.C. well steining	63mm.
(iii)	Well cap or pile cap; solid type piers, abutments and wing-walls, their pier caps.	40mm.
(iv)	R.C.C. works in cross girders, deck slab, wearing coarse, kerb, light posts, blast walls approach slab etc.; and, hollow type piers, abutments, wing-walls and their pier caps.	20 mm.
(v)	R.G.C. bearings	20mm.
(vi)	For any other item of construction not covered by items (i) to (v) above	As specified on the drawing or as desired by the Engineer-in-charge in case it is not specified on drawing.

For heavily reinforced concrete members as in the case of ribs of main beams, nominal maximum size of aggregate shall usually be restricted to 5 mm. less than the minimum lateral clear distance between the main bars or 5 mm. less than the minimum cover to the reinforcement whichever is the smaller.

7. Fine aggregate shall be clean, hard, coarse sand. It shall be free dust and such other substances. The sand be get approved by the Engineer-in-charge.

8. All materials shall be stored as to prevent their deterioration of there quality and fitness for the work. Any material which has deteriorated or has been damaged or is otherwise considered defective by the Engineer-in-charge shall not be used in the works.

9. Cement shall be stored above the ground level in prefectly dry and watertight sheds. Wherever bulk storage containers are used, their capacity should be sufficient to cater to the requirements at site and should be cleaned atleast once every 3 to 4 month s. The aggregates shall be stored in such a way as to prevent admixture of foreign materials. Different sizes of fine or coarse aggregate shall be stored in separate stock piles sufficintly away from such other to prevent intermixing the materials.

10. The water for mixing shall be potable water to satisfaction of the Engineer-in-charge. The quantity of water shall be just sufficient to produce a dense concrete of required workability for the job.

11. For all work concrete shall be mixed in a mechanical mixer which along with other accessories shall be kept in first class working condition and so maintained throughout the construction. Mixing shall be continued till materials are uniformly distributed and uniform colour of the entire mass is obtained and each indial particle of the coarse aggregate shows complete coating of mortar containing its proportionate amount of cement. In no case shall the mixing be done for less than 2 minutes after all ingredients have been put into the mixer.

12. Mixer which have been out of use more than 30 minutes shall be thoroughly cleaned before putting in a new batch. Unless otherwise agreed to be the Engineer-in-charge, the first batch of concrete from the mixer shall contain only two thirds of normal quantity of coarse aggregate. Mixing plant shall be thoroughly cleaned before changing from one type of cement to another.

13. The method of transporting and placing concrete shall be approved by the Engineer-in-charge. Concrete shall be so transported and placed that no contamination, segregation or loss of its constituent material takes place. All form work and reinforcement contained in it shall be cleaned and made free from standing water, dust, snow or ice immediately before placing of concrete. No concrete shall be placed in any part of the structure until the approval of the Engineer-in-charge has been obtained.

14. If concreting is not started within 24 hours of the approval being given. It shall have to be obtained again from the Engineer-in-charge. Concreting then shall proceed continuously over the area between construction joints. Fresh concrete shall not be placed against concrete which has been in position for more than 30 minutes unless a proper construction joint is formed. Concrete shall be compacted in its final position within 30 minutes of its discharge from the mixer-unless carried in properly design agitators, operating continuously when this time shall be within 3 hours of the addition of cement to the mix an within 30 minutes of its discharge from the agitator. Except where otherwise agreed to be the Engineer-in-charge. Concrete shall be deposited in horizontal layers to a compacted depth of not more than 0.45 metre when internal vibrator are used not exceeding 0.30 metre in all other cases.

15. Unless otherwise agreed to be the Engineer-in-charge concrete shall not be dropped i-to place from a height exceeding 2 metres. When trunking or chutes are used they shall be kept clean and used in such a way as to avoid segregation. When concreting has to be resumed on a surface which has hardened, it shall be roughened, swept clean, thoroughly wetted and covered with a 13 mm thick layer of mortar composed of cement and sand in the same ratio as in the concrete mix itself. This 13 mm. layer of mortar shall be freshly mixed and placed immediately before placing of new concrete. Where concrete has not fully hardened, all laitance shall be removed by scrubbing the wet surface with wire or bristle brushes, care being taken to avoid dislodgement of any particles of coarse aggregate. The surface shall then be thoroughly wetted, all free water removed and then coated with neat cement grout. The first layers of concrete to be placed on this surface shall not exceed 150 mm. in thickness and shall be well rammed against old particular attention being given to corners and close sports.

16. All concrete shall be compacted to produce a dense homogeneous mass with the assistance of Vibrators, unless otherwise permitted by the Engineer-in-charge for exceptional cases, such as concreting under water, where vibrators can not be used. Sufficient vibrator in serviceable condition shall be kept at site so that spare equipment is always available in the event of break downs.

17. Immediately after compaction, concrete shall be protected against harmful effects of weather including rain, running water, shocks, vibration, traffic, rapid temperature changes, frost and drying out process. It shall be covered with wet sacking, hessian or other similar absorbent material approved by the Engineer-in-charge soon after the initial set, and shall be kept continuously wet for a period of not less than 14 days from the date of placement. Masonry work over the foundation concrete may be started after 48 hours of its laying but the curing of concrete shall be continued for a minimum period of 14 days.

18. Form work shall include all temporary or permanent forms required for forming the concrete, together with all temporary construction required for their support. Formwork shall however be divided into following two distinct categories :-

(1) Shuttering i.e. formwork required for forming the concrete.

(2) Scaffolding i.e. formwork required for supporting shuttering.

Forms for shuttering shall be constructed only, in metal suitably lined. Forms for scaffolding shall be constructed of metal or timber. Both shuttering and scaffolding shall be substantial rigid construction and shuttering shall be true to shape and dimensions shown on the drawings. All bolts and rivets shall be counter-sunk and well ground to provide a smooth, plane surface.

19. Forms shall be mortar-tight and 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, without deflection from the prescribed lines occurring 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. Suitable camber shall be provided in horizontal members of structure specially in long spans to counteract the effects of any deflection. The formwork shall be so fixed as to provide for such camber. Forms shall be so constructed as to be removable in sections in the desired sequence. Without damaging the surface of concrete or disturbing other sections. Unless otherwise specified or directed, chamfers or fillets of sizes 25 mm x 25 mm shall be provided at all angles of formwork to avoid sharp corners.

20 The inside surface of shuttering shall, except in the case of permanent form work or where otherwise agreed to be the Engineer-in-charge, be coated with an approved material to prevent adhesion of concrete to the form work. 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 agent shall not be used in form work for concrete which will be visible in the finished works.

21. Special measures shall be taken to ensure that the form does not hinder the shrinkage of concrete because without these cracking could occur before the form work is removed. Wherever applicable arrangements must be made to ensure that the form work does not restrain the shortening and hogging of the beams or slabs during tensioning of the tendons. The formwork should take due account of the calculated amount of positive or negative camber so as to ensure the correct final shape of the structure having regard to the deformation due to false work, scaffolding or propping and the instantaneous or deferred deformation due to various causes affecting prestressed structures. Where they are re-entrant angles in the concrete sections the form work 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. Form work shall be tight enough to prevent any appreciable loss of cement during vibrations. Suitable tolerance should be provided in the formwork. Immediately before concreting all forms shall be thoroughly cleaned. Contractor shall give the engineer-in-charge due notice before placing any concrete in the forms to permit him to inspect and accept the false work and forms as to their strength, alignment and general fitness, but such inspection shall not relieve the contractor of his responsibility for safety of men, machinery, materials and for results obtained.

22. The Engineer-in-charge shall be informed in advance by the contractor of his intention to strike any formwork. While fixing the time for removal of formwork, due consideration shall be given to local conditions that influence the setting of concrete and of concrete and of the materials used in the mix. Where field operations are controlled by strength tests of concrete the removal of the load supporting of soffit forms may commence when concrete has attained strengthening props including the effect or any further addition of loads. When field operations are not controlled by strength tests of concrete the vertical forms of beams, columns and walls may be removed after 2 days. The props of slabs and beams may be removed after 14 and 21 days respectively. All formwork shall be removed without causing any damage to the 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. Where internal metal ties are permitted, they or their removable parts shall be extracted without causing any damage to the concrete and remaining holes filled with mortar.

No permanently embedded metal part shall have less than 25 mm. cover to the finished concrete surface. Where it is intended to be cleaned and made good to the satisfaction of the Engineer-in-charge.

23. Immediately after the removal of forms, all exposed bars or bolts passing through the Cement Concrete member to a depth of at least 25 mm. below the surface of the concrete and the resulting holes be filled by cement mortar. All fins caused by form joints, all cavities produced by the removal of form ties and all other holes and depressions, honeycomb spots, broken edges or corners and other defects, shall be thoroughly cleaned, saturated with water and carefully pointed and rendered true with mortar of cement and fine aggregated mixed in the proportions used in the grade of concrete that is being finished and of as dry a consistency as is possible to use. Considerable pressure shall be applied in filling and pointing to ensure thorough filling in all voids.

Surfaces which have been pointed shall be kept moist for a period of twenty four hours. If rock pockets/honey-combs, in the opinion of the Engineer-in-charge are of such an extent or character as to effect the strength of the structure materially or to endanger the life of the steel reinforcement, he may declare the concrete defective and require the removal and replacement of the portions of the structure affected.

24. In the case of reinforced concrete work, workability shall be such that the concrete surrounds and properly grips all reinforcement. The degree of consistency, which shall depend upon the nature of work and methods of vibration of concrete shall be determined regular slump tests.

Type		Slump (mm) (at the Time of Placing of Concrete)
1)	a) Structure with exposed inclined surface requiring low slump concrete to allow proper compaction	25
	b) Plain cement concrete	25
2)	RCC structure with widely spaced reinforcements; e.g. solid columns, piers, abutments, footings, well steining	40 – 50
3)	RCC structure with fair degree of congestion of reinforcement; e.g. pier and abutment caps, box culverts, well curb, well cap, walls with thickness greater than 300 mm	50 – 75
4)	RCC and PSC structure with highly congested reinforcements e.g. deck slab girders, box girders, walls with thickness less than 300 mm	75 – 125
5)	Underwater concreting through tremie e.g. bottom plug, cast in-situ piling	150 – 200

25. For controlled concrete preliminary tests shall consist of three sets of separate tests, and in each set/tests shall be conducted on six specimens. Not more than one set of six specimens shall be made on any particular day. Of the six specimen in each set, three shall be tested at seven days and the remaining three at 28 days. The preliminary tests at 27 days are intended only to indicate the strength likely to be attained at 28 days. Work strength tests shall be made in accordance with IS : 516. EACH test shall be conducted on ten specimens five of which shall be tested at seven days and the remaining five at 23 days. The samples of concrete shall be taken on each day of concreting and cubes shall be made at the rate of one for every 5 cubic metre of concrete or a part thereof. However, if concreting done in a day is less than 15 cubic metre, the minimum number of cubes can be reduced to 6 with the specific permission of the Engineer-in-charge. Similar works tests shall be carried out whenever the quality and grading of materials is changed irrespective of the quantity of concrete poured. The number of specimens may be suitably increased as deemed necessary by the Engineer-in-charge when procedure to tests given above reveals a poor quality of concrete and in other special cases.

26. The average strength of the group of cubes cast for each day shall not be less than the specified works cube strength 20 per cent of the cubes cast each day may have values less than the specified strength, provided the lowest value is not less than 85 per cent of the specified strength.

27. R.C.C. work shall have exposed concrete surface. Centering design and its erection shall be approved by the Engineer-in-charge. One carpenter with helper will invariably be kept throughout the period of concreting. Movement of labour and other persons shall be totally prohibited over reinforcement laid in position. For access to different parts, suitable mobile platforms shall be provided so that steel reinforcement in position is not disturbed. For ensuring proper cover, mortar blocks of suitable size shall be cast and tied to the reinforcement. Timber, kapachi or metal pieces shall not be used for this purpose. Concreting of important structural members shall always be done in the presence and under the supervision of departmental person not below the rank of Asst. Engineer/Addl. Asst. Engineer/Overseer or as instructed by the Engineer-in-charge. After removal of form work and shuttering, the executive Engineer shall inspect the work and satisfy by random checks that concrete produced is of good quality. Plastering shall not be allowed to the exposed faces of concrete.

28. In reinforced concrete the volume occupied by reinforcement shall not be deducted. The slab shall be measured as running continuously through and the beam as the portion below the slab.

29. All necessary labour, materials, equipment, etc., for sampling, preparing test cubes, curing etc., shall be provided by the Contractor. Testing of the materials and concrete may be arranged by the Engineer-in-charge in an approved laboratory at the cost of the contractor.

30. The payment will be made on cmt. basis of the finished work.

31. The unit rate for concrete shall include the cost of all materials, labour, tools and plant required for mixing, placing in position, vibrating and compacting finishing as per directions of the Engineer-in-charge, curing and all other incidental expenses for producing concrete of specified strength to complete the structure or its components as shown on the drawings and according to these specifications. The rate shall also include the cost of making fixing and removing of all centres and forms required for the work.

Item 14 A. Providing steel cutting edge including launching where necessary.

1. Finished rolled material shall be free from cracks, flaws, injurious seams, laps, blisters, regged and imperfect edges and other defects. It shall have a smooth, uniform finish, and shall be straight. It shall also be free from loose mill scale, rust, pits or other defects affecting its strength and durability. The acceptance of any material on inspection at the mill, i.e. rolling mills, foundry or fabricating plant where material for the work is manufactured, shall not be a bar to its subsequent rejection, if found defective. Mild steel for bolts and nuts shall conform to IS : 226 but have a minimum tensile strength of 44 kg/mm² and minimum percentage elongation of 14.

2. All work shall be in accordance with the drawings. Care shall be taken that all parts of an assembly fit accurately together. All structural steel members and parts shall have straight edge and blung surfaces. If necessary, they shall be straightened or flattened by pressure unless they are required to be of curvilinear forms. They shall also be free from twist. Pressure applied for

straightening or flattening shall be such as would not injure the materials. Adjacent surfaces or edges shall be in close contact or at uniform distance throughout. All structural steel parts, where required, shall be sheared, chopped, swan or flame cut and ground accurately to the required dimensions and shape. All edges of splice and gusset plates 12 mm. thick and over shall be machined and those less than 12 mm. thick may be sheared and ground.

3. The diameter or rivets shown on drawings shall be the size before heating. Each rivet shall be of sufficient length to form a head of the standard dimensions as given in I.S. Hand book on Steel Sections, Part-I. It shall be free from burrs on the underside of the head. All loose or burnt rivets and rivets with cracked or badly formed defective heads or with heads which are unduly centric with the shanks, shall be removed and replaced. In removing rivets, the head shall be sheared off and the rivet punched out so as not to injure the adjacent metal and if necessary, they shall be drilled out. Recapping and caulking shall not be permitted.

4. All welding shall be done with the prior approval of the Engineer-in-charge and the workmanship shall conform to the specifications of IS : 823. When material thickness is 20 mm. or more, special precautions like preheating shall be taken as laid down in IS :823.

5. The cutting edge shall be fabricated to the exact shape and dimensions shown on the detailed drawings. The steel sections shall be bent cold to the required shape by making V-cuts in the horizontal portion at not less than eight places for single well at uniform intervals along length. The V-cuts shall then be welded together electrically. Steel cutting edges shall be transported on site and shall be conveyed to the exact location by any means including launching by barges if necessary and shall be placed in true position as directed by Engineer-in-charge.

6. The measurements of this item shall be in tonnes based on the net weight of metal in the fabricated structure computed on the basis of nominal weight of materials. No payment shall be made for rivets, bolts, nuts, washer and for welding. No deduction shall be made for the hole punched or V-cuts made in the structure.

7. The unit rate shall include the cost of all materials labour, tools and plants including setting out on site to complete the work.

Item-14-B-Providing steel liner for curbs for wells/caissons and steel steining for caissons.

1. Para 1 to 4 of the item of cutting edge shall apply.

2. The steel liner for curbs and steel steining shall be fabricated to the exact shape and dimensions shown on the detailed drawings. The steel sections shall be bent cold to the required shape by making V-cuts in the horizontal portion at not less than eight places for single well and at uniform intervals along length. The V-cuts shall then be welded together electrically.

3. Para 6 and 7 of item of steel cutting edge shall apply.

Item-15 Providing and casting-in-situ well curb

1. The dimension and shape of the curb shall be strictly in conformity to drawings. The well curb shall be placed truly in position and level. All concreting in the well curb shall be done in one continuous operation.

3. Para 1 to 31 of item of controlled concrete shall apply.

Item-16 Providing and casting-in situ concrete for well steining.

1. The dimensions and shape of the well shall strictly conform to those shown on the drawings. The steining of the well shall be built in one straight line from bottom to top, the work being checked carefully with the aid of straight edges of lengths approved by the Engineer-in-charge. Plumb bob or spirit level shall not be used. Steining built in the first stage shall not be more than 2 metres and in subsequent stages it shall not exceed the diameter of the well or the depth of well sunk below the adjoining bed Level at a time. As far as possible, the stages of work shall not be kept at the location of joints in the vertical steining bars. The height of steining shall be calibrated by making at least 4 gauges distributed equally on, the outer periphery of the well each in the form of a 10 cm. wide strip painted on the well. Each in the form of a 10 cm. wide strip painted on the well, with every metre mark shown in black paint. The gauges shall start with zero at the bottom or cutting edge. Marking of the gauges shall be done carefully with a steel tape. After sinking of a stage in complete all damaged portions of stein; 3 at top of the previous stage shall be properly repaired before constructing the next stage. When dowel bars for foundations are to be provided, 100 mm. holes shall be kept in steining itself at regular intervals as shown in drawings or as directed by the Engineer-in-charge.

2. Para 1 to 31 of item of ordinary concrete shall apply.

Item-17-A Sinking of wells/caissons in all strata of soil and Murum.

1. This item includes sinking of wells for foundations through sand, gravel, loose boulders, silt, clay, soft and hard murum and all such other similar strata except through rock to the required level as may be directed by the engineer-in-charge including removal of excavated stuff, isolated boulders, any tree, logs or any other similar objects and adopting for this purpose, suitable methods such as open dredging, or mechanical grabbing by using winches, including use of drop chiselling, employing of divers including pneumatic drilling for breaking and removing loose isolated boulders and all such other methods of well sinking except resorting to pneumatic sinking.

2. The well shall as far as possible be sunk true and vertical through all types of soils. The well shall be sunk by excavating material uniformly from inside the dredge hole. Sinking or loading of the well with kentledge shall be commenced only after the steining has been cured for at least 48 hours or as specified in the approved drawings. Kentledge shall be placed in an orderly and safe manner and in such a way that it does not interfere with the excavation or the material from the dredge hole and also does not in any way damage the steining of the well. Normally dewatering of well shall not be permitted as a means for sinking the well. It also shall never be resorted to if there is any danger of sand-blowing under the well. Water jetting may be employed for well sinking wherever necessary.

3. Explosives shall not be generally used as an aid for well sinking. However in cases where explosives are to be used, prior approval of the Engineer-in-charge shall be obtained. Blasting of any sort shall only be done in the presence of Engineer-in-charge and not before the concrete in the steining has hardened sufficiently and is more than 7 days old. Mild explosive charges may be blasting has been used for setting the well only with the prior permission of the Engineer-in-charge. If blasting has been used for setting the well after it has reached the design foundation level, normally 24 hours shall be allowed to lapse before the bottom plug is laid. The charges shall be exploded well below the cutting edge by making a sump so as to avoid chances of any damage to the curb or to the steining of the well. All prevalent laws concerning handling, storing and using of explosives shall be strictly followed.

4. When the wells have to be sunk close to each other and distance between them is not greater than the diameter of wells, sinking shall be taken up on all wells and they shall be sunk alternately so that sinking of all wells proceeds uniformly and together. In sinking dumb-bell or doubled shaped wells the excavation in both the dredge holes should be carried out simultaneously and equally to facilitate even sinking. All wells on which sinking is in progress shall be sunk to sufficient depth below the designed scour level before the seasonal floods. Further, they shall be temporarily filled and plugged before the onset of the floods so that they do not suffer any tilt or shift. All necessary precautions shall be taken against any possible damage to the foundations of existing structures in the vicinity of the wells, prior to commencement of dredging from the well. The dredged material shall not be allowed to accumulate over the well. It shall be dumped, as far away from the well as possible, and then continuously and simultaneously removed. In case the river stream flows along one edge of the well being sunk, the dredged material shall not be dumped on the dry side of the bank but on the side in which the river current flows. Very deep sump shall not be made below the well curb as it entails risk of jumping (sudden sinking) of the well: normally the depth of sump shall not exceed 3.0 meters below the level of the cutting edge unless otherwise specifically permitted by the Engineer-in-charge. In case a well sinks suddenly and with a jerk, the steining of the well shall be examined to the satisfaction of the Engineer-in-charge to see that no damage has occurred to it.

5. Tilt and shift of each well shall be measured regularly during the entire sinking operation. Observations to this effect shall be taken at each stage of casting of the steining. Simultaneously as the sinking proceeds, necessary corrective measures be taken to obtain the tilts and shift within the permissible limits. Unless otherwise specified the tilt of any well shall not exceed 1 in 80 and the shift shall not be more than 5% of the outside diameter of the circular well or of the maximum outside dimension of the well for any other shape subject to a maximum of 150 mm. If the tilt and shift exceed the above limit for any well, that well shall be liable to rejection at the discretion of the Engineer-in-charge at the entire risk and cost of the contractor. If under any circumstances the Engineer-in-charge allows tilt and/or the shift more than that specified above and which cannot be corrected, the

dimensions of the concerned well cap shall be suitably increased so as to cover completely the well top and also allow the pier to be located a symmetrically, on the well cap provided that the stresses at the foundations of the well can be brought within permissible limits by suitably shifting the position of the pier center line to overcome the effect of the tilt and shift. No payment for any increase in the dimensions of well cap and the reinforcement therein shall be made. If even with the adjusted location of pier and increased dimensions of the well caps, the stresses at the foundation level due to tilt and shift can not be brought within permissible limits the contractor shall rectify the well or reconstruct the same at his own cost. In this even the contractor shall be paid only for new well sunk and the contractor shall also bear the additional cost resulting from any change in the design span length etc. due to such faulty well. The cost of the cement and steel supplied to the contractor and used in the rejected well as well as in the new well aid in its place shall be recovered from him. Payment of part or full rate during the process of sinking shall not be considered as part of full acceptance of the work till it is sunk to the designed or required level and satisfies the design requirements in regards to tilts and shifts.

6. Every well started during any working season must be completed, plugged, filled with sand and sealed with well cap at top within that working season so as to be safe from floods and tides as far as possible. If the sinking of a well upto the designed or required level, plugging it at bottom and top sand filling and concreting the well cap can not be completed in one working season, the following precautionary measures shall be taken by the contractor at his own risk and cost.

(i) All exposed reinforcing bars shall be carefully bent down along the stening and temporarily be embedded in lean concrete. (1:4:8)

(ii) The dredge holes shall be filled up with sand right upto top of well stening as cast and suitably covered up with adequate wooden planking or by any other method approved by the Engineer- in-charge.

(iii) All precautionary measures shall also be taken to prevent any damage or shift or tilt to the well due to floods during monsoon.

7. Measurement : Sinking of a well be measured from the water level at the time of casting the curb or from the level at which the bottom of the cutting edge is laid intially whichever is lower to the bottom of the cutting edge in the final position. Any scooping of the bottom of the foundation or 'Kundi' below the level of the bottom of the cutting edge shall not be measured or paid. If the level at which the bottom of cutting edge is actually laid is lower than the water level at the time of casting the curb, the same shall be recorded by the Deputy Ex- Engineer of the work and shall be recorded by the Deputy Ex- Engineer or Assistant Engineer-in-charge of the work and shall be countersigned by the contractor or his authorised representative in token of his acceptance. If for any valid reasons, in some very rare case, it becomes impracticable to lay the curb at or below the sub-soil water level, the contractor shall be permitted to lay the curb at level higher than the sub-soil level, but sinking shall be measured from water level only and in such cases, excavation above water level will, however, be payable under the item of open excavation for foundation of the relevant strata. For the purpose of payment the rate of sinking will vary according to range of depths as given in the schedule 'B' for this item.

8. The rate for sinking shall include the cost of all labour, tools and plant and other operations required, such as dewatering, excavation and bailing out material, providing and placing kentledge on top of well and removing the same, and contingencies warranting provision of temporary top plug in the event of floods being expected at site making further sinking not possible, and also other incidental works to sink the well to the level shown on the drawings. It shall also include blasting or use divers for removal of obstacles from under the cutting edge of the well. The rate_ shall_ be applicable for all types of soils except rock,

Item-17 B Extra for Sinking of wells/caissons in soft rock.

1. This item is for sinking of wells for foundation through soft rock such as lime stone, sand stone, laterite, hard conglomerate or other soft or disintegrated rock which do not require blasting. The classification of strata shall be decided by the Engineer-in- charge and his decision shall be final and binding to the contractor.

2. To 6. Para 2 to 6 of the item of sinking of wells in all sorts of soils shall apply.

7. Measurement for payment will be on Rmt. basis for the height sunk strata specified in para 1 above. The rate is extra over rate of sinking of well in all sorts of soils. In order to ascertain the level at which rock is struck with, four bores will be drilled at four equidistant locations near the inner periphery of the well, to a depth of 2 m. and the means of such four levels at which rock is struck with, will be taken as the level of such a strata.

8- The rate for sinking will be extra over the rate agreed in the proceeding item of sinking of wells/caissons in all sorts of soil and murrum and shall include the cost of all labour, tools and plant and other operations required such as dewatering, excavation and bailing out of material, providing and placing kentledge on top of well and removing the same, drilling four bores as above and Contingencies warranting provision of temporary top plug in the event of floods being expected at site Ticking further sinking not possible and also other incidental works to sink the well to the level shown on the drawings.

Item 17 C Extra for sinking of wells/caissons in hard rock.

1. This item includes sinking of well in rocks or boulders for which the use of mechanical plant or blasting is required. The classification of excavation shall be decided by the Engineer-in-charge and his decision shall be final and binding on the contractor. Merely the use of explosives in excavation will not be considered as a reason for higher classification unless blasting is clearly necessary in the opinion of the Engineer-in-charge. Where blasting is prohibited for any reason excavation shall be carried out by chiselling, wedging or any other agreed method. Blasting shall be carried out only with the written permission of the Engineer-in-charge. All the statutory laws, regulation rules, etc. pertaining to the acquisition, transport, storage, handling and use of explosives shall be strictly followed. The contractor may adopt any method or methods of blasting consistent with the safety and job requirement, after approval from the Engineer-in-charge.

2 to 6 Para 2 to 6 of the item of sinking of well in all sorts of soil shall apply.

7. Measurement for payment will be on Rmt. basis for the height sunk in strata specified in para 1 above. The rate is extra over rate of sinking of well in all sorts of soils. In order to ascertain the level at which rock is struck with, four bores will be drilled at four equidistant locations near the inner periphery of the well, to a depth of 2 m. and the mean of such four levels at which rock is struck with, will be taken as the level of such a strata.

8. The rate for sinking will be extra over the rate agreed in the preceding item of sinking of wells/caissons in all sorts of soil & murrum and shall include the cost of all labour, tools and plant and other operations required such as dewatering, excavation and bailing out of material, providing and placing kentledge on top of well and removing the same drilling four bores as above contingencies and warranting provision of temporary top plug in the event of floods being expected at site making further sinking not possible and also other incidental works to sink the well to the level shown on the drawings.

Item 17 D Extra for pneumatic sinking of wells/Caissons.

1. Para 1 to 6 of item of sinking of wells shall apply.

3. The resident engineers put in charge of pneumatic sinking shall familiarise themselves with particular reference to caisson diseases and working of the medical air-lock. A doctor competent to deal with the cases of 'Caisson Disease' or other complications arising as a result of working under high pressure, shall be stationed at the construction site when pneumatic sinking is in progress. The contractor shall provide complete facilities including the issuing of orders or the delegation of authority to the doctor, to ensure strict enforcement of the requirements outlined in these specifications. For pneumatic sinking provision made in IS : 4138 shall be complied with. In addition to IS : 4138 the safety provisions contained in the following paras shall also be strictly followed.

3. Locks, reducers, and shafting used in connection with caissons shall be of riveted construction throughout. The material used in their manufacture shall not be less than 6 mm. thick steel plate. Shafts shall be subjected to a hydrostatic or air-pressure test of 5.2 kg/cm² at which pressure they shall be tight and stamped on the outside shall about 30 cm. from each flange to show the pressure to which they have been subjected. Whenever a shaft is used it shall be provided, where space permits, with a safe proper, and suitable staircase for its entire length including landing platforms not more than 6 metres apart. Where this is impracticable, suitable ladders shall be installed with landing platforms located about 6 metres apart to break the climb. All shafting used in pneumatic caissons shall be provided with ladders which shall be kept clear and in good condition at all times and shall be constructed, inspected and maintained to the entire satisfaction of the Engineer-in-charge. All outside caissons air locks shall be provided with a platform not less than 1 metre wide and provided with a guard rail 1 metre high. Any caisson in which fifteen or more men are employed shall have two locks, one of which shall be used as a man-lock. Man locks and shafts shall be in charge of man whose duty shall be to operate the air valves in such locks. Locks shall be so located that the lowest part of the bottom door shall not be less than 1 metre above mean high water level. The supply of fresh air to the working chamber shall at all times be sufficient to permit work to be done without danger or excessive discomfort. All air supply lines shall be supplied with check valves and carried as near to the face as practicable. For every man-lock, reply signals repeating the original signals, shall be made before any cage, skip, bucket, or elevator is placed in motion. A man-lock shall be used solely for the compression or decompression of persons and not for the passage of plant or material and shall be maintained in a reasonably clean and sufficiently warm state. However, nothing in this shall prevent any person carrying with him into man-lock any hand-lock any hand-tools or hand instruments used for the purpose of the work. The specifications of preceding paragraph shall not apply where it is not reasonably practicable to provide a separate man-lock for persons only but in any such case not exempted by the specification given in succeeding paragraph that the lock when in actual use for the compression or decompression of a person or persons shall not be put, simultaneously, to any other and shall be in a reasonably clean and sufficiently warm state. Nothing in preceding paragraphs of these specifications shall apply to a lock which does not afford direct or indirect access to a working chamber in which the pressure exceeds 1.25 kg/cm² and in so far as a lock affords only indirect access to such a working chamber these paragraphs shall apply only whilst persons who have worked in the chamber are in the lock. Exhaust valves shall be provided, having risers extending to the upper part of chamber if necessary, and shall be operated at such times as may be required and especially after a blast, and man shall not be required to resume work after a blast until the gas and smoke have cleared.

4. Every employee absent from work for 10 or more consecutive days due to illness or other disability shall be required to pass the regular physical examination before being permitted to return to work. After a person has been employed continuously in compressed air for a period of 2 months, he shall be re-examined by the doctor and shall not be permitted work until such re-examination has been made and reported. The doctor shall at all times keep a complete and full record of examinations made by him, and the record shall contain dates on which examinations were made and a clear and full description of the person, examined, his age and physical condition at the time of examination and a statement as to the time such a person has been engaged in like employment. Records of such examinations shall be kept on file at the place where the work is in progress and shall be subject to inspection by authorities having jurisdiction. Every medical lock shall at all times have a doctor or other responsible person in attendance. When the doctor is absent, the person in charge shall have positive means of promptly communicating with and securing the services of a competent doctor in case of emergency. When the air pressure exceeds 1.95 Kg/cm² gauge or when 50 or more men are employed, a doctor shall be in attendance at all times while work is in progress. All cases of compressed air illness shall be reported and copies of all such reports shall be kept on file at the place where the work is in progress. No person known to be addicted to the excessive use of intoxicants shall be permitted to work in compressed air.

5. All lighting in compressed air chambers shall be by electricity exclusively and two independent electric-lighting systems with independent sources of supply shall be used. The emergency source shall be arranged to become automatically operative on failure of the regularly used source. The minimum intensity of light on way walk way ladder, stair-way, or working level shall be not less than one-quarter (1/4) candle-power and in all work places the lighting shall at all times be such as to enable workmen to see their way clearly. External parts of lighting fixtures and all other electrical equipment when within 2.5 meter of the floor shall be constructed of non-combustible, non-absorptive insulating materials, except that metal be used provided it is effectively grounded.

Portable lamps shall be equipped with non-combustible, non-absorptive insulating sockets, approved handles, basket guards and approved cables. The use of worm or defective portable and pendant conductors, shall be prohibited.

6. Head frames shall be constructed of structural steel or open frame work fire-proofed timber. Head houses and other temporary surface buildings or structures within 30 metres of the shaft, caisson, or tunnel opening shall be built of fire-resisting materials. No oil gasoline, or other combustible material shall be stored within 30 metres of any shaft, caisson, or tunnel opening, except that oils may be stored in suitable tanks in isolated fire-proof buildings, provided such buildings are not less than 15 metres from any shaft, caisson, or tunnel opening or any building directly connected thereto. Positive means shall be taken to prevent leaking flammable liquids from flowing into the areas specifically mentioned in preceding paragraphs. Where feasible, a fire house connected to a suitable source of water shall be provided at the top of every caisson. Where fire mains are not accessible, a supply of water shall be stored in tanks near the top of each caisson, provided fire pails or suitable pumps are kept available, or approved fire extinguishers may be substituted. In the event that water under pressure is not available, buckets of sand and approved fire extinguishers shall be substituted. Wherever, in the execution of work in which compressed air is used, the working chamber is less than 3-7 metres in length, and when such caissons are at any time suspended or hung while work is in progress, in such a way that the bottom of the excavation is more than 2.7 metres below the deck of the working chamber, a shield shall be erected therein for the protection of the workmen.

7. Properly heated, lighted and ventilated rooms shall be provided for all employees engaged in compressed air-work. Such rooms shall contain lockers and benches & be open and accessible to men during the intermission between shifts. Adequate toilet accommodation at the ratio of not less than one for every twenty-five men employed shall be provided. Care shall be taken to keep all parts of caissons and other working compartments, including lockers, dry rooms, rest rooms and other equipment in a sanitary condition and free from refuse, decaying, or other objectionable matter. No nuisance shall be tolerated in the air chamber, smoking shall be strictly prohibited and all matches and smoking materials shall be left in the locker rooms. A separate dry-room shall be provided where working clothes may be dried within reasonable time. This room shall be well heated. In all cases where gas is expected including alluvium impregnated with decayed vegetable matter, the use of Day Safty Lamp in a pneumatic caisson sinking be compulsory.

8. Measurement shall be on Rmt. basis and shall be measured from the level of the cutting edge from which sinking by pneumatic process is started.

9. The rate for pneumatic sinking shall include cost of all labour, material, tools & plant and other incidental expenses required for pneumatic sinking. This payment shall be over the rate for the sinking by open dredging.

Item 18 : Load Testing of wells.

1. The well to be tested shall first be relieved of all the kentledge and other superimposed loads if any and then shall be filled inside to a depth of at least 3 m. above the cutting edge with sand. The sand filling may be done through water if standing in the well but it shall be ascertained that the well as been evenly filled with sand to a depth not less than 3 m. as above. Standing water need not be pumped out but before commencing the loading, it shall be allowed to attain a permanent level.

2. Marks for taking levels will then be made on the well steining at up stream and down stream and on the left and right sides of the well. For single well there shall be four marks and (or wells of other shape, six such marks. The reduced levels of all these marks shall be recorded carefully before commencing the test load.

3. The test load to be applied to a particular well shall be determined by the Engineer-in-charge. A load of 50 tonnes shall first be applied and the levels of all the marks shall be observed and recorded. The load will then be allowed to remain for 12 hours and the levels of all the marks again observed and recorded. A further load of 50 tonnes shall then be added and the whole process repeated till the full test load had been reached and allowed to remain for 12 hours. If the full test load is not a multiple of 50 tonnes the last increment will be less than 50 tonnes. Total settlement in 12 hours shall not be more than 8 cms.

4. Unloading also shall be done in steps of 50 tonnes with an interval of 12 hours between each unloading operation and the level observed at each stage just after unloading as well as 12 hours after that is just before further unloading. V.I. results will then be plotted and settlement

against test load, the recovery of settlement against removal of test load and the permanent settlement of the well shall be noted. For this purpose average of the reading at all marks shall be adopted.

The test load for each well shall be equal to Steining $\frac{\text{area}}{\text{total area of well}}$
(designed dead load + twice the live load).

The designed dead load shall be the one at the base of the well (under test) in the completed form of the bridge structure, less the weight of the steining already in position. The test load shall in no case be less than the maximum kentledge required during the sinking of the well.

5. The measurement for payment shall be per tonne of the test load actually placed on the well.

6. The unit rate includes all materials, labour equipment/plant platform guages for purpose of recording results and sand filling in well before the test and its removal after the test, to complete the job.

Item 19-A. Ordinary concrete for Bottom plug.

1. For each well a written permission of the Engineer-in-charge to plug the well shall first be obtained. After this is done, divers shall be sent down to clean the inside faces of the curbs and to remove any adhering clay or other deposit therefrom, and to remove away any rubbish or loose material that may accumulate in the bottom. Before commencing plugging, all the loose material from the bottom of the well shall be removed and the depth of the bulb so formed more than 1/6 the dia. of the well shall be filled up with sand then with concrete. Careful soundings shall be taken and the entire bottom surface shall be brought to uniform grade.

2. The laying of concrete wherever and whenever possible shall be done in dry condition by pumping out water and where not practicable, concrete shall be laid under still water by tremie or by specially designed water tight collapsible drop bottom buckets or other approved methods as may be decided by the Engineer-in-charge. When laid under water concreting shall be done with water levels both inside as well as outside the well equal. Concreting under hydrostatic pressure shall not under any circumstances be permitted. No pumping shall be permitted during the course of concreting. The placing operations of concrete for the bottom plug shall be continuous without any break till the full thickness of the plug is formed to effectively seal the interior of the well without any laminations. The concreting by tremie or other method as may be approved by the Engineer-in-charge shall also conform to the requirements as per clause 13.2 of I.S. Code of practice for plant and reinforced concrete for general building construction No. IS : 456.1978.

3. Where tremie is used it shall be of suitable size having dia of not less than 25 cm. and the hopper large enough to hold not less than one entire batch of the mix or the entire contents of the transporting bucket when one is used. Each tremie shall be supported independently in such a manner as to permit free movement of the discharge and over the entire top surface of the work and so as to permit quick lowering when necessary to slow down or stop the flow of concrete. The consistency of concrete shall be got approved from the Engineer-in-charge and shall be laid by the most satisfactory method in proper manner.

4. After depositing, concrete shall be allowed to set for atleast 14 days during which period water in the well shall not be pumped nor disturbed for any purpose. After the plug concrete has sufficiently set i.e. after 14 days of concreting it shall be tested for water-tightness by dewatering the well to the extent of about 4.5 m. below the average water level or the tide level in the creek at the site of work. Necessary precautionary measures shall be taken against buoyancy of the well due to differential head of water acting from below by way of putting kentledge load on the well if so necessary before dewatering.

5. The well plug shall be considered satisfactory if after dewatering to the extent as above, the rate of leakage through or by the side of the plug is such as not to raise water level in the well by more than 0.3 Mt. in the first two hours. If the test does not prove successful and much leakage is noticed during the pumping, more concrete shall be deposited at the cost of the Contractor until the safe height is reached to effectively seal the leakage of water into the well.

6. Relevant specifications for ordinary concrete shall apply except for the above modification and additions.

7. The rate to be paid for this item shall be per cubic measurement of plug concrete actually laid. Generally the cubic quantity of concrete shall be calculated on the basis of average foundation level and the actual top level of the plug. For determining average level of the base, sounding shall be taken at different points in the well and levels recorded and signed by both the Engineer-in-charge and the contractor before starting the work.

8. The method of measurement may however be changed at the discretion of the Engineer-in-charge in case it is difficult to ascertain the correct depth of plug laid, in which case quantity to be paid shall be based on the average yield of the finished concrete under water per bag of cement, which shall be taken as 0.15 cmt. per bag of cement consumed. This shall include extra 10% cement to be used for concrete to be laid under water.

9. Unit rate of the item shall include cost of labour, materials, tools and plant required to complete the work.

ITEM-19 B ORDINARY CONCRETE FOR TOP PLUG

1. Before concreting, the well shall be dewatered to the extent required, to enable the concrete of the top plug to be laid at the level, as shown on the detail drawing or as directed by the Engineer-in-charge.

2. Relevant specifications for ordinary concrete shall apply except for the above modification and additions.

3. The rate to be paid for this item shall be per cubic measurement of plug concrete actually laid, and is inclusive of the cost of dewatering where necessary.

4. Unit rate of the item shall include cost of labour, materials, tools and plant required to complete the work.

It is imperative to do videography before filling the bottom plug.

ITEM- 20 Providing Mild Steel dowel bars for Foundations.

1. This item provides for necessary mild steel bar; of 32 mm. dia. for anchoring in foundations strata as per detailed drawings and as directed by Engineer-in-charge. For this purpose, 100 mm holes shall be kept in steining itself at regular intervals as shown in drawing or as directed by Engineer in-charge. Mild steel bars shall be supplied by the department at the rate and place shown in schedule A of the tender. The item includes transporting the bars to the site of work, handling, cutting, bending, hooking and placing the same in position as required as per drawing. The grout holes shall be not less than 100 mm. dia. The anchorage length of bars shall not be less than 60 times dia. of bar. Grouting of grout hole shall be of 1:2 proportion (1 part of cement, 2 parts of sand) and shall be done under pressure as directed. These dowels bars shall be inserted through holes kept in the well steining to the bottom of the grout holes. Grout holes shall not be less than 1 Mt. in depth. In case, no dowel bars are ultimately decided to be provided in the holes of the steining kept for the purpose, the same shall be filled with the concrete of the same proportion as of well steining at the cost of the contractor.

2. Mode of measurement will be per number of dowel bar considered as one number from bottom of grout hole to the top of steining.

3. Unit rate includes cost of material, labour, tools and plant and grouting the steining holes to complete the work.

(A) Mild Steel Reinforcement

Item-21 Providing (B) High yield strength Deformed bars, reinforcements.

1. The work shall consist of furnishing and placing reinforcement of the shape and dimensions shown on the drawings or as directed by the Engineer-in-charge.

2. Steel shall be clean and free from loose rust and loose scale at the time of fixing in position and subsequent concreting.

3. Reinforcing steel conform accurately to the dimensions given in the Bar bending schedules shown on relevant drawings. 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 attain proper radius of bends. Bars shall not be bent or straightened in a manner that will injure the material. Bars bent during transport or handling shall be straightened before being used on work; they shall be not heated to facilitate bending. Unless otherwise specified a 'U' type hook at the end of each bar shall invariably be provided. The radius of the bend shall not be less than twice the diameter of the round bar and the length of the straight part of the bar beyond the end of the curve shall be at least four times the diameter of the round bar. In the case of bars which are not round and in the case of deformed bars, the diameter shall be taken as the diameter of circle having an equivalent effective area. The hooks shall be suitably encased to prevent any splitting of the concrete.

4. All reinforcement bars shall be accurately placed in exact position shown on the drawings, and shall be securely held in position during placing of concrete by annealed binding wire not less than 1 mm. in size and conforming to IS : 280 and by using stay blocks or metal chairs, spacers, metal hangers supporting wires or other Approved devices at sufficiently close intervals. Bars will not be allowed to sag between supports nor displaced during concreting or any other operation of the work. All devices used for positioning shall be of non-corrodible material. Wooden and metal supports will not extend to the surface of concrete, except where shown on the drawings. Placing bars on layers of freshly laid concrete as the work progresses for adjusting bar spacing will not be allowed. Pieces of broken stone or brick and wooden blocks shall not be used. Layers of bars shall be separated by spacer bars, precast mortar blocks or other approved devices. Reinforcement after being placed in position shall be maintained in a clean condition until completely embedded in concrete. Special care shall be exercised to prevent any displacement of reinforcement in concrete already placed. To protect reinforcement from corrosion concrete cover shall be provided as indicated on the drawings. All bars protruding from concrete and to which other bars are to be spliced and which are likely to be exposed for an indefinite period shall be protected by a thick coat of neat cement grout.

5. Bars crossing each other, where required, shall be secured by binding wire (annealed) of size not less than 1 mm. and conforming to IS : 280 in such a manner that they do not slip over each other at the time of fixing and concreting.

6. As far as possible, bars of full length shall be used. In case this is not possible, overlapping of bars shall be done as directed by the Engineer-in-charge. When practicable, overlapping bars shall not touch each other, but be kept apart by 25 mm. or 1.25 times the maximum size of the coarse aggregate whichever is greater, by concrete between them. Where not feasible, overlapping bars shall be bound with annealed steel wire, and not less than 1 mm. thickness twisted tight. The overlaps shall be staggered for different bars and located at points, along the span where neither shear nor bending moment is maximum.

7. Whenever indicated on the drawings or desired by the Engineer-in-charge bar shall be jointed by couplings which shall have a cross-section sufficient to transmit the full stresses of bars. The ends of the bars that are jointed by couplings shall be upset for a sufficient length so that the effective cross-section at the base of threads is not less than the normal cross-section of the bar. Threads shall be standard white iron threads. Steel for coupling shall conform to IS : 226.

8. When permitted or specified on the drawings, joints of reinforcement bars shall be butt welded so as to transmit their full stresses. Welded joints shall preferably be located at points where steel is not 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 rods are welded. Only electric arc welding using a process which excludes air from the molten metal and conforms to any or all other special provisions for the work will 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 and when welding is done in 2 or 3 stages, previous surface shall be cleaned properly. Ends of the bars shall be cleaned of all loose scale, rust, grease, paint and other foreign matter before welding. Only competent welders shall be employed on the work. The M. S. Electrodes used for welding shall conform to IS : 814. Welded pieces of reinforcement shall be tested. Specimen shall be taken from the actual site and their number and frequency of tests shall be as directed by the Engineer-in-charge.

9. For the purpose of calculating consumption, wastage shall not be permitted beyond 5 percent. Excess consumption over 5% will be charged at penal rate. Useful pieces of steel, as may be decided by the Engineer-in-charge shall be taken back by the Government at issue rate and at P.W.D. Store from where the steel was supplied. All the expenses of loading, carting, unloading and returning the waste will be borne by the contractors.

10. Reinforcement shall be measured in length remaining overlaps, separately for differed diameters as actually used in the work, where welding or coupling is restored to, in place of lap-joints such joints shall be measured for payment as the equivalent length of over-lap as per design requirement. From the length so measured the weight of reinforcement shall be calculated in tonnes on the same basis of IS : 1732 even though steel is supplied to the contractor by the Department on actual weightment. Length shall include hooks at ends. Wastage and annealed steel wire for binding shall not be measured and cost of these items shall be deemed to be included in the rates to reinforcement.

11. Rate for reinforcement shall include cost of all steel, its carting from P.W.D. Store to work site, cutting, bending, placing, binding and fixing in position as shown on the drawings and as directed by the Engineer-in-charge. It shall also include cost of all devices for keeping reinforcement in approved position, cost of Joints as per approved methods, and all wastage, and spacer bars.

Item 22-Empty boring through all sorts of strain for R.C.C Road pipes.

1. The diameter of the piles shall be as given in the item. The casing pipe shall be of sufficient thickness and strength to hold its original form and show no harmful distortion after it and adjacent shells have been driven and the driving core, if any, has been withdrawn. Where bore cast-in-situ piles are used in soils liable to flow the bottom of the casing shall be kept enough in advance of the boring tool to prevent the entry of soil into the casing, thus preventing the formation of cavities and settlements in the adjoining ground. The water level in the tube should also be maintained at the natural ground water level until the tube is sealed. The joints of the casing shall be made as tight as possible to minimise inflow of water or leakage of air, where compressed air is employed to facilitate concreting. Before concreting, where the use of compressed air is unnecessary, the bottom of the boring shall be plugged and dired as far as possible.

2. Casing of pipes will be allowed to be withdrawn if possible without any reduction in the rate. In case, casing pipes can not be withdrawn due to site-conditions, the cost of pipes shall be borne by the Contractor and that he shall not be entitled to any payment for non withdrawal of the pipes. The displacement or distortion of reinforcement during these operations and shall while extracting the tube shall be avoided. After installation to final depth and immediately before placing the concrete the inside of the tube or bore shall be free from any foreign matter.

3. The reinforcement in the pile shall be exposed for a sufficient distance to permit it to be adequately bended into the pile cap. In cases where the pile cap is to be laid on ground a levelling course of 1:4:8 lean concrete 8 cm. thick shall be provided.

4. The measurement shall be in metres of the piles ordered in writing by the Engineer-in-charge, measured from the head to the but of the shoe or the tapered point.

5. Unit rate includes boring through all sorts of strata, providing necessary casing pipe, materials, labour and equipment to complete the work. Steel for reinforcement and concrete for piles will be paid separately.

Item 23-Load Testing of Piles

1. Load test may be carried out as decided by the Engineer-in-charge on one or more working piles. Preloading shall be not less than one and a half times the estimated safe load carrying capacity of the pile in case of sandy soils and two times the estimated safe load in the case of clayey soils.

2. The test shall commence as early as possible after driving of the piles.

The test shall be carried out by applying a series of load on R.C.C. Cap over a pile or group of piles unaided by any other support. The load shall preferably be applied by means hydraulic jack reacting against a loaded platform or against heavy R.S. Joists or a suitable frame held down by anchor piles or other anchorages, which shall be pre-loaded to not less than one and-a-half times the estimated safe load carrying capacity of the pile. The load applied by jack should be co-axial with the test pile. Wherever tension piles or other suitable anchors are used to sustain the loaded platform, the centre distance between the test pile and anchor pile should minimum of 5 times the test pile diameter. The hydraulic jack used shall be of adequate capacity and shall have a pressure gauge and a remote control pump.

3. Before load test is performed, the proposed set up and the load frame shall be approved from the Engineer-in-charge. Readings of settlement and rebound shall be recorded the help of

at least two dial gauges (preferably four) of 0.02 mm. sensitivity and resting on a diametrically opposite ends of the pile cap. The dial gauges shall be fixed in a datum bar whose ends rest upon non-movable supports. The supports for datum bar with reference to which the settlement of the pile would be measured shall be at least 5 'd' away, clear from the piles, where 'd' is the diameter of the pile subject to a minimum of 2 meters for good sandy soils and 5 metres for loose soils.

4. The test load shall be applied in equal increments of about one fifth of the estimated safe load and reduced to smaller increments at the final stages as or directed by the Engineer-in charge. Alternate loading and unloading of each load increment shall be performed and the elastic and plastic settlement recorded.

5. Each stage of loading or unloading shall be maintained till the rate of movement of the pile top is not more than 0.02 mm. per hour in case of clay soil and 0.1 mm. per hour for sandy soil.

6. The loading shall be continued upto 1 1/2 times the estimated safe load on the pile or when the total settlement of pile top/cap equals the value specified below.

Assessment of safe load shall be as under:

(a) Two-thirds of the final load at which the total settlement attain a value of 12 mm unless it is established that a total settlement different from 12 mm. is permissible in a given case on the basis of nature and type of the structure; in the latter case the actual total settlement permissible shall be used for assessing the safe load instead of 12 mm.

(b) For a group of piles, two-thirds of the final load at which the total settlement attains a value of 40 mm.

7. Lateral load test.-This test shall be carried out at the cut off level of the piles. Two or more test pile which may be part of the working piles driven to the required depth and spacing shall be used for the tests. The lateral load at the cut off level shall either be applied by a jack inserted between the piles or by some other arrangement capable of facilitating the application of desired pull.

The loading shall be applied in increments of about 20 percent of the estimated safe load, reducing to smaller increments in the final stages of the test. The next increment shall be applied after the rate of displacement is about 0.05 mm. per hour in sandy soils and 0.02 mm. per hour in clayey soils or two hours whichever is earlier.

Lateral displacement shall be recorded by using at least two dial gauges spaced at 30 cm. and kept horizontally one above the other on each pile. Where it is not possible to locate the dial gauges in line of the jack axis, then the two dial gauges be kept at a distance of 30 cm. at a suitable height and the displacement at load point, interpolated from similar triangles.

The safe lateral load on the pile shall be taken as the least of the following :

(a) 50 per cent of the final load at which total displacement increases to 12 mm.

(b) Final load at which total displacement corresponds to 5 mm and,

(c) Load corresponding to any other specified displacement due to performance requirements.

8. The measurement for payment shall be per number of load test on piles.

9. The Unit includes all materials, labour, equipment plant, platform, gauges for the purpose of recording result to complete the job.

ITEM 24 A Coursed Rubble stone Masonry in cement mortar without cement Pointing.

1. Stone shall be hard, sound free from cracks decay and weathering and shall be freshly quarried from approved quarry. Stone, with round surface shall not be use. 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 : 1125. The length of stone shall not exceed three times its height and the breadth on base shall not be greater than three fourth of the thickness of wall not less than 15 cm. Minimum crushing strength of stone shall not be less than 105 kg/sq.cm.

2. Cement and sand shall be mixed in proportion as a specified in the item. Cement and sand shall be proportioned by volume after making due allowance for bulking. The required quantity of water shall than be added and the mortar mixed to produce workable consistency.

3. The mixing shall be done intimately, on a clean water tight platform. Cement and sand shall be first mixed dry in the required proportion to obtain a uniform colour and then after addition of water the mortar shall be mixed for at least two minutes. In case cement mortar has stiffened because of evaporation of water, the same shall be retempered by adding water as frequently as needed to restore the requisite consistency but this retempering shall be permitted only within thirty minutes from the time of addition of water at the time of initial mixing.

4. dressing of stone shall conform of the general requirements for dressing of stone covered in IS : 1129. Stone shall be sufficiently wetted before laying to prevent absorption of water from mortar. The bed which is to receive the stones shall be cleaned wetted and covered with a layer of fresh mortar. All stones shall be laid full in mortar both in bed and in vertical joints and settled carefully in place with a wooden mallet immediately on placement so that it is solidly bedded in before the same has set. Clean chips and spalls shall be wedged into the mortar joints and beds wherever necessary to avoid thick beds or joints of mortar. Whenever foundation, masonry is laid directly on rock, the face stones of the first course shall be dressed to fit into the rock snugly when pressed down in the mortar bedding over the rock. No dry or hollow space shall be left anywhere in the masonry and each stone shall have all the embedded faces completely covered with mortar. Vertical joints shall be staggered as far as possible. Sufficient transverse bond shall be provided by the use of bond stones extending from the front to the back of the masonry. In case of thick walls bond stones shall overlap each other their arrangement. Bell shaped bond stones or headers shall not be used.

5. At all angular junction stones at each alternate course shall be well bonded into the respective course of the adjacement wall. All connected masonry in structure shall be carried up at one uniform level throughout as far as possible but when breaks, are unavoidable, the masonry shall be raked in sufficient long steps to facilitate jointing of new work with old. The stepping of ranking shall not be more than 45° with the horizontal. Wing walls, abutments and piers, etc. shall be carried up truly plumb or to the specified batter. Face work and hearting shall be brought up evenly. The top of each course, however shall not be levelled up by use of flat chips.

6. Stones shall be hammer dressed on the face, the sides and beds to enable it to come in proximity with the neighbouring stone. The bushing on the face shall be more than 4 cm. on exposed face. Chips and spalls of stones may be used wherever necessary to avoid thick mortar beds or joints and it shall also be ensured that no hollow spaces are left anywhere in the masonry. The chips shall not be used below hearting stones to bring these upto the level of face stones use of chips shall be restricted to filling of interstices between the adjacent stones in hearting and they shall not exceed 20 per cent of the quantity of stone masonry.

7. The hearting or interior filling wall face shall consist of rubble stones not less than 15 cm. in any direction carefully laid, hammered down with a wooden mallet into position and solidly bedded in mortar. The hearting should be laid early level with facing and backing. Through bond stones shall be provided in masonry upto 60 cm. thickness and in case of masonry above 60 cm. thickness a set of two or more bond stones overlapping each other at least by 15 cm, shall be provided in a line from face to back. In case of highly absorbant type of stones (porous limestone and sand stones, etc.) the bond stone shall extend only about two-third into the wall, as through stone in such cases may give rise to penetration of dampness and, therefore, for all thickness of such masonry a set of two or more bond stones overlapping each other by at least 15 cm. shall be provided for every 0.50 square metres of the masonry surface. Bond stone shall be stacked separately and marked to distinguish from other stones. Masonry work shall be started after sufficient number of bond stones are collected on-site as directed by the Engineer-in-charge. Vertical bond stones shall be inserted at the rate of one per 3 sq.mt. and shall be staggered.

8. The quoins shall be laid header and stretcher alternately. Every stones shall be fitted to the adjacent stones so as to form neat and close joint. Face stone shall extend and bond well in the back. These shall be arranged to break joints, as much as possible, and to avoid long vertical lines of joints.

9. The face joints shall be more than 20 mm thick but be sufficiently thick to prevent stone to stone contact and shall be completely filled with mortar.

10 Green work shall be protected from rain by suitable covering. Masonry work in cement or composite mortar shall be kept consistently moist on surface for a minimum period of seven days. The top of the masonry work shall be left flooded with water at the close of the day. During hot weather all finished or partly completed work shall be covered or wetted in such manner as to prevent repaid drying. The raking of joints, where necessary shall be done at the end of day's work when mortar is green.

11. The scaffolding shall be found and strong to withstand all loads likely to come upon it. The holes which provide resting space for horizontal members shall not be left in masonry under one metre in width or immediately near the screw backs or arches. The holes left in the masonry work for supporting the scaffolding shall be filled and made good.

12. When fresh masonry is to be placed against existing surface of structure, these shall be cleaned of all loose material, roughened and wetted as directed by the Engineer-in-charge as to effect a good bond with the new work.

13. Stone masonry shall be measured in cubic metres.

14. The unit rate for stone masonry work shall include the cost of all labour, materials, tools and plant, scaffolding and other expenses incidental to the work.

15. Masonry shall be laid with courses- Where there is variation in the height of courses, larger courses shall be placed at lower levels, with height of courses decreasing gradually towards the top.

16. In case of abutment and wing walls, weep holes shall be provided in the masonry to drain moisture from the backfilling. Weep holes shall be 8 cm. wide, 15 cm. high or circular of 15 cm. diameter and shall extend through the full width of the masonry with slope of about 1 vertical M 20 horizontal towards the draining face. The spacing of weep holes shall be generally 1 m. in either direction with the lowest one at about 15 cm. above the low water level or ground level whichever is higher or as directed by the Engineer-in-charge.

ITEM-24 B Coursed rubble : stone masonry in Cement mortar with Cement pointing

Para 1 to 16 item of coursed rubble stone masonry in cement mortar without cement pointing shall apply.

Para 17 to 22 : Para 1 to 6 of item of cement pointing in cement mortar shall apply.

ITEM-25 Uncoursed rubble stone masonry in Cement mortar with cement. Pointing.

Para 1 to 14 : Para 1 to 14 of item if coursed rubble stone masonry shall apply.

Para 15 to 20 : Para 1 to 6J item of cement pointing in cement mortar shall apply.

ITEM 26 Extra for Khanki facing.

1. Relevant specification of item of C.R. Masonry shall apply.

2. Khanki facing shall be provided for the depths shown in the drawings or upto 30 cm. below the probable depth of exposure of masonry or as may be directed by the Engineer-in-charge. At least 50 per cent of the khankies shall tail twice their height into the masonry. 5 cm. chisel draft shall be provided at the end of the straight portions of the piers near cut and ease waters for checking the batters which shall be uniform throughout. Cut and ease water shall be provided exactly to the shapes shown in the plans and their face work shall correspond to that of the straight portion of the piers. 5 cm. chisel drafts shall be provided on both sides of the noses of the Cut and ease waters to check that the batters are uniform. 'Jose stones shall be laid header and stretchwise.

3. For cement pointing, relevant specification of that item shall apply.

4. Khankis shall be properly dressed due vertical and horizontal at least for 25 mm. on all sides of the joints and it shall at least project 1.2d times inside than the height of the same. The joints shall then be pressed as soon as the mortar has begun to set and the hollow spaces be filled with fresh mortar, tapped and pressed to allow the mortar to consolidate in the joints. Joints shall be rubbed straight truly vertical and horizontal. After rubbing, the extra mortar found spread on the edges of joints shall be carefully scraped off to give a neat appearance. Joint will be raked to 6 mm. depth when the mortar is fresh.

5 Measurement for payment shall be on Smt. basis of the surface areas of Khanki facing. Nothing shall be deducted in the item of C.R. Stone masonry for Khanki stones used under this item.

6. Unit rate includes all material, labour, tools & plant to complete the job.

ITEM-27 Providing M.S. Dowel bars in sub-structure for [A] free [B] fixed end

1. For Mild Steel, specifications for Me reinforcement shall apply.
2. The M.S. dowel bars shall be provided and anchored in pier caps, abutment caps and super-structure as per detailed drawings for free ends and fixed ends. G.I. Pipes and other, materials such as mastic asphalt as directed by Engineer-in-charge or as per drawing shall be provided G.I. pipes shall as approved by-Engineer-in-charge.
3. The payment shall be made per number of dowel bars in anchored condition.
4. Unit rate shall include cost of all materials, labour and equipments to complete the Job.

ITEWI-28 Mild Steel & cast steel bearings.

(A) Fixed & sliding plate bearings.

(B) Roller & Rocker bearings.

1. This work shall consist of furnishing and fixing in position of bearings in accordance span to details shown on the drawings. Bearing plates, bars, rockers, assemblies, and other exhtision or fixed devices shall be constructed in accrodance with the details shown the drawings, when bearing assemblies or plates are shown to be placed (not embecled) directly on concrete in the drawings, the concrete bearing area shall be constructed slightly above grade and shall be finished by grinding. It shall be ensured that the bearings are set truly level and in exact position as indicated on the drawings so as to have full and even bearing on the seats. Thin mortar pads (not exceeding 12 mm.) may be made to meet with this requirement. .It shall be ensured that the bottoms of girders to be received on the bearings are plane at the location of these Bearings and care shall be taken the bearings are not displaced while placing the girders. Wherever rockers and rollers are provided for expansion or construction of superstructure spans longer than 30 metres, they shall be so adjusted at the time of placement that after subsequent computed or expected movement of the bridge seat, the line of bearing is as central as possible on the bearing plates at normal design temperature.

2. Materials for bearings shall conform to I.S.S. Cat steel component thicker than 200 mm. shall be subjected to radiographic, ultrasonic or any other accepted method of testing to check the quality of casting. Mild steel for roller shall be made from Cl. III or Class IV steel in accordance with IRS Specification of relevant items. It may alternatively be turned from carriage or wagon axles.

3. All work shall strictly conform to the drawings. Care shall be taken to ensure that all parts of an assembly fit accurately together. The workmanship shall satisfy all relevant provisions laid down in specification of cutting edge. Knuckle pins, rolling surfaces of the rollers and bearing surface of the bearing plates shall be machined and all bolt holes shall be drilled. The whole bearings shall be fitted and finished as required for good quality machined work to the satisfaction of the Engineer-in-charge. However, bearings which are to be grouted or bedded on a suitable yeilding materials on any surface which is to be in permanent contact with the grout or the yeilding material, may be left unmachined.

4. Tolerance for individual components or of the assembled bearing shall be as shown in the drawings or subject to the approval of the Engineer-in-charge. Unless otherwise specified, the following tolerances shall be maintained. Tolerances on diameter of rollers and all convex surfaces shall conform to K7 of IS : 919. Tolerances on diameter of all concave surfaces shall conform to D8 of IS : 919. Tolerances on the height of any component casting shall not exceed + 0.5 mm. No minus tolerance will be allowed. The edges of all ribs shall be parallel throughout their length. Tolerance on length and width of the base plate shall not exceed 5 mm. All rolling, rocking and sliding surfaces shall have a machine smooth finish to 20 micron maximum mean deviation as per IS : 3073.

5. The contractor shall, whenever required in the course of manufacture, arrange and afford all facilities for the purpose of inspection and tests for all or any the parts of bearings and materials used therein to any officer of the Directorate of Inspection of the Ministry of works, Production and Supply of the Government of India or Gujarat Government Department, and shall obtain necessary certificate of having satisfied the requirements. All inspection charges shall be payable by the Contractor. In addition to the certificate to be obtained from the officer of Government of India regarding metallurgical composition and tests on samples of metal used in casting or in manufacture of the bearings as referred in the foregoing

paras above, the contractor shall make all necessary arrangement at his cost, to carry out load test, on at least 5 per cent of the total number of bearings, in the presence of the Engineer-in-charge or his authorised agent for 1 1/2 times the designed load of bearings and unless the tests give satisfactory results duly certified in writing by the Engineer-in-charge or his authorised agents, no bearing shall be permitted to be used on the work. In case the test results are not satisfactory all the remaining of the extra number of bearings as may be decided by the Engineer-in-charge shall have to be tested at his risk and cost in similar manner and only those number of bearings which stand the test satisfactorily and are certified as passed by the Engineer-in-charge shall be allowed to be used on works and the contractor shall not have right or claim for the rejected bearings. The tests shall be considered successful if noticeable dents are not formed at points of contacts or no undesirable flaws are noticed in the surface of the bearings after the test.

6. All bearings shall be surrounded by grease boxes of either R.C.C. or mild steel plates. The size of the grease box shall be adequate to cover the bottom plate and its height will be upto the top of the top plate. The grease box shall be filled fully with the grease, of the relevant I. S. Specification.

7. Bearings fixed at free end and fixed end should be counted separately. Bearings shall be measured per number consisting of bottom and top plate in case of fixed, sliding and rocker bearings; and roller bottom and top plates in case of roller bearings and all other accessories.

8. The rate for each type of bearing shall include the cost of supplying and fixing the bearings in position complete as specified on the drawings or as directed by the Engineer-in-charge. The rate shall also include the cost of samples and their testing as desired by the Engineer-in-charge. The rate shall include the cost of all nuts, bolts, supplying and filling the grease boxes with the specified grease.

ITEM 29. Restrained Elastomer Bearings.

1. The term 'bearings' in this case shall refer to an elastomeric bearing consisting of one or more elastomer slabs bonded to metal plates during manufacture so as to form a sandwich arrangement, while 'Bearings Pads' shall, denote single unreinforced elastomer slabs.

2. The elastomer to be used for bearings shall be made from natural or synthetic rubber and satisfy the physical properties given below. The test pieces required for the tests shall be selected from the centre layer of the bearings while making up the selection.

ITEMS	ASTM Designation	Requirement
(i) Durometer Hardness	D - 2240	55 to 70 (# 5 Points for the nominated Value).
(ii) Ultimate Tensile Strain per cent	D - 412	450 for 55 grade 400 for 60 grade 300 for 70 grade.
(iii) Tensile Strength Kg/cm ² .	D - 412	175 minimum 135 minimum for natural rubber of harness greater than 65.
(iv) Adhesion to Metal Kg/cm ² .	D - 429 (Method - B)	9
(v) Tear Resistance Kg/cm.	D - 624 40 (DIEC)	
(vi) Compression set 22 hrs. At 70° C %	D - 395 (Method - B)	25 maximum
(vii) Ozone resistance 22% strain 100 hrs. 380° C ± 10° C (1 part per million in air by volume).	D - 1149	No cracks.
(viii) Accelerated ageing 70 hours, 1000 C Hardness increase. Tensile strength reduction, Elongation At break reduction.	D - 573	10 points. 15% of original. 25% of original.
(ix) Low temperature stiffness young's Modulus - 40° C Kg/cm ² .	D - 797	700 maximum.

3. Adhesive used in bearing location attachment to bridge decks shall be subject to the approval by the Engineer-in-charge. It shall be of high viscosity resins, which are cold setting and free of solvent. Adhesive shall not be used to bond layers of cured elastomer. Mild steel used for plate reinforcement shall comply with the requirements of relevant I.S. The Contractor shall furnish to the Engineer-in-charge a certificate by the Manufacturer that the elastomer and fabric (if used) in the elastomeric bearing conforms to all the above requirements. The certification shall be supported by a certified copy of the results of tests, performed by the Manufacturer upon samples of the elastomer and fabric to be used in the bearings.

The contractor shall, whenever required, during the course of manufacture arrange and offer all facilities for the purpose of inspection and test of all or any of the material used therein, to any officer as directed by the Engineer-in-charge and the bearings and similar parts shall be used in the superstructure except on the production of certificate of acceptance thereof from the Directorate of Inspection whenever necessary. All the inspection charges shall be payable by the contractor.

4. The thickness of a single layer bearing shall not exceed 20 per cent of the least plan dimension. The total thickness of a laminated bearing shall not exceed 40 per cent of the least plan dimension. The thickness of any internal layer of elastomer shall not be less than 6 mm. nor greater than 12 mm. The thickness of outer plates shall be not less than 3 mm. and that of inner plate not less than 1.5 mm. Metal plates in which dowels are located shall be, in general, not less than 6 mm. thick. The edges of all plates shall be lightly rounded to approximately 5 mm. radius. The metal plates referred above should not be composed of thinner plates joined together. Laminated Bearings shall have side cover of elastomer of minimum thickness of 6 mm. to protect the ends of the steel plates and to give a reduced surface strain to that occurring at the edge of the bonded plates but shall not be considered in evaluation of deformations. The cover of elastomer at the top and bottom surfaces shall not be less than 3 mm. or more than half the thickness of internal layer. The outer cover at top and bottom surfaces having thickness less than half that of a single internal layer and not exceeding 3 mm. may be considered as a simple protection and need not therefore be considered in calculating deflections. Where above elastomer covers are provided, there is no objection to keeping the thickness of top most and bottom most plates same as that of inner plates.

5. Bearing shall be set back from the edge of a bearing surface a distance not less than the thickness of the layer of elastomer in contact with bearing surface to allow for spreading of the elastomer under load. Bearings may be located in position by means of dowels or studs or other devices, or bonded to the structure with approved adhesives which shall generally be of the high viscosity resin type cold setting and free from solvent. For spans on an inclined grade and without hinge bearings: the sole plates shall be provided and the same bevelled so that masonry surfaces and the bearing shall be kept horizontal. To facilitate maintenance, the ends of trusses and plate girders shall preferably be supported on plates or pedestals so that there is at least 15 centimetres clearance between the bottom chord or flange and the substructure. The plan dimensions of the bearings to be finally adopted shall preferably be selected from series 'R' 20 of IS : 1076. The arrangement of placing only one bearing under a girder shall be permitted. Further, bearings of different sizes must not be placed next to each other to support a span. The bearings shall be fully moulded when metal laminations are used. These laminated elastomeric bearings shall consist of one or more elastomer slabs bonded to metal plates so as to form a sandwich arrangement. Such fully moulded bearings shall be manufactured to required size. The bond between elastomers and metal or fabric shall be such that, when a sample is tested for separation, failure shall occur within the elastomers and not between the elastomer and metal.

6. The contractor shall get the bearings tested for the physical properties and performance of bearings. The test pieces required for the test shall be selected from the Central layer of bearing making up the selection. For the Size of the test pieces and method of tests etc. the relevant A.S.T.M. Standard shall be followed. The tests shall be carried out in a recognised laboratory acceptable to the department for all the necessary tests required by the Department. The specimen for tests as may be required shall be supplied by the contractor at his own cost and the testing charges shall also be fully borne by the contractor. Only those bearings which pass the tests satisfactorily will be accepted and will be permitted to be used. The Department shall not accept any responsibility for the cost of bearings rejected.

- | | | |
|----|--|---------------|
| 7. | (i) Tolerances on length and width | 0, +5 mm. |
| | (ii) Tolerances on thickness for single layer pad. | ± 0.5 mm. |

- (iii) Tolerance on total thickness.
 'h' of finished bearings.

$10 < h \leq 30$ mm	:	± 0.5 mm,
$30 < h \leq 50$ mm	:	± 0.8 mm,
$50 < h \leq 80$ mm	:	± 0.9 mm,
$80 < h \leq 120$ mm	:	± 1.1 mm,

(iv) The parallelism of the individual elastomer laminations for a finished bearing, shall not exceed the tolerance specified at (ii) above when measured at the extremities of the laminations.

8. Proper arrangement shall be made to avoid corrosion of metal plates or deteriorating of adhesive by encasing the bearings totally in elastomer or by some other method approved by the Engineer in charge.

9. (i) When bearing assemblies on plates are shown on the drawing to be placed (not embedded) directly on concrete, the concrete bearing area shall be constructed slightly above grade and shall be finished by grinding.

(ii) It shall be ensured that bearings are set truly level and in exact position as indicated on the drawings so as to have full and even bearing on the seats. Thin mortar pads (not exceeding 12 mm.) may be made to meet with this requirements.

(iii) It shall be ensured that the bottoms of the girders to be received on the bearings are plane at the location of these bearings and care shall be take that the bearing are not displaced while placing the girders.

(iv) Before fixing the elastomeric bearings the concrete surface on which the bearings is to be placed shall be wood float finished to a level plane which shall not vary more than 1.5mm from a straight edge placed in any direction across the area.

(v) The position of the bearings shall be accurately marked on the pier/abutment cap and the area where the bearings are to be located levelled accurately.

(vi) The concrete surface shall be free from any loose material and cleared of any grease oil, paint etc., and it shall be dry at the time of fixing.

(vii) The surface of elastomer shall be free any foreign material.

(viii) Once prepared, the concrete or elastomer shall not be touched with bare hand.

(ix) The bearings shall be covered with canvas or a suitable covering material to protect from direct sun-light and weather until the concrete on superstructure is cast.

(x) The bearings shall be fixed in position, with epoxy resin adhesive of approved quality.

(xi) The concreting of superstructure shall be taken up only after ensuring that the adhesive for fixing the bearings or pier/abutment cap has set.

10. Unit rate shall be cubical contents of the bearing measured in cms.

11. The rate for each type of bearings shall include the cost of supplying and fixing the bearings in position complete. The rate shall also include the cost of samples and their testing as desired by the Engineer-in-charge. The rate shall also include the cost of adhesives for fixing them.

Item - 30 Providing pre-moulded asphalt filter joint.

1. Open joints shall be constructed at the loations as directed by the Engineer-in-charge using a wood strip, metal plate, other suitable material which is subsequently removed. When removing the material, care shall be exercised to avoid chipping or breaking the corners of the concrete. The edge of the concrete at the joints shall be edge finished. Reinforcement shall not extend across as open joint.

2. When performed filler is to be provided the filler shall be placed in correct position before concrete is placed against the filler. The filler material shall form part of the joint and while concreting the slab, care shall be taken to prevent the former from bring displaced. After the work is completed, the exposed face of the joint shall be cleaned of all loose material sticking to it.

3. The material used for filling expansion joint shall be bitumen impregnated felt which shall conform to the requirements of IS : 1838, and shall be got approved from the Engineer-in-charge.

The joint shall consist of large pieces and assembly of small pieces to make up the required size shall be avoided.

4. The expansion joint shall be measured in running metres. Thickness of the expansion joint will be 20 to 25 mm. Width of the expansion joint shall be equal to full depth of the slab.

5. The rate shall include the cost of all materials, labour, equipments and other incidental charges for fixing the joints complete in all respect as per these specifications and as shown on the drawings.

Item 31-Providing metal expansion joints.

1. Expansion joint shall be constructed according to the details shown on the drawings. The position of all bolts cast and holes drilled in plates shall be accurately determined from templates.

2. Steel plates, angles, or other structural sections provided in the expansion joints shall conform to the relevant IS specification and shall be accurately shaped to the section of concrete deck and shall be hot-dip galvanised after fabrication. Positive methods shall be employed in placing the assemblies, to keep them in correct position during the placing of concrete. Care shall be taken to avoid impairment of the clearance in any manner. The material used for filling expansion joint shall be bitumen impregnated felt, elastomeric or any other suitable material as specified on the drawings. Impregnated felt shall conform to the requirement of IS : 1838 & shall be got approved from the Engineer-in-charge. The joint filler shall consist of large pieces and Assembly of small pieces to make up the required size shall be avoided.

3. The expansion joints shall be measured in running metres.

4. The rate shall include the cost of all material, labour, equipment and other incidental charges for fixing the joints complete in all respects as shown on the drawings.

Item 32- Load test of super-structure

1. The Engineer-in-charge shall instruct that a load test be made on any part of the super structure if in his opinion such a test is deemed necessary for one or more of reasons specified below:-

- (a) The work test cubes failing to attain the specified strength.
- (b) The shuttering being prematurely removed.
- (c) Over loading during construction of the structure or part thereof.
- (d) Concrete improperly cured.
- (e) Any other circumstances attributable to negligence on the part of the contractor which, in the opinion of the Engineer-in-charge, results in the reduction of required strength of the structure or part thereof.
- (f) Any reason other than the foregoing.

2. If the load test be ordered to be made solely or in part for the reasons (a) to (e) the test shall be carried out at the contractor's own cost. If the test is required to be carried out for the reasons specified at (f) hereinbefore, the contractor shall make the test and shall be paid for the same.

3. The test load shall not be applied earlier than 28 days of the completion of placing of the concrete in the part of the structure to be tested and the latter shall not be supported during the test by the shuttering or other non-permanent support. Necessary care shall, however, be taken to ensure that in the event of failure under the test temporary support of the loaded member shall be immediately available.

4. If the result of the load test (or the reasons mentioned at (a) to (e) is not satisfactory in the opinion of the Engineer-in-charge he shall instruct that the part of the structure concerned shall be taken down or cut out and reconstructed to his satisfaction or that other remedial measures shall be taken to make the structure secure and strong as per requirement at the contractor's own risk and cost or the work may be accepted as sub-standard work and paid at reduced rate as may be decided by the Engineer-in-charge and his decision in the matter shall be binding, on the contractor. The contractor shall provide necessary materials, instruments, equipments observations platforms, plant and labour needed for carrying out the test as required. The load in general shall be in the form of sand bags. However, the contractor may apply the test load in any other suitable manner as may be approved by the Engineer-in-charge. The contractor shall make all necessary arrangements for observation platforms, centering, taking deflection by deflectometers etc. to the entire satisfaction of the Engineer-in-charge. The test load shall be kept at least 24 hours or as directed before removal.

Test load of superstructure shall be 1.5, times the equivalent load including maximum stresses at sections of maximum bending moment and or shear force for which the superstructure is designed,

5. The item for the purpose of payment shall be measured per number of load test placed on the superstructure and the payment of the same made on completion of the test.

6. Unit rate shall include all materials, labour, measuring instruments, tools and plant necessary to carry out the load test.

Item 33-A-Providing R.C.C. parapet precast in controlled concrete.

1. For concrete and steel, specifications of the items of controlled concrete and reinforcement shall apply.

2. All components of the parapets shall be precast and arranged in the pattern as shown on the drawing, and shall be jointed together as per details shown on the drawing.

3. The parapet shall be truly and correctly aligned in line and level, along the centre line of the parapet over the top rail. All edges and corners shall be straight and finished in true line and level.

4. Parapet shall be measured in running metres. Reinforcement in the parapet shall not be paid separately.

5. Unit rate includes cost of all materials including steel, form work, labour, tools and plants to complete the job.

Item 33-B-Providing R.C.C. Parapet cast-in-situ in controlled concrete

1. For concrete and steel, specifications of the items of controlled concrete and reinforcement shall apply.

2. The parapet shall be truly and correctly aligned in line and level, along the centre line of the parapet over the top rail. All edge's and corners shall be straight and finished in true line and level. Forms shall either be of single width boards or shall be lined with suitable material duly approved by the Engineer-in-charge. Form joints in plain surface will not be permitted. All mouldings, panel work and level strips shall be constructed according to the details shown on the drawings.

3. Parapet shall be measured in running metres. Reinforcement in the parapet shall not be paid separately.

4. Unit rate includes cost of all materials including steel, form work, labour, tools and plants to complete the job.

Item 34- Providing post and pipe railing

1. G.I. Pipes shall be of light duty type. Concrete shall conform to relevant specifications of item of concrete of ordinary grade specified in the item. For structural steel relevant specifications of item of steel cutting edge and for mild steel, relevant specifications of item of M.S. reinforcement shall apply.

2. The pipe railing shall consist of R.C.C. posts of required dimensions as approved by the Engineer-in-charge or structural steel sections as shown on the drawings. The structural section shall be anchored to R.C.C. in the manner as directed by the Engineer-in-charge. Three rows of G.I. pipe, upper one of 50 mm. dia. and lower two of 40 mm. diameter shall be provided. Holes of required size shall be made in the posts and the pipe shall be fixed with necessary couplings and three coats of enamel paint shall be applied to iron work (first coat shall be of red lead) If R.C.C. posts are used, they shall be applied 2 coats of white wash. The posts shall be fixed at 2 m. to 2.5 m. centre to centre depending upon the span-length.

3. Railing shall be measured in running metres.

4. Unit rate includes cost of all materials, labour, tools and plant to complete the job.

Item 35-Providing Water spout of 100 mm. dia. Of-

- (A) Cast Iron
- (B) Galvanised Iron
- (C) P.V.C.

1. Material for the water spout shall be as mentioned in the item and shall be got approved from the Engineer-in-charge.

2. Water spout shall be 100 mm. internal dia. Cast iron grating shall be provided at the entry and shall be fixed in the recess so as to be flush with the road surface. The quality and size of The grating shall be got approved from the Engineer-in-charge. The water spouts shall project at least 10 cm. outside the concrete and shall be rigidly fixed in it. The grating and C.I. pipes shall be painted with two coats of anticorrosive black bitumen paint.

3. Measurement shall be per number of water spout fixed.

4. Unit rate includes cost of all materials, labour and tools to complete the work.

Item 36-Providing Marble Plate

1. Marble plate shall be white and of approved quality and shall be of size as mentioned in the item. Lettering shall be done by V-shape engraving and shall be filled with black paint of approved quality, lettering shall be done as directed by the Engineer-in-charge. The Marble plate shall be fixed in neat cement at a place as directed by the Engineer-in-charge. Cement shall conform to relevant IS Specification.

2. Measurement shall be per number of marble plate fixed.

3. Unit rates includes cost of all material labour and tools to complete the work.

Item 37-Prestressed concrete work

1. Para 1 to 31 of the item of controlled concrete shall apply.

2- As an alternative to centering work and casting the girders in situ. The girders may be precast in a yard and launched into position using any approved method of launching with prior approval of the Engineer-in-charge satisfying all the requirements and supporting their proposals for launching with detailed design and drawings. All materials and equipment required for launching shall have to be designed and got approved from the Engineer-in-charge. The launching shall be the responsibility of the contractor and the approval by the Engineer-in-charge to the design and drawing of the launching system shall in no way relieve the contractor of the responsibility for its successful working. The contractor is expected to take all necessary precautions. The contractor shall be responsible for any damage or loss in the process of launching, side-shifting and any other operation, and the same shall be made good by him at his own cost. Sheaths shall be placed and aligned strictly as shown on the drawings and maintained securely to prevent displacement during placing the compaction of concrete.

3. Grout holes shall be left in concrete at such places and in such manner as directed by the Engineer-in-charge. Water shall be injected to clean the passage thoroughly before grouting and the ducts will be dried with compressed air. Regrouting shall be done to fill up the space formed as a result of the settlement of the grout.

4. If the girders are not cast or launched in position, the same shall be shifted sideways by a suitable device which shall be got approved from the Engineer-in-charge before placing them in position.

Item-38-Providing High Tensile steel wires including Prestressing.

1. All wires or bars shall be assigned a lot number and shall have suitable tags for identification. All samples shall be truly representative of the lot to be furnished and in the case of wire or strand, they shall be taken from the same master roll. All materials specified for testing shall be furnished as per instructions of Engineer-in-charge, free of use. When High Tensile steel wires are brought by the Contractor, he shall produce all relevant certificates from the manufacturers. Additional tests if required by the Engineer-in-charge, shall be got conducted by the Contractor at his cost, through an independent agency approved by the Engineer-in-charge.

2. Sheaths shall be manufactured from Bright Galvanized metal sheet or any other specified material. They shall be preferably machine made and of a large enough bore to allow easy threading of the cable or bar in long lengths. They shall be strong enough as not to be dented or deformed during handling or concreting.

3- Preferably proprietary forms of anchorages shall be used and they shall be strictly in accordance with the manufacturer's instructions. If the Engineer-in-charge so desires, few anchorage cones shall be got tested by the Contractor at his own cost. The anchorage shall be furnished, complete with distribution plates of each size of type to be used, free of charge, for testing.

4. Cement for grouting shall conform to relevant specifications but rapid hardening Portland cement may be used at temperatures less than 7.2°C. Sand, where used for large ducts, shall be of a size smaller than 2 mm. additives (Plasticizers) shall be used only when experience has shown that their use improves the quality of the grout. They shall contain no chloride or nitrate or any other ingredient which may induce corrosion of steel. The compressive strength of the grout at 7 days measured on 100 mm. cubes, shall be at least 175 kg/sq.cm. The test cubes shall be cured in a moist atmosphere for 24 hours and subsequently in water.

5. All prestressing steel shall be free from loose mill scale, rust, oil, grease or any other harmful matter at the time of its placing in the member. Cleaning of the steel may be carried out by immersion in suitable solvent solutions, wire brushing, or passing through a pressure box containing carborundum powder.

6. As far as possible prestressing wire shall be obtained from the manufactures in coils having diameter of not less than 350 times the diameter of the wire itself, so that the wire springs back straight on being uncoiled. If due to smaller of the coil or any other reason it does not happen the wire shall be straightened before use. Prestressing steel bars, may be obtained from the manufacturers in straight condition. Any small adjustments necessary because of site conditions shall be made by bending in a normal type bar bender. Bars shall not be bent when their temperature is less than 10%.

7. Prestressing steel shall be accurately located and maintained in position, both vertically and horizontally, as per drawings. The method of supporting and fixing shall be such that profile of cables is not at all disturbed by heavy and prolonged vibrations, by pressure of wet concrete, by workmen or by construction. The steel sheaths or duct formers shall be suitably tied to secondary reinforcement or to properly located withdrawably through shutter bolts, precast concrete blocks or similar effective means, in such a manner that they do not give rise to excessive friction when the steel being tensioned.

8. All cutting to length and trimming of ends shall be done by suitable mechanical or flame cutters, when a flame cutter is used, care shall be taken to ensure that the flame does not come in contact with other stressed steel. In post-tensioning ends of prestressing steel projecting beyond the anchorages shall be cut after the grout has set. Welding of prestressing steel shall not be permitted. Internal prestressing steel shall be protected by grouting as detailed in above. External prestressing steel shall be protected by encasing it in a dense concrete cover secured to the main concrete.

9. Sheaths shall be sufficiently water tight to prevent concrete laitance penetrating them in quantities likely to increase friction. Special care shall be taken to ensure water tightness at joints. Anchor cones, blocks and plates shall be positioned, and maintained during concreting so that the centre line of the duct passes axially through the anchorage assembly. All bearing surface of the anchorages shall be cleaned prior to concreting and tensioning. Adequate provision shall be made for protection of the anchorages against corrosion.

10- It shall be ensured that all necessary equipment for prestressing is available at site of work. The prestressing shall be carried out with approved jacking equipment. The tensioning apparatus shall satisfy the following requirements :

- (i) The means of attachments of the prestressing steel to the jack or any other tensioning apparatus shall be safe and secure.
- (ii) Where two more wires are stressed simultaneously, provision shall be made for equal stressing of the wires;

(iii) The tensioning apparatuses shall be such that it can apply controlled total force gradually on the concrete without inducing dangerous secondary stresses in steel anchorage or concrete;

(iv) Means shall be provided for direct measurement of the force in prestressing steel during stressing or gauges fitted in the hydraulic system itself to determine the pressure in the jacks. Facilities in such a case shall be provided for the measurement of the extension of prestressing steel and of any movement of the gripping devices at transfer.

Combination of the jack and the gauge shall be calibrated and a graph or table showing the calibration shall be furnished and got approved from the Engineer-in-charge prior to the commencement of work. Calibration of gauges of the jacks shall be done at suitable intervals, the prestressing equipment shall be checked to determine any variation from the normal values during use. So far as these variations depend upon external influence (e.g., temperature in the case of oil jacks) they shall be taken into account. Any equipment which gives an error in values of more than +5% shall not be used on the works.

11: All reasonable precautions shall be taken when working with or near steel which has been tensioned or is in the process of being tensioned. Person shall not stand in line with the steel; anchorages or the jacking equipment, neither shall they walk on the steel. Simple, protective measures such as stout timber shields armoured with steel shall be placed in line with prestressing steel and behind the jacks so as to protect personnel crossing in the course of their duties. In all cases, cable extension and the prestressing force to be applied shall be worked out in advance after allowing for all the factors like (i) tensioning in stages; (ii) hindrance to elongation on account of friction due to non-rectilinear alignment of the prestressing elements; (iii) slip in the anchorages; and (iv) creep; and an approved record of the same shall be kept. The change in length of the cables as well as the tensioning force shall be measured at the time of tensioning and it shall be proved by comparison that the losses allowed for are not exceeded. Tensioning shall be carried out under competent supervision in such a manner that the stress in the steel increases at a gradual and steady rate. When stressing from one end only, the pull at the end remote from the jack shall be accurately measured and an appropriate allowance made in the measured extension at the jacking end. No tensioning of bars shall be carried out when the temperature is less than 2 °C.

12. Where wires in a cable are not stressed simultaneously spacing members shall be sufficiently rigid so as not to be displaced during the successive tensioning operations. Wires and cables, shall be so arranged that they do not pass round sharp corners or bends to avoid setting up of stresses likely to provide rupture. Tensioning shall be conducted in such a manner that the applied tension and elongation can be measured at all times. It shall be ensured that in no case the load is applied to the concrete before it attains the specified strength. To determine the specified strength additional cube test shall be conducted at contractor's cost. After the steel has been anchored, the force exerted by the tensioning apparatus shall be decreased gradually and steadily so as to avoid shock to the prestressing steel or anchorage.

13 Vents shall be provided at all crests and valleys in the duct profile and at intervals of not more than 15 metres in straight reaches. Threaded entries shall be provided at the duct ends to permit use of a screwed connector from the grout pump. Before grouting, the ducts shall be thoroughly cleaned and shall be free of water, any dirt or other foreign substances. Ducts formed without metal sheathing shall be flushed with water before grouting, and all surplus water removed by compressed air injection. The anchorages shall be thoroughly sealed with mortar of strength equal to that of the grout to prevent ingress of air into the duct during grouting operation. The equipment shall be capable of producing a grout of colloidal consistency, by means of high frequency turbulence but imparting only a slow motion to the body of the grout. It shall have delivery pressure of upto 7 Kg/cm² and be capable of continuous operation without any appreciable pressure variation and include a system for recirculating the grout while actual grouting is not in progress. The piping shall have a minimum of bends, valves and changes in diameter, the baffle shall be fitted with sieve strainers 2 mm in size. The equipment and in particular the piping, shall be thoroughly washed with clean water after every operation and more frequently if necessary. Water shall be added to the mixer first and then the cement. After these have been thoroughly mixed, sand and the additive, if any, shall be added. The water content of the mix shall be kept as low as possible and the water/cement ratio of 0.40 will be preferable when using a neat cement grout. The approximate proportion of the mix shall be one part cement to 0.74 part sand, the exact proportion being adjusted to form a grout giving proper consistency. Mixing shall continue for at least 2 minutes until a uniform consistency is obtained. Injection shall be continuous.

Grout shall be allowed to flow from vent openings until its consistency at exit is equivalent to that of the grout injected. The vent opening shall thereafter be firmly closed one after another in the direction of flow. Sufficient pressure shall be used to force the grout completely through the duct, care being taken not to repute the ducts. Grouting shall be carried out as soon as practicable after the steel has been stressed. The injection tubes shall be topped up with cement grout if any wastage or subsidence of grout occurs when the pump is disconnected. When grouting is done at temperature below 7 °C, provision shall be made for thoroughly protecting the concrete member against frost. Grouting is not recommended in very cold weather.

14. To provide for any deficiency in the prestressing free, sand- bye cables shall be provided in the girders and the same shall not be paid for even if they are used in the girder. Stand bye cable will be permitted to be withdrawn if not required to be stressed.

15. For the purpose of measurement, the length of the high tensile steel shall be measured as actually used in the finished work. From the length so measured its weight shall be calculated in tonnes on the basis of which tensile steel is supplied to the Contractor by the Department or as per IS : 1732 if steel is arranged by the Contractor. Anchorage devices, ducts or metal sheath shall be deemed to be included in the item of high tensile steel and shall not be measured separately.

16. The item rate for high tensile steel cover the cost of all materials, labour, tools and paint required for fixing, placing, tensioning, anchoring, and grouting the high tensile steel in the prestressed cement concrete as shown on the drawings. The cost of anchoring devices and ducts or metal sheath shall also be included in this rate.

Item-39 Cement pointing in Cement Mortar.

1. For a surface which is to be subsequently pointed, the joints shall be squarely raked out to a depth of 15 mm, while the mortar is still green. The raked joints shall be well brushed to remove dust and loose particles and the surface shall be thoroughly washed with water, cleaned and wetted.

2. Cement and sand shall be mixed in proportions as specified in the item. Cement and sand shall be proportioned by volume after making due allowance for bulking. The required quantity of water shall then be added and the mortar mixed to produce workable consistency.

3. The mixing shall be done intimately by hand-mixing, on a clean wastertight platform. Cement and sand shall be first mixed dry in the required proportion to obtain a uniform colour and then the mortar shall be mixed for at least two minutes after addition of water. In case of cement mortar, that has stiffened because of evaporation of water the same shall be re-tempered by adding water as frequently as needed to restore to requisite consistency but this retempering shall be permitted only within thirty minutes from the time of addition of water at the time of initial mixing.

4. For pointing, the mortar shall be filled and pressed into the raked out joints before giving the required finished- The pointing shall then be proper type given on the drawings. If type of pointing is not mentioned on the drawing the same shall be ruled pointing. For ruled pointing after the mortar has been filled and pressed into the joints and finished off level with the edges, it shall while still green be ruled along the centre with a half round tool of such width as may be specified by the Engineer-in-charge. The superfluous mortar shall then be cut off from the edges of the lines and the surface of the masonry shall also be cleaned off all mortar.

5. Curing shall be started as soon as the mortar used for finishing has hardened sufficiently not be damaged when watered. It shall be kept wet for a period of at least 7 days. During this period it shall be suitably protected from all damages.

6. Stage scaffolding shall be approved for the work. This shall be independent of the structure.

7. The work of pointing shall be measured in square metres of the surface treated.

8. The rate for pointing shall include erecting and removal of scaffolding all labour, materials and equipment incidental to complete the pointing, raking out joints, cleaning, wetting filling with mortar, trowelling, pointing and watering .

Item-40 Provide in and placing precast R.C.C. footpath slab in controlled concrete.

1. The relevant specifications of controlled cement shall apply for the precast R.C.C. slabs. The footpath slab shall be precast and shall be grade and thickness as per item. The relevant specifications for reinforcement shall apply for the reinforcement in the slab. The chequered tiles shall be of the quality and make as approved by the Engineer-in-charge. The thickness of chequered tiles be 25 mm. The R.C.C. slabs and chequered tiles shall be laid in C.M. 1:5 as directed by the Engineer-in-charge. Specification of mortar as given in the item of cement pointing shall apply.

2. The measurements for payment shall be on Sq. Mt. basis.

3. The item includes cost of materials including necessary reinforcement, providing and fixing of chequered tiles on the slab, labour, plant, from work including fixing the R.C.C. slabs and chequered tiles in position.

required operations including full compensation for all components listed in Clause 401.7 (i) to (v).

404 WATER BOUND MACADAM SUB-BASE/BASE

404.1 Scope

This work shall consist of clean crushed aggregates mechanically interlocked by rolling and bonding together with screening, binding material where necessary and water laid on a properly prepared subgrade/sub-base/base or existing pavement, as the case may be and finished in accordance with the requirements of these Specifications and in close conformity with the lines, grades, cross-sections and thickness as per approved plans or as directed by the Engineer.

404.2 Materials

404.2.1 Coarse Aggregates

Coarse aggregates shall be either crushed or broken stone, crushed slag, overburnt (Jhama) brick aggregates or any other naturally occurring aggregates such as kankar and laterite of suitable quality. Materials other than crushed or broken stone and crushed slag shall be used in sub-base courses only. If crushed gravel /shingle is used, not less than 90 percent by weight of the gravel/shingle pieces retained on 4.75 mm sieve shall have at least two fractured faces. The aggregates shall conform to the physical requirements set forth in Table 400-8. The type and size range of the aggregate shall be specified in the Contract or shall be as specified by the Engineer. If the water absorption value of the coarse aggregate is greater than 2 percent, the soundness test shall be carried out on the material delivered to site as per IS:2386 (Part 5).

Table 400-8 : Physical Requirements of Coarse Aggregates for Water Bound Macadam for Sub-base/Base Courses

S.No.	Test	Test Method	Requirements
1) ***	Los Angeles Abrasion value	IS: 2386(Part 4)	40 percent (Max)
	or Aggregate Impact value	IS: 2386 (Part-4) or IS:5640*	30 percent (Max)
2)	Combined Flakiness and Elongation Indices (Total) **	IS:2386 (Part-1)	35 percent (Max)

* Aggregates which get softened in presence of water shall be tested for Impact value under wet conditions in accordance with IS:5640.

- ** The requirement of flakiness index and elongation index shall be enforced only in the case of crushed broken stone and crushed slag.
- *** In case water bound macadam is used for sub-base, the requirements in respect of Los Angeles Value and Aggregate Impact Value shall be relaxed to 50 percent and 40 percent maximum respectively.

404.2.2 Crushed or Broken Stone

The crushed or broken stone shall be hard, durable and free from excess flat, elongated, soft and disintegrated particles, dirt and other deleterious material.

404.2.3 Crushed Slag

Crushed slag shall be made from air-cooled blast furnace slag. It shall be of angular shape, reasonably uniform in quality and density and generally free from thin, elongated and soft pieces, dirt or other deleterious materials. The weight of crushed slag shall not be less than 11.2 kN per m³ and the percentage of glossy material shall not be more than 20. It should also comply with the following requirements:

- | | | |
|------|----------------------|--|
| i) | Chemical stability : | To comply with requirements of appendix of BS:1047 |
| ii) | Sulphur content : | Maximum 2 percent |
| iii) | Water absorption : | Maximum 10 percent |

404.2.4 Overburnt (Jhama) Brick Aggregates

Jhama brick aggregates shall be made from overburnt bricks or brick bats and be free from dust and other objectionable and deleterious materials. This shall be used only for road stretch when traffic is low.

404.2.5 Grading Requirement of Coarse Aggregates

The coarse aggregates shall conform to one of the Gradings given in Table 400-9 as specified.

404.2.6 Screenings

Screenings to fill voids in the coarse aggregate shall generally consist of the same material as the coarse aggregate. However, where permitted, predominantly non-plastic material such as moorum or gravel (other than rounded river borne material) may be used for this purpose provided liquid limit and plasticity index of such material are below 20 and 6 respectively and fraction passing 75 micron sieve does not exceed 10 percent.

Table 400-9 : Grading Requirements of Coarse Aggregates

Grading No.	Size Range	IS Sieve Designation	Percent by weight Passing
1)	63 mm to 45 mm	75 mm	100
		63 mm	90 – 100
		53 mm	25 – 75
		45 mm	0 – 15
		22.4 mm	0 – 5
2)	53 mm to 22.4 mm	63 mm	100
		53 mm	95 – 100
		45 mm	65 – 90
		22.4 mm	0 – 10
		11.2 mm	0 – 5

Note : The compacted thickness for a layer shall be 75 mm.

Screenings shall conform to the grading set forth in Table 400-10. The quantity of screenings required for various grades of stone aggregates are given in Table 400-11. The Table also gives the quantities of materials (loose) required for 10 m² for sub-base/base compacted thickness of 75 mm.

The use of screenings shall be omitted in the case of soft aggregates such as brick metal, kankar, laterites, etc. as they are likely to get crushed to a certain extent under rollers.

404.2.7 Binding Material

Binding material to be used for water bound macadam as a filler material meant for preventing ravelling shall comprise of a suitable material approved by the Engineer having a Plasticity Index (PI) value of less than 6 as determined in accordance with IS:2720 (Part-5).

The quantity of binding material where it is to be used, will depend on the type of screenings. Generally, the quantity required for 75 mm compacted thickness of water bound macadam will be 0.06–0.09 m³ per 10 m².

Table 400-10 : Grading For Screenings

Grading Classification	Size of Screenings	IS Sieve Designation	Percent by Weight Passing the Sieve
A	13.2 mm	13.2 mm	100
		11.2 mm	95 - 100
		5.6 mm	15 - 35
		180 micron	0 - 10
B	11.2 mm	11.2 mm	100
		9.5 mm	80 - 100
		5.6 mm	50 - 70
		180 micron	5 - 25

Table 400-11 : Approximate Quantities of Coarse Aggregates and Screenings Required for 75 mm Compacted Thickness of Water Bound Macadam (WBM) Sub-Base/Base Course for 10 m² Area

Classification	Size Range	Compacted Thickness	Loose Qty.	Screenings			
				Stone Screening		Crushable Type Such as Moorum or Gravel	
				Grading Classification & Size	For WBM Sub-base/ Base Course (Loose Quantity)	Grading Classification & Size	Loose Qty.
Grading 1	63 mm to 45 mm	75 mm	0.91 to 1.07 m ³	Type A 13.2 mm	0.12 to 0.15 m ³	Not uniform	0.22 to 0.24 m ³
-do-	-do-	-do-	-do-	Type B 11.2 mm	0.20 to 0.22 m ³	-do-	-do-
Grading 2	53 mm to 22.4 mm	75 mm	-do-	-do-	0.18 to 0.21 m ³	-do-	-do-

The above mentioned quantities should be taken as a guide only, for estimation of quantities for construction etc.

Application of binding materials may not be necessary when the screenings used are of crushable type such as moorum or gravel.

boats) and labour for loading, unloading and laying within the time frame for construction of guide bund. Adequate reserve of stones should be maintained for major works as decided by the Engineer. Reserve stones shall be stacked away from the main channel of the river.

2502.6 Where the alignment of guide bund or the approach embankment crosses branch channel of the river, the branch channel shall be either diverted to the main channel of the river with the help of spurs, etc. or closed by a properly designed closing dyke or closure bund, before taking up construction of guide bund.

2503 APRON

2503.1 General

This work shall consist of laying boulders directly or in wire crates on the bed of rivers for protection against scour.

The stones used in apron shall be sound, hard, durable and fairly regular in shape. Stones subject to marked deterioration by water or weather shall not be used.

Quarry stones having angular shapes shall be preferred to round boulders.

Where the stones of required size are not economically available, cement concrete blocks in minimum M15 grade conforming to Section 1700 of these Specifications or stones in wire crates shall be used.

2503.2 Boulder Apron

The size of stone shall conform to Clause 5.3.7.2 of IRC: 89.

The size of stone shall be as large as possible and no stone shall weigh less than 40 kg. The specific gravity of stones shall be as high as possible and not less than 2.4.

To ensure regular and orderly disposition of the full intended quantity of stone in the apron, template cross walls in dry masonry shall be built about a metre thick and to the full height of the specified thickness of the apron, at intervals of 30 metres all along the length and width of the apron. Within these walls, the stone shall be hand packed.

The surface on which the apron is to be laid shall be levelled and prepared for the length and width, as shown on the drawings. In case the surface is below the low water level, the ground level may be raised upto low water level by dumping earth and the apron laid thereon. In such cases, the quantity of stone required in apron shall be re-worked by taking the toe of pitching at higher level.

2503.3 Wire Crates and Mattresses for Apron

Wire Crates and Mattresses shall be any of two types mechanically woven and hand woven.

2503.3.1 Mechanically Woven Crates (Gabions and Mattresses)

2503.3.1.1 Description

Mechanically woven wire crates shall be made of hot dipped galvanized mild steel wire of diameter not less than 2.2 mm having minimum tensile strength 350 MPa conforming to IS:280. The galvanisation shall be heavy coating for soft condition conforming to IS:4826. For corrosive environment, an additional PVC coating of 0.5 mm thickness shall be provided over the galvanisation, or zinc alloy coating as per EN 10244-2 shall be provided in place of galvanisation. The mesh of the crate shall be of type 10 x 12, 8 x 10, and 6 x 8 as per EN 10223. Mesh shall be given double twist at each intersection and shall be mechanically selvaged all along the edges of the boxes. Wire crates standard sizes shall be as per ASTM A975. The wire crates shall be divided into compartments by diaphragms placed at 1 m centre to centre.

2503.3.1.2 Mesh and Box Characteristics

Mesh types and shapes shall be as given in Table 2500-1. The mesh and box characteristics of gabions and mattresses shall be as per Tables 2500-2 and 2500-3 respectively.

Table 2500-1 : Mesh Types and Sizes

Mesh Type	'D' Nominal Size, mm	Tolerances
10 x 12	100	+ 16% to - 4%
8 x 10	80	
6 x 8	60	

Table 2500-2 : Mesh & Box Characteristics for Gabions

Mesh Type	10 x 12			8 x 10		
'D', mm	100			80		
Wire Type	Only Zinc Coated		Zinc + PVC Coated	Only Zinc Coated		Zinc + PVC Coated
Mesh Wire Dia, mm	2.70	3.00	2.70/3.70*	2.70	3.00	2.70/3.70*
Edge/Selvage wire Dia, mm	3.40	3.90	3.40/4.40*	3.40	3.90	3.40/4.40*
Lacing wire dia, mm	2.20	2.20	2.20/3.20*	2.20	2.20	2.20/3.20*
PVC coating thickness, mm	N. A		Nominal – 0.50 Minimum – 0.38	N. A		Nominal – 0.50 Minimum – 0.38
Typical Sizes Length x Width x Height (m)/ Number of diaphragms	4 x 1 x 1 / 3 Nos, 3 x 1 x 1 / 2 Nos, 2 x 1 x 1 / 1 No, 1.5 x 1 x 1 / 0 No, 2 x 1 x 0.5 / 1 No, 3 x 1 x 0.5 / 2 Nos, 4 x 1 x 0.5 / 3 Nos, 2 x 1 x 0.3 / 1 No, 3 x 1 x 0.3 / 2 Nos, 4 x 1 x 0.3 / 3 Nos					
Tolerances in Size of Gabion Boxes	Length & Width... +/- 5%; Height > 0.3m... +/- 5% and Height <= 0.3m... +/- 10%					

* Internal Diameter/External diameter of PVC Coated Wire

Only standard sizes of Gabion boxes are indicated in the table above. Special sizes can also be ordered as agreed between the purchaser and manufacturer.

Table 2500-3 : Mesh & Box Characteristics for Revet Mattresses

Mesh Type	6 x 8	
'D', mm	60	
Wire Type	Only Zinc Coated	Zinc + PVC Coated
Mesh Wire Dia, mm	2.20	2.20/3.20*
Edge/Selvedge wire Dia, mm	2.70	2.70/3.70*
Lacing wire dia, mm	2.20	2.20/3.20*
PVC coating thickness, mm	N. A	Nominal – 0.50 Minimum – 0.38
Typical Sizes Length x Width x Height (m)/Number of diaphragms	4 x 2 x 0.17 / 3 Nos, 3 x 2 x 0.17 / 2 Nos, 2 x 2 x 0.17 / 1 No 4 x 2 x 0.23 / 3 Nos, 3 x 2 x 0.23 / 2 Nos, 2 x 2 x 0.23 / 1 No 4 x 2 x 0.30 / 3 Nos, 3 x 2 x 0.30 / 2 Nos, 2 x 2 x 0.30 / 1 No	
Tolerances in Size of Revet Mattresses	Length & Width ... +/- 5%; Height <= 0.3m ... +/- 10%	

* Internal Diameter/External diameter of PVC coated wire

2503.3.1.3 Dimensions and Tolerances

The diameter of galvanized steel wire shall conform to the values as per Table 2500-2 for Gabions and Table 2500-3 for Revet mattresses. The diameter of the wires shall also conform to the tolerance limits plus and minus the values as shown in Table 2500-4.

Table 2500-4 : Permitted Tolerances on Galvanized Steel Wire Diameters

Nominal Diameter of Galvanized Wire, mm	Permitted Tolerances (+/-) on Wire Diameters, mm
2.00	0.05
2.20	0.06
2.40	0.06
2.70	0.07
3.00	0.08
3.40	0.09
3.90	0.10

Note :

- 1) The minimum and nominal thickness of PVC coating uniformly applied in a quality workmanlike manner shall be as shown in Tables 2500-2 and 2500-3.

- 2) Gabions shall be manufactured with a 10 x 12 or 8 x 10 mesh type (Fig. 2500-1) having a nominal mesh opening size as per Table 2500-2. Dimensions are measured at right angles to the center axis of the opening and parallel to the twist along the same axis.
- 3) Revet mattresses shall be manufactured with a 6 x 8 mesh type (Fig. 2500-1) having a nominal mesh opening size as per Table 2500-2. Dimensions are measured at right angles to the center axis of the opening and parallel to the twist along the same axis.
- 4) The width and length of the gabions and revet mattresses as manufactured shall not differ more than $\pm 5\%$ from the ordered size prior to filling. Typical gabion and revet mattress sizes are shown in Tables 2500-2 and 2500-3 respectively.
- 5) The height of the gabions and revet mattresses as manufactured shall not differ more than $\pm 10\%$ if the height is less than or equal to 0.3 m and shall not differ more than $\pm 5\%$ if the height is more than 0.3 m from the ordered size prior to filling.
- 6) Mesh Opening Tolerances – Tolerances on the hexagonal, double-twisted wire mesh opening shall not exceed $+16\%$ to -4% on the nominal dimension D values mentioned in Table 2500-1.

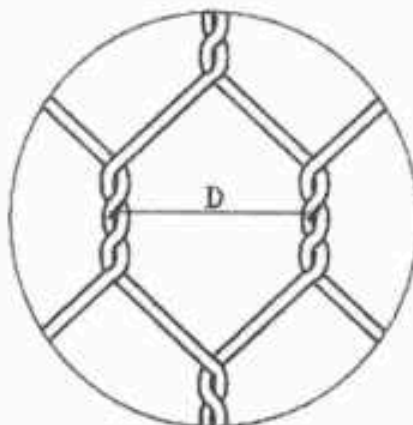


Fig. 2500-1 : Mesh Type & Nominal Size 'D'

2503.3.1.4 Terminology, mechanical properties, physical properties, number of tests and test methods related to mechanically woven wire crates shall be as per Appendix-2500/I.

2503.3.2 Hand Woven Wire Crates

Wire crates shall be made from hot dipped galvanized mild steel wire of diameter not less than 4 mm in annealed condition having tensile strength of 300 MPa-450 MPa conforming to IS:280. The galvanizing shall be heavy coating for soft condition conforming to IS:4826.

The mesh size of the crate shall not be more than 150 mm.

Wire crates for shallow or accessible situations shall be 3 m x 1.5 m x 1.25 m in size. Where these have to be deposited and there is a possibility of overturning, the crate shall be divided into 1.5 m compartments by cross netting.

For deep or inaccessible situations, wire crates can be made smaller subject to the approval of the Engineer.

Wire crates built in-situ, shall not be larger than 7.5 m x 3 m x 0.6 m, nor smaller than 2 m x 1 m x 0.3 m. Sides of large crates shall be securely stayed at intervals of not more than 1.50 m to prevent bulging.

The netting shall be made by fixing a row of spikes on a beam at a spacing equal to the mesh. The beam must be a little longer than the width of netting required. The wire is to be cut to lengths about three times the length of the net required. Each piece shall be bent at the middle around one of the spikes and the weaving commenced from the corner.

A double twist shall be given at each intersection. The twisting shall be carefully done by means of a strong iron bar, five and half turns being given to the bar at each splice.

The bottom and two ends of the crate or mattress shall be made at one time. The other two sides shall be made separately and shall be secured to the bottom and the ends by twisting adjacent wires together. The top shall be made separately and shall be fixed in the same manner as the sides after the crates or mattress have been filled.

2503.3.3 Laying of Wire Crates

Wherever possible, crates shall be placed in position before filling with boulders. Undulations in the bed shall be levelled prior to placement of wire crate units. The crates shall be filled by carefully hand-packing the boulders as tightly as possible and not by merely throwing in the stones or boulders.

Where the crates are to be laid on the sides and bed of the stream in underwater conditions, they shall be prefilled on dry area, lifted by cranes using suitable size frames with lifting slings at every 0.5 m to 1 m maximum spacing and placed at designated locations. Sacrificial steel rods of diameter 20 mm to 25 mm may also be used, in place of frame, by tying them to the edges and lifting directly with closely spaced slings. Once placed, divers shall lace the crates together at all contact surfaces. For sides of the banks a tilting platform, pantoon or barge can be used where mattresses are filled with stones on the level platform, resting at one end on the bank and has the other edge hinged to the pantoon/barge. One end of the filled wire crate is anchored to the dry edge of the slope and then the pantoon/barge is moved away

from the bank, thus lowering and sliding out the tilted platform under the crate, gradually placing the crate on the slopes while the tilted platform rotates around its hinges.

2504 PITCHING/REVTMENT ON SLOPES

2504.1 Description

The work shall consist of covering the river side slopes of guide bunds, training works and road embankments with stone, boulders, cement concrete blocks or stones in wire crates over a layer of granular material which will act as a filter. The rear slopes, not subjected to direct attack of the river, may be protected by 300 mm - 600 mm thick cover of clayey or silty earth and turfing.

2504.2 Pitching and Filter Medium

2504.2.1 Pitching

The pitching shall be provided with stones of thickness and shape as indicated on the drawings.

The stones shall be obtained from quarries and shall be sound, hard, durable and fairly regular in shape. Round boulders shall not be allowed. Stones showing marked deterioration by water or weather shall not be accepted.

The size and weight of stone shall conform to Clause 5.3.5.1 of IRC: 89. No stone, shall weigh less than 40 kg. The size of spalls shall be a minimum of 25 mm and shall be suitable to fill the voids in the pitching.

Where the stones of required size are not economically available, cement concrete blocks in minimum M15 grade concrete conforming to Section 1700 of these Specifications or stones in wire crates, shall be used.

Geosynthetics, if used in pitching, shall conform to Section 700 of these Specifications.

2504.2.2 Filter Medium

The material for the filter shall consist of coarse sand, gravel or stone. One or more layers of graded materials, to act as a filter medium, shall be provided underneath the pitching, to prevent loss of the embankment material and build up of uplift head on the pitching.

CHEQUE LIST FOR DTP

Sr. No.	Details	Clause No.	Page No.	Name of work	JOB No Date	Amount in Lakh.
1	Principle Approval Date and Amount (Attach letter)	-		CONSTRUCTION OF CROSS DRAINAGE STRUCTURES ON VARIOUS ROADS IN MORBI DISTRICT - PACKAGE -I		
2	Administrative Approval Date and Amount (Attach letter)	-		Attached herewith		
3	Technical Approval Date and Amount (Attach letter)	-		Name of work	Date of T.S	Amount in Lakh.
				CONSTRUCTION OF CROSS DRAINAGE STRUCTURES ON VARIOUS ROADS IN MORBI DISTRICT - PACKAGE -I		
4	SOB Year	-		2024-2025		
5	DTP amount	IFB		219715096.75		
6	Tender Fee Rs. (As per GR- PRCH-102000-IB221(39)-C, dated 24/01/2007) (1.0 Cr. To 3.0Cr.- Rs.3600/- 3.0 Cr. to 5.0 Cr. - Rs 6000 5.0 Cr. to 10.0 Cr. - Rs 12000 Above 10.0 Cr.- Rs 18000)	-		18000/-		
7	Earnest Money Deposit (Bid Security-1% of DTP amount) Rs.	IFB point 6		2197200/-		
8	Time Limit (Months)	Section 3 cl. 17		12 Months		
9	Annual Financial Turnover Amount Rs.	Section 1 cl. 4.5.3(a)		Not Applicable		
10	Defect Liability Period (in Months & includes no. of Monsoons)	Section 3 cl. 33.1		12 Months		
11	Free Maintenance Guarantee Period (for Road & Bridge Construction)	Section 3 cl. 332.2		Five Year		
12	Registration/ Category required	-		AA Class and above with Special Category-I (Bridge)		
13	Site Possession Date	Section 3 cl. 21		1st day of Work order //		

14	Period between Program Update (Days)	Section 3 cl. 27.3		30 days			
15	Amount to be withheld for late submission of Program	Section 3 cl. 27.3		1 Lakh			
16	Milestone: -	Section 3 cl. 49.1		%	Days		
A	Milestone 1			10	36		
B	Milestone 2			40	144		
C	Milestone 3			80	288		
D	Milestone 4			100	365		
17	Price Adjustment Components	Section 4 cl. 24		%	Input index/price		
A	Labour, Pl	Section 4 cl. 24 (i)	Pl	20.91	Lo		
B	Cement, Pc	Section 4 cl. 24 (ii)	Pc	14.54	Co		
C	Steel, Ps	Section 4 cl. 24 (iii)	Ps	24.71	So		
D	Bitument, Pb	Section 4 cl. 24 (iv)	Pb	0.00	Bo		
E	POL, Pi	Section 4 cl. 24 (v)	Pi	2.49	Fo		
F	Plant and Machinery Spares Pp	Section 4 cl. 24 (vi)	Pp	31.37	Po		
G	Other Materials, Pm	Section 4 cl. 24 (vii)	Pm	5.98	Mo		
	Total			100.00			
18	Amount to be withheld for failing to supply "as built" drawings	Section 3 cl. 58		5 Lakhs			
19	Percentage Rate Contract (upto INR 50 Cr.)/ Item Rate Contract (above INR 50 Cr.)	Section 7		Percentage Rate			

This is to certify that the contract document prepared for the work

**CONSTRUCTION OF CROSS DRAINAGE STRUCTURES ON VARIOUS ROADS IN MORBI
DISTRICT - PACKAGE -1**

is based on the Standard Bidding Document Procurement of Civil Works published by R&B department letter No. RBD/0346/10/2023 dated 12/10/2023. No further modification and alteration in this standard format has been made by this office.


Deputy Executive Engineer
Panchayat R&B Sub Division
Morbi


Executive Engineer
Panchayat R&B Division
Morbi

Superintending Engineer
Panchayat R&B Circle-1
Rajkot

CONSTRUCTION OF CROSS DRAINAGE STRUCTURES ON VARIOUS
ROADS IN MORBI DISTRICT - PACKAGE -1

PART-II
DOCUMENTS NOT TO BE ISSUED TO CONTRACTOR
INDEX

SR NO	DETAILS OF DOCUMENTS	PAGE NO.
1	Proforma-A	
2	Certificate Issued by A.A.E. of sub division,Dy. Ex. Engineer, and Executive Engineer.	
3	Put to and Not put to Amount Details.	
4	Quantity Sheet	
5	Schedule-B	
6	Asphalt Requirement Statement.	
7	Cement Requirement Statement.	
8	P.O.L	


CONSTRUCTION OF CROSS DRAINAGE STRUCTURES ON VARIOUS ROADS IN
MORBI DISTRICT - PACKAGE -1


PROFORMA-A

(To Accompany with Submission of DTP)

1. Tender Forms DTP			
A	Whether the Old clauses are replaced by the latest clauses as per Government instruction. ?		Yes
B	If yes, State the number wise details of clauses replaced.		-
C	Whether time limit entered its is proportion with the amount and number of work. ?		Yes
D	Whether the details vise mention of security Deposit etc. are written in tender form ?		As per SBD
2. Schedule-A			
A	Whether schedule-A gives details of the materials to be supplied under Schedule-A ?		To be purchase from open market through contractor.
B	Does it mention the correct place of dilivery of materials to be supplied under Schedule-A ?		N.A
C	Whether the rates of materials are mentioned in the Figure as well as in the words. ?		N.A
D	Whether the rate entered in schedule-A is correctly Derived ?		N.A
E	Whether the rate entered in schedule-A correctly arrived at as norms ?		N.A


I have personally verified the fact as stated above and found in order.


Divisional Accountant
Panchayat R&B Division
Morbi


Executive Engineer
Panchayat R&B Division
Morbi

3. Bil of Quantitiy		
(i)	Whether the description of each item literely tally with the sanctioned estimate except specifying of lead etc. comp.	Yes.
(ii)	Whether quantity of each item is as per sanctioned estimate/ If not, state the reasons with due justification of deviation in covering letter of the DTP.	Yes.
(iii)	Whether the rate of each items is as per sanctioned estimate ? If not, state the reasons with due justification for Deviation in covering letter of the DTP. and incorporate the analysis in covering letter of DTP.	Yes.
(iv)	Whether unit of each item is per sanctioned estimate ? If not, state reasons with due justification for diviation in covering letter of DTP.	Yes.
(v)	Whether the rate of each item in BOQ is mentioned in words in case of % rate tender.	Yes.
(vi)	Whether the standard method is adopted in each item in writing the Units. (e.g Cubic meter to abbreviated as Cum and not applicable not C.M. etc.)	Yes.
(vii)	Whether the Govt, remarks if any observed at the time of according sanctioned are fully incorporate in the DTP. If, yes submit compliance report.	N.A.
(viii)	Whether correct name of work is entered at the top of BOQ	Yes.
(ix)	Whether standard form for BOQ is adopted.	Yes.
(x)	Whether the standard words for discount or premium on tendred rate as " I/we am/are." is mentioneda at the end ?	N.A.
(xi)	Whether the amount worked out for each item is correctly calculated and submit up ?	Yes.
(xii)	Whether alternate items are proposed in the DTP, ? If yes state the Item no. for which alternative item is proposed,	No
4. Detailed of Specification		
(i)	Whether the detailed specification correctly reflect the tender Item ?	Yes.
(ii)	Whether items with sepcified lead and lift are counverted in to with all lead and lift.	Yes.
(iii)	Whether correct made of mesurement is mentioned ?	Yes.

(iv)	Whether correct mode of payment is as per BOQ ?	Yes.
(v)	Whether suitable use of excavated materials or cutting stuff is incorporated in the DTP. ?	N.A.
(vi)	Whether the mentioned regarding the test to be carried out before execution is made herewith in the respective item of DTP.	Yes Test schedule attached herewith.
(vii)	Whether reference to PWD hand book is specification of IRC clause are mentioned correctly and relevantly in the respective item ?	Yes.
(viii)	Whether the test to be carried out during execution is made ? Stated the item No. with description and details of tests to be carried out in brief ?	Yes Test schedule attached herewith.
(ix)	Whether average rate of earthwork derived and entered in BOQ If, yes give rate analysis.	No
(x)	Whether the description of each item literally and exactly with that in BOQ. ?	Yes.
4. Detailed of other items.		
(i)	Whether statement of item not put to tender is incorporated with detailed justification.?	No.
(ii)	Whether the amount of sanctioned estimated tally with the total of amount put to tender and amount not put to tender ?	Yes.
(iii)	Whether page number in DTP is made.	Yes.
(iv)	Whether permission to split up the work ? If yes give information with competent authority.	N.A.
(v)	Whether the general specification and other relevant records are incorporated DTP.	Yes.
(vi)	Whether Executive Engineer has signed the DTP. and all correction are attested by him.	Yes.
(vii)	Whether the DTP. are submitted in well bound volume and in neat and tidy fashion /	Yes.


 A.A.E. (PB)
 R&B Division
 Morbi

Deputy Executive Engineer
 Panchayat R&B Sub Division
 Morbi


Executive Engineer
 Panchayat R&B Division
 Morbi

CONSTRUCTION OF CROSS DRAINAGE STRUCTURES ON VARIOUS ROADS IN MORBI
DISTRICT - PACKAGE -1


CERTIFICATE

This is Certify that


- 1.0 Description of the condition of contract attached with DTP are throughly checked and found a per gujarat Public works manuals.
- 2.0 The condition of contract and precibed from attached with DTP of the proposed Road works are ammended/modified/replaced as per the time to time instruction issued by Government.
- 3.0 BOQ memorendum and other precribed forms of DTP is 100% throughly checked w.r.t. arithmatically aspects and forund correct.


Senior Clerk
Panch. R&B Sub Division
Morbi


Tender Clerk
Panch. R&B Division
Morbi


Divisional Accountant
Panch. R&B Division
Morbi


Deputy Executive Engineer
Panch. R&B Sub Division
Morbi



Executive Engineer
Panch. R&B Division
Morbi


CONSTRUCTION OF CROSS DRAINAGE STRUCTURES ON VARIOUS ROADS IN MORBI
DISTRICT - PACKAGE -1


CERTIFICATE


This is Certify that

- 1.0 Description of the General Technical Specification the Detailed Specification of Items attached with DTP are thoroughly checked and found as per Gujarat public work manuals,
- 2.0 The General Technical specification and detailed sepcification of items of the proposed road works are amended/modified/replaced as per the time ti time istruction issued by the Government.
- 3.0 The detailed sepcification of each items are provided as per accorded technical sanctioned plan and estimated.
- 4.0 BOQ, C and schedule for restig of materials of DTP is thoroughly checked w.r.t technical aspects,
- 5.0 Submitted DTP is checked and verified with respect to all points and found is order personally and there is no any ambiguity of descrepancy so as to lead any finanacial or contractual implications.
- 6.0 Necessary required drawing i.e Index Map, Alighment plant and Taluka map and Typical cross section are attached with DTP


Add. Asst. Engineer
Panch. R&B sub Division
Morbi


Deputy Executive Engineer
Panch. R&B subDivision
Morbi


Executive Engineer
Panch. R&B Division
Morbi


A.A.E.
R&B (M), morbi-2


SO
amulane


S. Taluka