

be longer than in normal grade concrete mixes.

The temperature of concrete at the time of placement shall not exceed 25°C. The temperature of concrete at the mixing stage should be lower, to allow for rise in temperature during transport. When considerable distance of transport is involved, particular attention should be paid to ensure retention of slump as targeted for placement.

1715.7 Prototype Testing

Mock-up trials or prototype testing may be carried out to ensure that the concrete can be satisfactorily placed and compacted, taking into account the location of placement and provision of reinforcement, and required adjustments made in concrete mix design and/or detailing of reinforcement.

1715.8 Curing of Concrete

High performance concrete containing silica fume is more cohesive than normal mixes hence, there is a little or no bleeding and no bleed water to rise to the surface to offset water loss due to evaporation. Plastic shrinkage cracking is possible, if curing is not proper. Initial curing should commence soon after initial setting of concrete. Concrete should be covered with moist covers, opaque colour plastic sheets or suitable curing compound. Final moist curing should commence after final setting of concrete and continue for at least 14 days.

1715.9 Additional Tests for Concrete

Apart from the strength tests prescribed in other Sections of these Specifications, the additional tests as specified under Clause 1714.3 shall also be carried out.

1716 TOLERANCES

Tolerances for dimensions/shape of various components shall be as indicated in these Specifications or shown on the drawings or as directed by the Engineer.

1717 TESTS AND STANDARDS OF ACCEPTANCE

1717.1 Concrete shall conform to the surface finish and tolerance as prescribed in these Specifications for respective components.

1717.2 Random sampling and lot by lot acceptance inspection shall be made for the 28 days cube strength of concrete.

1717.3 Concrete under acceptance, shall be notionally divided into lots for the purpose of sampling before commencement of work. The basis of delimitation of lots shall be as follows:

No individual lot shall be more than 30 cu.m in volume

Different grades of mixes of concrete shall be divided into separate lots.

Concrete of a lot shall be used in the same identifiable component of the bridge.

1717.4 Sampling and Testing

Concrete for preparing 3 test cubes shall be taken from a batch of concrete at point of delivery for construction, according to procedure laid down in 18:1199.

A random sampling procedure shall be adopted which ensures that each of the concrete batches forming the lot under acceptance inspection has equal chance of being chosen for taking cubes.

150 mm cubes shall be made, cured and tested at the age of 28 days for compressive strength in accordance with 18:516. The 28 day test strength result for each cube shall form an item of the sample.

Tests at other age shall also be performed, if specified.

Where automated batching plant/Ready Mixed Concrete Plant is located away from the place of use and the time gap between production and placement is more than the initial setting time or where any ingredients are added subsequent to mixing, separate sets of samples shall be collected and tested at batching plant and at location of placement. The results shall be compared and used to make suitable adjustment at batching plants so that properties of concrete at placement are as per the requirements.

1717.5 Test Specimen and Sample Strength

Three test specimens shall be made from each sample for testing at 28 days. Additional cubes may be required for various purposes such as to determine the strength of concrete at 7 days or for any other purpose.

The test strength of the sample shall be the average of the strength of 3 cubes. The individual variation should not be more than ± 15 percent of the average. If variation is more, the test results of the sample are invalid.

1717.6 Frequency

The minimum frequency of sampling of concrete of each grade shall be in accordance with Table 1700-9.

Table 1700-9: Minimum Frequency of Sampling

Quantity of Concrete in Work, m ³	No. of Samples
1 – 5	1
6 – 15	2
16 – 30	3
31 – 50	4
50 and above	4 plus one additional sample for each additional 50 m ³ or part thereof

At least one sample shall be taken from each shift of work.

1717.7 Acceptance criteria

1717.7.1 Compressive Strength

Cubes

The concrete shall be taken as having the specified compressive strength when both the following conditions are met:

The mean strength determined from any group of four consecutive non-overlapping samples exceeds the specified characteristic compressive strength by 3 MPa.

Strength of any sample is not less than the specified characteristic compressive strength minus 3 MPa.

The quantity of concrete represented by the test results include the batches from which the first and last samples were taken, together with all intervening batches.

Cores

When the concrete does not satisfy both the conditions given in (1) above, representative cores shall be

extracted from the hardened concrete for compression test in accordance with the method described in IS: 1199 and tested to establish whether the concrete satisfies the requirement of compressive strength. Evaluation of compressive strength by taking cores may also be done in case of doubt regarding the grade of concrete used either due to poor workmanship or based on results of cube strength tests. The locations from which core samples are to be taken and their number shall be decided so as to be representative of the whole of the concrete under consideration. However, in no case shall fewer than three cores be tested. Cores shall be prepared and tested as described in IS:516. Concrete in the member represented by a core test shall be considered acceptable if the average equivalent cube strength of the cores is equal to at least 85 percent of the cube strength of the grade of concrete specified for the corresponding age and no individual core has strength less than 75 percent of the specified strength.

1717.7.2 Chloride and Sulphate Content

The total chloride and sulphuric anhydride (S03) content of all the constituents of concrete as a percentage of mass of cement in the mix shall not exceed the values given in this Section.

1717.7.3 Density of Fresh Concrete

Where minimum density of fresh concrete is specified, the mean of any four consecutive non-overlapping samples shall not be less than the specified value and any individual sample result shall not be less than 97.5 percent of the specified value.

1717.7.4 Density of Hardened Concrete

Where minimum density of hardened concrete is specified, the mean of any four consecutive non-overlapping samples shall not be less than the specified value and any individual sample result shall not be less than 97.5 percent of the specified value.

1717.7.5 Permeability Test

Water permeability test as per DIN:1048 Part 5-1991 shall be carried out as described below:

A cylindrical test specimen 150 mm dia. and 160 mm high shall be prepared.

After 28 days of curing, the test will be conducted between 28 and 35 days. The test specimen shall be fitted in a machine such that specimen can be subjected to a water pressure of up to 7 bars. A typical machine is shown in Appendix-1700/1.

The concrete specimen shall be subjected to a water pressure of 0.5 N/mm² from the top for a period of 3 days. The pressure shall be maintained constant throughout the test period. If the water penetrates through to the underside of the specimen, the test may be terminated and the specimen rejected as failed.

After 3 days, the pressure shall be released and the sample shall be taken out. The specimen shall be split in the middle by compression applied on two round bars on opposite sides above and below.

When the split faces show signs of drying (after 5 to 10 minutes) the maximum depth of penetration in the direction of height shall be measured with the scale and extent of water penetration established.

The mean of maximum depth of penetration obtained from three specimens thus tested, shall be taken as the test result and it shall not exceed 25 mm.

1717.7.6 If the concrete is not able to meet any of the standards of acceptance as prescribed, the effect of such deficiency on the structure shall be investigated by the Contractor as directed by the Engineer. The Engineer may accept the concrete as sub-standard work. Any additional work required by the Engineer for such acceptance, shall be carried out by the Contractor at his cost. In case the concrete is not found to be acceptable even after investigation, the Contractor shall remove the rejected concrete forthwith.

1717.7.7 When durability of concrete is desired the rapid chloride ion permeability test as stated under Clause 1714.3.1 shall also be performed in addition to above tests.

1718 MEASUREMENTS FOR PAYMENT

Structural concrete shall be measured in cubic metres. In reinforced or prestressed concrete, the volume occupied by reinforcement or prestressing cables and sheathing shall not be deducted. The slab shall be measured as running continuously through and the beam as the portion below the slab.

1719 RATE

The contract unit rate for structural concrete shall cover costs of all materials, labour, tools, plant and equipment required for mixing, transporting and placing in position, vibrating and compacting, finishing and curing as per this Section or as directed by the Engineer, including all incidental expenses, sampling and testing, quality assurance and supervision. Unless mentioned separately as an item in the contract, the contract unit rate for concrete shall also include the cost of providing, fixing and removing formwork required for concrete work as per **Section 1500** of these Specifications.

If the concrete is found to be acceptable by the Engineer as sub-standard work, the Contractor shall be subjected to reduction in his contract unit rate. For deficiency in compressive strength of concrete when accepted by the Engineer, the reduction in rate shall be applied as under:

$$\text{Percentage reduction in rate} = \frac{\text{Design Strength} - \text{Observed Strength}}{\text{Design Strength}} \times 100$$

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

Item No. 28

Providing and fixing c.c m-20 grade pre-cast finished surface kerb stone of approved design including the cost of from work rubber mould (as directed by engineer incharge), curing etc. complete. The rate shall also include for erecting and fixing the pieces in position with necessary equipment and materials and include the flush pointing in (cm 1:2) for all joint of the kerb stones. CHAMFERD EDGE KERB [100mm(H) X 300mm(W) X 150mm(T)]

409 CEMENT CONCRETE KERB AND KERB WITH CHANNEL**409.1 Scope**

This work shall consist of constructing cement concrete kerbs and kerbs with channel in the central median and/or along the footpaths or separators in conformity with the lines, levels and dimensions as specified in the drawings or as directed by the Engineer.

409.2 Materials

Kerbs and kerb with channel shall be provided in cement concrete of Grade M20 in accordance with Section 1700 of these Specifications.

409.3 Type of Construction

These shall be cast-in-situ construction with suitable kerb casting machine in all situations except at locations where continuous casting with equipment is not practicable. In those locations precast concrete blocks shall be used.

409.4 Equipment

A continuous kerb casting equipment of adequate capacity and controls, capable of laying the kerbs in required cross-sections and producing a well-compacted mass of concrete free of voids and honeycombs, shall be used.

409.5 Construction Operations

409.5.1 Kerb shall be laid on firm foundation of minimum 150 mm thickness of cement concrete of M 15 grade cast in-situ or on extended width of pavement. The foundation shall have a projection of 50 mm beyond the kerb stone. Before laying the foundation of lean concrete, the base shall be leveled and slightly watered to make it damp.

409.5.2 In the median portions in the straight reaches, the kerb shall be cast in continuous lengths. In the portions where footpath is provided and/or the slope of the carriageway is towards median (as in case of superelevated portion), there shall be sufficient gap/recess left in the kerb to facilitate drainage openings.

409.5.3 After laying the kerbs and just prior to hardening of the concrete, saw cut grooves shall be provided at 5 m intervals up to finished road level or as specified by the Engineer.

409.5.4 Kerbs on the drainage ends such as along the footpath or the median in superelevated portions, shall be cast with monolithic concrete channels as indicated in drawings. The slope of the channel towards drainage pipes shall be ensured for efficient drainage of the road surface.

409.5.5 Vertical and horizontal tolerances with respect to true line and level shall be ± 6 mm.

409.6 Measurements for Payment

Cement concrete kerb/kerb with channel including foundation shall be measured in linear meter for the complete item of work.

409.7 Rate

The Contract unit rates for cement concrete kerb/kerb with channel including foundation for kerb shall be payment in full compensation for furnishing all materials, labour, tools, equipment for construction and other incidental cost necessary to complete the work.

Mode of Payment: The payment shall be made on Rmt basis work done

Item No. 29

Construction of cement concrete Vacuum Wet press kerb with Height= 380mm, Length=300 and width=200mm, foundation having 50 mm projection beyond kerb stone, kerb stone laid with kerb laying machine, foundation concrete laid manually.

The relevant specification of Item No. 28 shall be followed for the execution for the work is **Construction of cement concrete Vacuum Wet press kerb with Height= 380mm, Length=300 and width=200mm, foundation having 50 mm projection beyond kerb stone, kerb stone laid with kerb laying machine, foundation concrete laid manually.**

Mode of Payment: The payment shall be made on Rmt basis work done

Item No. 30

Construction of cement concrete Vacuum Wet press kerb stones of approved make as per approved sample of any size and any type. Kerbs shall be fixed on the foundation prepared as per approved design. The rate shall also include for erecting and fixing the pieces in position for complete kerb system with chamfered type of kerbs including necessary accessories of kerb like radius kerb, angles and quadrant kerbs, droplet kerbs etc. complete as per drawing. Kerb shall be fixed as paper joint without any jointing material. However cement mortar shall be provided at the back side of kerb stone joint. (Sample must be approved) Cost of excavation, cutting, base, side filling shall includes as directed engineer - incharge in above item description as per BOQ (a) 450 mm high Plantation/ Green belt kerb.

The relevant specification of Item No. 28 shall be followed for the execution for the work is **Construction of cement concrete Vacuum Wet press kerb stones of approved make as per approved sample of any size and any type. Kerbs shall be fixed on the foundation prepared as per approved design. The rate shall also include for erecting and fixing the pieces in position for complete kerb system with chamfered type of kerbs including necessary accessories of kerb like radius kerb, angles and quadrant kerbs, droplet kerbs etc. complete as per drawing. Kerb shall be fixed as paper joint without any jointing material. However cement mortar shall be provided at the back side of kerb stone joint. (Sample must be approved) Cost of excavation, cutting, base, side filling shall includes as directed engineer - incharge in above item description as per BOQ (a) 450 mm high Plantation/ Green belt kerb.**

Mode of Payment: The payment shall be made on Rmt basis work done

Item No. 31

Construction of cement concrete Vacuum Wet press kerb on Central Verge (Both side) with Height= 680mm, Length=230 and width=235mm, foundation having 50 mm projection beyond kerb stone, kerb stone laid with kerb laying machine, foundation concrete laid manually.

The relevant specification of Item No. 28 shall be followed for the execution for the work is Construction of cement concrete Vacuum Wet press kerb on Central Verge (Both side) with Height= 680mm, Length=230 and width=235mm, foundation having 50 mm projection beyond kerb stone, kerb stone laid with kerb laying machine, foundation concrete laid manually.

Mode of Payment: The payment shall be made on Rmt basis work done

Item No.32

Wall painting two coats with plastic emulsion paint of approved brand and manufacturer on wall surfaces to give an even shade including thoroughly brushing the surface to remove all dirt, dust, mortar drops and other foreign matter.

1.0. Materials

The plastic emulsion shall conform to I.S.: 5411-1969 (part-I).

2.0. Workmanship

2.1. Preparation of surface :

2.1.1. The undecorated surface to be painted shall be thoroughly brushed from dust, dirt, grease, mortar dropping and other foreign matter and sand papered smooth. New plaster surface shall be allowed to dry for at least 2 months before applications of paint.

2.1.2. All unnecessary nails shall be removed. Pitting in plaster shall be made good with plaster again with a fine grade sand paper and made smooth. A coat of paint shall be applied over the patches. The surface shall be allowed to dry thoroughly before the regular coat of paint is allowed. The surface affected by moulds, moss, fungi, algae lichens, efflorescence etc. shall be treated in accordance with I.S; 2395 (Part 01) 1966. Before applying painting, any unevenness shall be made good by applying putty made of plaster of paris mixed with water on entire surface including filling up the undulation and then sand papering the same after it is dry.

2.2. Preparation of Mix :

This shall be done as per manufacture's instructions. The thinning of emulsion is to be done with water and not with turpentine. The quantity of thinner to be added shall be as per manufacturer instructions.

2.3. Application :

2.3.1. Before pouring into small containers for use, the paint shall be stirred thoroughly in item container. When applying also, the paint shall be continuously stirred in the smaller container, so that its consistency is kept uniform.

2.3.2. The paint shall be laid on evenly and smoothly by means of crossing and laying off the crossing and consist of covering the area over with paint, brushing the surface hard for the first time over and then,

brushing alternately in opposite direction two or three times and then finally brushing lightly in direction at right angles to the same. In this process, no brush Marks shall be left after the laying off is finished. No hair marks from the brush or clogging of paint puddles in the corners of panels, angles of moldings, etc. shall be left on the work. The full process of crossing and laying off will constitute one coat.

2.3.3. The paint shall be applied with brush or rollers. For undecorated surfaces, the surface shall be treated with minimum two coats of cement water proofing paint. The second or subsequent coat shall not be started until the proceeding coat as become sufficiently hard to resist marking by brushing being used.

2.3.4. The surface on finishing shall present a flat velvety smooth finish. It shall be even and uniform in shade without patches, brush marks, paint drops etc.

2.3.5 The shade of colour and pattern of paint to be applied on wall surface shall be got approved from the Engineer in charge before carrying out the work.

2.4. Precautions :

(a) Old brushes if they are to be used with emulsion paints, shall be completely dried of turpentine or oil paint by washing in warm soap water. Brushes shall be quickly washed in water immediately after use and kept immersed in water fusing break periods to prevent the paint from hardening on the brush.

(b) In the preparation of wall for plastic emulsion painting, no oil base petals shall be used in filling cracks, holes etc.

(c) Splashes on floors etc. shall be cleaned out without delay as they will be difficult to remove after hardening.

(d) Washing or surfaces treated with emulsion paint shall not be done within 3 to 4 weeks of application

3.0. Mode of measurement & payment

3.1. Wall painting shall be measured in the decimal system as under:

(a) Dimensions shall be measured to the nearest 0.01 m.

(b) Area in individual item shall be worked out to the nearest 0.01 sq.m.

All the work shall be measured in sq. mt.

3.2. No deductions shall be made for ends of joists, beams, posts, etc. and openings not exceeding 0.5 sqmt. each. No addition shall be made for reveals, jambs, soffits, sills etc. of these openings not for finish around ends of joints, beams, posts etc.

3.3. No deductions for openings exceeding 0.5 sq.mt. but not exceeding 3 sq. mt. each shall be made as follows and no addition will be made for reveals, jambs, soffits etc. of these openings :

(a) When both the faces of walls are provided with finish, deduction shall be made for one face only.

(b) When each face of wall is provided with different finish, deduction shall be made for that side of frame for door, windows, etc. on which width of reveals is less than that of the other side. Where width of reveals on both faces of wall are equal, deduction of 50% of area of opening on each face shall be made from total area of finish.

3.4. The rate shall be for a unit of One sq. meter.

Item No. 33

Providing and fixing steel work welded in built up section, framed work including cutting, hoisting and fixing in position and applying priming coat of red lead paint. fabrication. (Plantation/ Green belt)

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 Covered Electrodes for Metal Arc Welding of Structural steel for (Part 1) welding other than sheets
IS:814 For welding sheets(Part 2)
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 liters 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.

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 smoothened 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 subdrilled 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

codal 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 1½ 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 builtup 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 smoothed 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
1	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 μ m	Moderate
2	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 μ m (life up to 5 years)	Polluted inland environment
3	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 μ m	Moderate
4	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	Polluted inland Environments
5	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 μ m	Severe coastal and non-coastal interior situations
6	Blast clean the surface; 350 – 450 μ m thickness coal tar epoxy.	Severe
7	Pickle; hot dip galvanised (Zinc). Total thickness : 85 μ m (life up to 15-20 years)	Moderate
8	Grit blast, hot dip galvanised. (Zinc). Total thickness = 140 μ m (life more than 20 years)	Moderate
9	Grit blast; 1 coat of sprayed zinc/aluminum followed by suitable sealer Total thickness = 150 μ m (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.

Mode of Payment: The payment shall be made on Kg basis work done

Item No.34

Excavation for foundation incl. sorting out & stacking of useful materials & disposing of the excavated stuff upto 50 mt. lead & all lift , watering etc. comp. loose or soft soil with machinaries up to 1.5 Mt. depth.

304 EXCAVATIONS FOR STRUCTURES

304.1 Scope

Excavation for structures shall consist of the removal of material for the construction of foundations for bridges, culverts, retaining walls, headwalls, cutoff 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. The work shall include construction of the necessary cofferdams and cribs and their subsequent removal; all necessary sheeting, shoring, bracing, draining and pumping; the removal of all logs, stumps, grubs and other deleterious matter and obstruction, necessary for placing the foundations; trimming bottoms of excavations; backfilling and clearing up the site and the disposal of all surplus material.

304.2 Classification of Excavation

All materials involved in excavation shall be classified in accordance with Clause 301.2.

304.3 Construction Operations

304.3.1 Setting Out

After the site has been cleared according to Clause 201, the limits of excavation shall be set out true to lines, curves and slopes to Clause 301.3.1.

304.3.2 Excavation

Excavation shall be taken to the width of the lowest step of the footing including additional width as required for construction operation. The sides shall be left plumb where the nature of soil allows it. Where the nature of soil or the depth of the trench and season of the year do not permit vertical sides, the Contractor at his own cost shall put up necessary shoring, strutting and planking or cut slopes to a safer angle or both with due regard to the safety of personnel and works and to the satisfaction of the Engineer.

The depth to which the excavation is to be carried out shall be as 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. Propping shall be undertaken when any foundation or stressed zone from an adjoining structure is within a line of 1 vertical to 2 horizontals from the bottom of the excavation.

Where blasting is to be resorted-to, the same shall be carried out in accordance with Clause 302 and all precautions indicated therein observed. Where blasting is likely to endanger adjoining foundations or other structures, necessary precautions such as controlled blasting, providing rubber mat cover to prevent flying of debris etc. shall be taken to prevent any damage.

304.3.3 Dewatering and Protection

Normally, open foundations shall be laid dry. 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, constructing diversion channels, drainage channels, bunds, depression of water level by well-point system, cofferdams and other necessary works 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 the approval of the Engineer. Approval of the Engineer shall, however, not relieve the Contractor of the responsibility for the adequacy of dewatering and protection arrangements for the quality and safety of the works.

Where cofferdams are required, these shall be carried to adequate depths and heights, be safely designed and constructed and be made as watertight as is necessary for facilitating construction to be carried out inside them. The interior dimensions of the cofferdams shall be such as to give sufficient clearance for the construction and inspection and to permit installation of pumping equipment, etc., inside the enclosed area.

If it is determined beforehand that the foundations cannot be laid dry or the situation is found

that the percolation is too heavy for keeping the foundation dry, the foundation concrete shall be laid under water by tremie pipe only. In case of flowing water or artesian springs, the flow shall be stopped or reduced as far as possible at the time of placing the concrete.

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

At the discretion of the Contractor, cement grouting or other approved methods may be used to prevent or reduce seepage and to protect the excavation area.

The Contractor shall take all precautions in diverting channels and in discharging the drained water as not to cause damage to the works, crops or any other property.

304.3.4 Preparation of Foundation

The bottom of the foundation shall be levelled both longitudinally and transversely or stepped as directed by the Engineer. 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, the extra depth shall be made up with concrete as per Clause 2104.1 at the cost of the Contractor. Ordinary filling shall not be permitted to bring the foundation to the design level as shown in the drawing.

When rock or other hard strata is encountered, it shall be freed of all soft and loose material, cleaned and cut to a firm surface either level or stepped as directed by the Engineer. All seams shall be cleaned out and filled with cement mortar or grout to the satisfaction of the Engineer. In the case of excavation in rock, annular space around footing shall be filled with lean concrete M 15 upto the top level of rock.

If the depth of fill required is more than 1.5 m in soft rock or 0.6 m in hard rock above the foundation level, the filling upto this level shall be done with M-15 concrete and portion above shall be filled by concrete or by boulders grouted with cement.

When foundation piles are used, the excavation for pile cap shall be done after driving/casting of all piles forming the group. After pile driving operations in a given pit are completed, all loose and displaced materials therein shall be removed to the level of the bottom of the pile cap.

304.3.5 Slips and Slip-Outs

If there are any slips or slip-outs in the excavation, these shall be removed by the Contractor at his own cost.

304.3.6 Public Safety

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. For safety precautions, guidance may be taken from IS:3764.

304.3.7 Backfilling

Backfilling shall be done with approved material 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 in layers not exceeding 150 mm compacted thickness. The compaction shall be done with the help of suitable equipment such as trench compactor, mechanical tamper, rammer, plate vibrator etc., after necessary watering, so as to achieve the maximum dry density.

304.3.8 Disposal of Surplus Excavated Materials

Clause 301.3.11 shall apply.

304.4 Measurements for Payment

Excavation for structures shall be measured in cu.m for each class of material encountered, limited to the dimensions shown on the drawings or as directed by the Engineer. Excavation over increased width, cutting of slopes, production/support to the existing structures shoring, shuttering and planking shall be deemed as incidental to the main work and shall not be measured and paid separately. Preparation of rock foundation shall be measured in square meters.

304.5 Rates

304.5.1 The Contract unit rate for the items of excavation for structures shall be payment in full for carrying out the required operations including full compensation for:

- i) setting out;
- ii) transporting the excavated materials for use or disposal with all leads and lifts;
- iii) construction of necessary cofferdams, cribs/sheeting, shoring and bracing and their subsequent removal;
- iv) removal of all logs, stumps, grubs and other deleterious matter and obstructions, for placing the foundations including trimming of bottoms of excavations;
- v) foundation sealing, dewatering including pumping when no separate provision for it is made in the Contract;
- vi) backfilling, clearing up the site and disposal of all surplus material with all leads and lifts

or as otherwise specified; and

- vii) all labour, materials, tools, equipment, safety measures, diversion of traffic and incidentals necessary to complete the work to Specifications.

304.5.2 The Contract unit rate for preparation of rock foundation shall be full compensation for cutting, trimming and cleaning the foundation surface and filling/sealing of all seams with cement grout or mortar including all materials, labour and incidentals required for completing the work.

Mode of Payment: The payment shall be made on Cum basis work done

Item No. 35

Providing and laying in-situ PCC M20 grade cement concrete in foundations of Railing including formwork, transporting, placing, compacting, finishing, curing, etc. complete with all leads and lifts as per drawing & specification and as directed by Engineer. (Plantation/ Green belt)

The relevant specification of Item No. 27 shall be followed for the execution for the work is **Providing and laying in-situ PCC M20 grade cement concrete in foundations of Railing including formwork, transporting, placing, compacting, finishing, curing, etc. complete with all leads and lifts as per drawing & specification and as directed by Engineer. (Plantation/ Green belt).**

The contract rate shall be for a unit of One **Cum.** of completed item.

Item No. 36

Providing and laying in-situ PCC M20 grade cement concrete in foundations of Railing including formwork, transporting, placing, compacting, finishing, curing, etc. complete with all leads and lifts as per drawing & specification and as directed by Engineer. (Median)

The relevant specification of Item No. 27 shall be followed for the execution for the work is **Providing and laying in-situ PCC M20 grade cement concrete in foundations of Railing including formwork, transporting, placing, compacting, finishing, curing, etc. complete with all leads and lifts as per drawing & specification and as directed by Engineer. (Median).**

The contract rate shall be for a unit of One **Cum.** of completed item.

Item No. 37

Painting two coats (excluding priming coat) on new steel and other metal surface with synthetic enamel paint, brushing to give an even shade including cleaning the surface of all dirt, dust and other foreign matter.

The relevant specification of Item No. 32 shall be followed for the execution for the work is **Painting two coats (excluding priming coat) on new steel and other metal surface with synthetic enamel paint, brushing to give an even shade including cleaning the surface of all dirt, dust and other foreign matter.**

The contract rate shall be for a unit of One **Sqmt.** of completed item.

Item No. 38

Excavation for foundation in sand, gravel, clay soft soil & murrum etc. including shoring, strutting and dewatering as necessary and disposing of the excavated stuff as directed depth upto 3.0 mt.

304. EXCAVATION FOR STRUCTURES

304.1 Scope

Excavation for structures shall consist of the removal of material for the construction of foundations for bridges, culverts, retaining walls, headwalls, cutoff 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. The work shall include construction of the necessary cofferdams and cribs and their subsequent removal; all necessary sheeting, shoring, bracing, draining and pumping; the removal of all logs, stumps, grubs and other deleterious matter and obstruction, necessary for placing the foundations; trimming bottoms of excavations; backfilling and clearing up the site and the disposal of all surplus material.

304.2 Classification of Excavation

All materials involved in excavation shall be classified in accordance with Clause 301.2.

304.3 Construction Operations

304.3.1 Setting Out

After the site has been cleared according to Clause 201, the limits of excavation shall be set out true to lines, curves and slopes to Clause 301.3.1.

304.3.2 Excavation

Excavation shall be taken to the width of the lowest step of the footing including additional width as required for construction operation. The sides shall be left plumb where the nature of soil allows it. Where the nature of soil or the depth of the trench and season of the year do not permit vertical sides, the Contractor at his own cost shall put up necessary shoring, strutting and planking or cut slopes to a safer angle or both with due regard to the safety of personnel and works and to the satisfaction of the Engineer.

The depth to which the excavation is to be carried out shall be as 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. Propping shall be undertaken when any foundation or stressed zone from an adjoining

structure is within a line of 1 vertical to 2 horizontals from the bottom of the excavation.

Where blasting is to be resorted-to, the same shall be carried out in accordance with Clause 302 and all precautions indicated therein observed. Where blasting is likely to endanger adjoining foundations or other structures, necessary precautions such as controlled blasting, providing rubber mat cover to prevent flying of debris etc. shall be taken to prevent any damage.

304.3.3 Dewatering and Protection

Normally, open foundations shall be laid dry. 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, constructing diversion channels, drainage channels, bunds, depression of water level by well-point system, cofferdams and other necessary works 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 the approval of the Engineer. Approval of the Engineer shall, however, not relieve the Contractor of the responsibility for the adequacy of dewatering and protection arrangements for the quality and safety of the works.

Where cofferdams are required, these shall be carried to adequate depths and heights, be safely designed and constructed and be made as watertight as is necessary for facilitating construction to be carried out inside them. The interior dimensions of the cofferdams shall be such as to give sufficient clearance for the construction and inspection and to permit installation of pumping equipment, etc., inside the enclosed area.

If it is determined beforehand that the foundations cannot be laid dry or the situation is found that the percolation is too heavy for keeping the foundation dry, the foundation concrete shall be laid under water by tremie pipe only. In case of flowing water or artesian springs, the flow shall be stopped or reduced as far as possible at the time of placing the concrete.

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

At the discretion of the Contractor, cement grouting or other approved methods may be used to prevent or reduce seepage and to protect the excavation area.

The Contractor shall take all precautions in diverting channels and in discharging the drained water as not to cause damage to the works, crops or any other property.

304.3.4 Preparation of Foundation

The bottom of the foundation shall be levelled both longitudinally and transversely or stepped as directed by the Engineer. 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, the extra depth shall be made up with concrete as per Clause 2104.1 at the cost of the Contractor. Ordinary filling shall not be permitted to bring the foundation to the design level as shown in the drawing.

When rock or other hard strata is encountered, it shall be freed of all soft and loose material, cleaned and cut to a firm surface either level or stepped as directed by the Engineer. All seams shall be cleaned out and filled with cement mortar or grout to the satisfaction of the Engineer. In the case of excavation in rock, annular space around footing shall be filled with lean concrete M 15 up to the top level of rock.

If the depth of fill required is more than 1.5 m in soft rock or 0.6 m in hard rock above the foundation level, the filling up to this level shall be done with M-15 concrete and portion above shall be filled by concrete or by boulders grouted with cement.

When foundation piles are used, the excavation for pile cap shall be done after driving/casting of all piles forming the group. After pile driving operations in a given pit are completed, all loose and displaced materials therein shall be removed to the level of the bottom of the pile cap.

304.3.5 Slips and Slip-Outs

If there are any slips or slip-outs in the excavation, these shall be removed by the Contractor at his own cost.

304.3.6 Public Safety

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. For safety precautions, guidance may be taken from IS:3764.

304.3.7 Backfilling

Backfilling shall be done with approved material 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 in layers not exceeding 150 mm compacted thickness. The compaction shall be done with the help of suitable equipment such as trench compactor, mechanical tamper, rammer, plate vibrator etc., after necessary watering, so as to achieve the maximum dry density.

304.3.8 Disposal of surplus excavated materials clause 301.3.11 shall apply.

304.4 Measurements for Payment

Excavation for structures shall be measured in cu.m for each class of material encountered, limited to the dimensions shown on the drawings or as directed by the Engineer. Excavation over increased width, cutting of slopes, production/support to the existing structures shoring, shuttering and planking shall be deemed as incidental to the main work and shall not be measured and paid separately.

Preparation of rock foundation shall be measured in square meters.

304.5 Rates

304.5.1 The Contract unit rate for the items of excavation for structures shall be payment in full for carrying out the required operations including full compensation for:

- i) setting out;
- ii) transporting the excavated materials for use or disposal with all leads and lifts;
- iii) construction of necessary cofferdams, cribs/sheeting, shoring and bracing and their subsequent removal;
- iv) removal of all logs, stumps, grubs and other deleterious matter and obstructions, for placing the foundations including trimming of bottoms of excavations;
- v) foundation sealing, dewatering including pumping when no separate provision for it is made in the Contract;
- vi) backfilling, clearing up the site and disposal of all surplus material with all leads and lifts or as otherwise specified; and
- vii) all labour, materials, tools, equipment, safety measures, diversion of traffic and incidentals necessary to complete the work to Specifications.

304.5.2 The Contract unit rate for preparation of rock foundation shall be full compensation for cutting, trimming and cleaning the foundation surface and filling/sealing of all seams with cement grout or mortar including all materials, labour and incidentals required for completing the work

Mode of Payment: The payment shall be made on Cum basis work done

Item No. 39

Refilling pipeline trenches and for manholes with available stacked excavated stuff with ramming, watering, consolidating as directed by Engineer-in-charge.

This work shall consist of Refilling pipeline trenches and for manholes with available stacked excavated stuff with ramming, watering, consolidating as directed by Engineer-in-charge.

In addition to these, the Contractor shall also observe the 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. The Engineer-in-charge shall frequently check the Contractor's compliance with these precautions.

The unit rate for the item shall be for a unit of one **Cum.**

Item No. 40

Bedding : Providing and laying compacted granular bedding as per drawing attached.

This work shall consist of Bedding : Providing and laying compacted granular bedding as per drawing attached etc. complete as per instruction of engineer-in charge.

In addition to these, the Contractor shall also observe the 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. The Engineer-in-charge shall frequently check the Contractor's compliance with these precautions.

The unit rate for the item shall be for a unit of one **Cum.**

Item No. 41

Supplying and fixing reinforced concrete heavy duty nonpressure pipes with collars for culverts including setting and joining the pipes in C.M. 1:2 watering and laying (To level of slopes of I.S. 458 / 1971 Class NP4 of following internal diameter. (i) 300 mm dia.

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.

Pipe Culverts Section 2900

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. Section 2900

Mode of Payment: The payment shall be made on Rmt basis work done

Item No. 42

Supplying and fixing reinforced concrete heavy duty nonpressure pipes with collars for culverts including setting and joining the pipes in C.M. 1:2 watering and laying (To level of slopes of I.S. 458 / 1971 Class NP4 of following internal diameter. (ii) 450 mm dia.

The work shall be carried out as directed with relevant specifications of this tender Item No. 41

Mode of Payment: The payment shall be made on Rmt basis work done

Item No. 43

Supplying and fixing reinforced concrete heavy duty nonpressure pipes with collars for culverts including setting and joining the pipes in C.M. 1:2 watering and laying (To level of slopes of I.S. 458 / 1971 Class NP4 of following internal diameter. (ii) 600 mm dia.

The work shall be carried out as directed with relevant specifications of this tender Item No. 41

Mode of Payment: The payment shall be made on Rmt basis work done

Item No. 44

Providing constructing brick masonry Inlet Chamber of 750 x 600 x 1500 mm internal dimension with necessary excavation refilling 350 mm thick brick masonry in CM 1:4, 150 mm thick PCC and benching in CC 1:2:4, 12 mm thick plaster in CM 1:3 for inside and cement pointing in CM 1:3 for outside, providing and fixing pre-cast RCC frame and cover of M-30 grade as per drawing and specifications -Rate for 1.5m depth.

This work shall consist of Providing constructing brick masonry Inlet Chamber of 750 x 600 x 1500 mm internal dimension with necessary excavation refilling 350 mm thick brick masonry in CM 1:4, 150 mm thick PCC and benching in CC 1:2:4, 12 mm thick plaster in CM 1:3 for inside and cement pointing in CM 1:3 for outside, providing and fixing pre-cast RCC frame and cover of M-30 grade as per drawing and specifications -Rate for 1.5m depth. etc. complete as per instruction of engineer-in charge.

In addition to these, the Contractor shall also observe the 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. The Engineer-in-charge shall frequently check the Contractor's compliance with these precautions.

The unit rate for the item shall be for a unit of one No.

Item No. 45

Constructing Bombay Pattern Type Catch Pit of size 0.60 x 0.60 depth up to 1 mt including excavation, B.B.C.C. (1:5:10), 23 cms thick brick maso. wall in the prop. of CM (1:6) with 40 mm thick IPS flooring in the prop M15 at bottom and 15 mm thick cement plaster inside the catch pit in the proportion of CM (1:3) with out jali etc. comp. as directed.

This work shall consist of Constructing Bombay Pattern Type Catch Pit of size 0.60 x 0.60 depth up to 1 mt including excavation, B.B.C.C. (1:5:10), 23 cms thick brick maso. wall in the prop. of CM (1:6) with 40 mm thick IPS flooring in the prop M15 at bottom and 15 mm thick cement plaster inside the catch pit in the proportion of CM (1:3) with out jali etc. complete as per instruction of engineer-in charge.

In addition to these, the Contractor shall also observe the 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. The Engineer-in-charge shall frequently check the Contractor's compliance with these precautions.

The unit rate for the item shall be for a unit of one No.

Item No. 46

CatchPit Jali Fixing P/F FRC catch pit jali with frame 600mm x 600mm clear opening etc. comp.. As directed by engineer in charge.

This work shall consist of CatchPit Jali Fixing P/F FRC catch pit jali with frame 600mm x 600mm clear opening etc. complete as per instruction of engineer-in charge.

In addition to these, the Contractor shall also observe the 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. The Engineer-in-charge shall frequently check the Contractor's compliance with these precautions.

The unit rate for the item shall be for a unit of one No.

Item No. 47

Providing & supplying heavy duty I.S.I. mark RCC precast machine hole frame with cover at site as per design for circular machine hole complete (A) For Circular machine hole.

This work shall consist of Providing & supplying heavy duty I.S.I. mark RCC precast machine hole frame with cover at site as per design for circular machine hole complete (A) For Circular machine hole etc. complete as per instruction of engineer-in charge.

In addition to these, the Contractor shall also observe the 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. The Engineer-in-charge shall frequently check the Contractor's compliance with these precautions.

The unit rate for the item shall be for a unit of one No.

Item No. 48

Constructing Manhole with R.C.C. top slab in 1:2:4 mix (1-cement :2 coarse sand : 4-graded stone aggregate 20mm nominal size) foundation concrete 1:3:6 mix (1 cement : 3- coarse sand :6-Brick bats 40 + 50mm size) inside plastering 15mm thick with Cement Mortar 1:3 (1-Cement : 3-coarse sand) finished with a floating coat of neat cement and making channels in cement concrete 1:2:4 mix (1-Cement :2- Coarse sand :4-stone aggregate 20mm nominal size) finished smooth complete including curing and festing (i) Inside size 900mm x 1200mm and 1.5M. deep including C.I. cover with frame size 560mm diameter total weight of cover and frame to be not less than 128 kgs. (Wt. of cover 64 Kg. and Wt. of frame 64 Kg.)(A) With 230mm thick walls of brick msonry using brick having crushing strength not less than 35Kg. / Sq.cm. in Cement Mortar 1:5 (1- Cement: 5-Coarse sand) (2) B type depth 1.50 Metre for 150mm diameter sewer.

This work shall consist of Constructing Manhole with R.C.C. top slab in 1:2:4 mix (1-cement :2 coarse sand : 4-graded stone aggregate 20mm nominal size) foundation concrete 1:3:6 mix (1 cement : 3- coarse sand :6-Brick bats 40 + 50mm size) inside plastering 15mm thick with Cement Mortar 1:3 (1-Cement : 3-coarse sand) finished with a floating coat of neat cement and making channels in cement concrete 1:2:4 mix (1-Cement :2- Coarse sand :4-stone aggregate 20mm nominal size) finished smooth complete including curing and festing (i) Inside size 900mm x 1200mm and 1.5M. deep including C.I. cover with frame size 560mm diameter total weight of cover and frame to be not less than 128 kgs. (Wt. of cover 64 Kg. and Wt. of frame 64 Kg.)(A) With 230mm thick walls of brick msonry using brick having crushing strength not less than 35Kg. / Sq.cm. in Cement Mortar 1:5 (1- Cement: 5-Coarse sand) (2) B type depth 1.50 Metre for 150mm diameter sewer etc. complete as per instruction of engineer-in charge.

In addition to these, the Contractor shall also observe the 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. The Engineer-in-charge shall frequently check the Contractor's compliance with these precautions.

The unit rate for the item shall be for a unit of one No.

Item No. 49

Raising / lowering manholes to the required level upto FRL of BC including all materials, formwork and with 16 cm thick M20 CC coping under frames of the manhole, including removing existing manhole frame cover and fixing existing manhole frame & cover or fresh heavy duty I.S.I. mark RCC precast manhole frame with cover if required, curing etc. complete as specified and as directed and item also includes all safety measures like cover the manhole with an M.S. plate during execution of each layer of C.C. pavement and cleaning the manhole from all road debris fallen inside the manhole during construction activity & certified the same from engineer in charge about cleaned manhole. (1) For the depth upto 875mm.

This work shall consist of Raising / lowering manholes to the required level upto FRL of BC including all materials, formwork and with 16 cm thick M20 CC coping under frames of the manhole, including removing existing manhole frame cover and fixing existing manhole frame & cover or fresh heavy duty I.S.I. mark RCC precast manhole frame with cover if required, curing etc. complete as specified and as directed and item also includes all safety measures like cover the manhole with an M.S. plate during execution of each layer of C.C. pavement and cleaning the manhole from all road debris fallen inside the manhole during construction activity & certified the same from engineer in charge about cleaned manhole. (1) For the depth upto 875mm etc. complete as per instruction of engineer-in charge.

In addition to these, the Contractor shall also observe the 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. The Engineer-in-charge shall frequently check the Contractor's compliance with these precautions.

The unit rate for the item shall be for a unit of one **No.**

Item No. 50

Raising / lowering manholes to the required level upto FRL of BC including all materials, formwork and with 16 cm thick M20 CC coping under frames of the manhole, including removing existing manhole frame cover and fixing existing manhole frame & cover or fresh heavy duty I.S.I. mark RCC precast manhole frame with cover if required, curing etc. complete as specified and as directed and item also includes all safety measures like cover the manhole with an M.S. plate during execution of each layer of C.C. pavement and cleaning the manhole from all road debris fallen inside the manhole during construction activity & certified the same from engineer in charge about cleaned manhole. (2) For the depth upto 425mm.

This work shall consist of Raising / lowering manholes to the required level upto FRL of BC including all materials, formwork and with 16 cm thick M20 CC coping under frames of the manhole, including removing existing manhole frame cover and fixing existing manhole frame & cover or fresh heavy duty I.S.I. mark RCC precast manhole frame with cover if required, curing etc. complete as specified and as directed and item also includes all safety measures like cover the manhole with an M.S. plate during execution of each layer of C.C. pavement and cleaning the manhole from all road debris fallen inside the manhole during construction activity & certified the same from engineer in charge about cleaned manhole. (2) For the depth upto 425mm etc. complete as per instruction of engineer-in charge.