

**SPECIAL CONDITIONS & GUIDE LINES FOR**  
**FABRICATION, ERECTION AND REGIRDERING OF STEEL**  
**GIRDERS**

**1. Specification & Interpretation**

1.1 This specification is intended mainly to cover technical provisions relating to fabrication and erection of steel girder bridges including supply of the materials through contract.

1.2 This specification makes reference to the Indian Standard (IS), Indian Railway Standard(IRS), RDSO's Specifications (M&C) & RDSO Guidelines(BS).

1.3 Wherever reference to the standards mentioned in clause i.e., IS, IRS & RDSO Specification, it shall be taken as a reference to the latest version of the standards.

1.4 Any revision or addition or deletion of the provisions of this Specification shall be issued only through correction slip. No cognizance shall be given to any policy directives issued through other means.

**2. Responsibility for Completeness**

2.1 The Contractor shall be entirely responsible for the execution of the contract in all respects in accordance with the terms of this Specification and the conditions of contract, notwithstanding any approval which the Engineer/Inspecting Officer may have given to the detailed drawings prepared by the Contractor or Sub-Contractor for materials or other parts of the work involved in the contract or for tests carried out, either by the Contractor or by the Engineer/Inspecting Officer.

2.2 Any fitting, accessory or apparatus which may not have been mentioned in this Specification, but which are usual or necessary in the execution of such work, are to be provided by the Contractor without extra charge. The whole work must be completed in all details, whether mentioned in this Specification or not, with the exception of such work as has been specified in the Schedule of Requirements to be separately provided for by the Purchaser.

**3. Sub-letting of Work**

3.1 Before ordering sub-letting of work, the Contractor shall submit the names of the Sub-Contractors proposed for the approval of the Engineer and shall afterwards send the Inspecting Officer a copy of the orders for the sub-letted work.

**3.1.1** The Contractor shall be responsible for all the sub-letted work. Such work shall be inspected and verified by the Inspecting Officer.

**4. Stacking of Materials**

4.1.1 On receipt of materials at the bridge yard they shall be carefully unloaded examined for defects, checked, sorted and stacked securely on a level bed out of danger from flood or tide and out of contact with water or ground moisture. All

Material shall be available for inspection by the Engineer or Inspecting Officer.

**4.1.2** Materials shall be verified with the markings shown on the marking plan of part list, which shall be supplied by the manufacturers or the Engineer.

**4.1.3** Any material found damaged during transit or while unloading should be stacked separately and damaged portions shall be indicated by paint with distinctive colour. All such materials shall be dealt with under the orders of the Engineer without delay. If any component after receipt at site, has in the opinion of the Engineer or Purchaser, been damaged in transit, such component shall be replaced or repaired to the satisfaction of the Engineer or Purchaser free of cost.

**4.1.4** All such damaged material shall be dealt with as per the orders of the Engineer. Badly damaged portions may require replacement. Slightly distorted parts may be straightened by gradual pressure without heat or annealing. Badly distorted or broken parts must be dealt with as the case demands and as directed by the Engineer.

**4.1.5** Where the work has been passed in the manufacturer's works as strictly interchangeable, all members bearing the same marks can be stacked together without reference to any particular span.

**4.1.6** The Contractor shall unload the material promptly on delivery; otherwise he/she shall be responsible for demurrage charges.

**4.1.7** On receipt of rolled steel at workshop or fabrication yard they shall be carefully unloaded and stacked properly to avoid bending, twisting, corrosion etc.

## **5. Imported Material**

5.1 In case of work fabricated in India, where any material or component is imported, such material or component will be inspected, if desired by the Contractor, Purchaser or Inspecting Officer, and passed in the country of origin before dispatch to India. In such cases the Contractor shall submit to the Inspecting Officer details on prescribed form in quadruplicate of the materials or components to be inspected together with the requisite number of copies of all necessary documents, to enable inspection to be carried out prior to dispatch. The cost of such inspection and supervision of tests in connection there with will be borne by the Purchaser, the Sub-Contractor providing free of charge all material, labour and appliances for carrying out tests made in his/her works and any material which may be required for independent tests and analysis.

## **6. Leading to Site**

6.1 Care must be taken by the Contractor to see that the parts at site are available in proper sequence.

## **7. Lines and Levels**

7.1 All lines and levels should be given by the Engineer and all stakes and marks so given shall be carefully preserved by the Contractor who shall give all necessary

assistance and facilities to establish or check the lines and levels and to measure the work.

## **8. Steel**

8.1 IS:2062, Quality "A" Grade Designation E250 as rolled semi-killed or killed shall be used for foot-over bridges and other structures subjected to non-critical loading.

8.2 IS:2062, Quality "B0" Grade Designation E250 fully killed and with normalizing/normalizing rolling/controlled rolling where service temperature does not fall below 0°C, shall be used for welded/riveted girders subjected to Railway loading. Plates less than 12 mm thick need not be with normalizing/normalizing rolling/controlled rolling.

8.3 IS:2062, Quality "C" Grade Designation E250 fully killed and with normalizing/normalizing rolling/controlled rolling ensuring impact properties at (-) 20° C shall be used for sub-zero temperature areas for welded/riveted girders subjected to Railway loading. Plates less than 12 mm thick need not be with normalizing/normalizing rolling/controlled rolling.

NOTE:

1. In case Rolled Steel Section confirming to IS:2062 Quality "B0" or "C" are not available in market, BBJ / Railway may permit use of steel confirming to IS:2062 Quality "BR" on case to case basis by satisfying himself about non availability of quality "B0" or "C"

2. In case Rolled Steel Section confirming to IS:2062 Quality "BR" is also not available in market, BBJ / Railway may permit use of steel confirming to IS:2062 Quality "A" on case to case basis, by satisfying himself about non availability of quality "BR".

8.4 High tensile steel shall comply in all respects with the requirement of IS:2062 Grade Designation E410 Quality B0 or C (copper bearing quality) for the welded work.

8.5 For superior and enhanced corrosion resistance for sections, plates and bars for welded, rivetted or bolted construction, the material shall comply with the requirement of IRS:M-42, Gr.I or Gr.II for rivetted/bolted or welded work respectively.

8.6 Steel, which is to be cold pressed, shall comply with the requirements of IS:2002.

8.7 Steel for bolts shall conform to property class 4.6 or 6.6 as specified in IS:1367 accordingly, as the structural steel specification is for mild steel or high tensile steel.

8.8 Steel for drifts shall be in accordance with IS:1875 for forged quality steel or IS:7283 for hot rolled bars.

8.9 Steel for rivets shall comply with the requirement of IS:1148 for hot rolled rivet bars for general structural purposes and IS:1149 for high tensile steel rivet bars for high strength structural purposes. For high strength low alloy structural steel rivet bars with enhanced corrosion resistance for use in bridges, steel shall comply with the requirement of IRS:M-43.

8.10 The dimensions of all rolled sections must agree with the contract drawings or as agreed to between the Purchaser and the Contractor.

8.11 The rolling and cutting tolerances shall be in accordance with IS:1852 or as agreed to between the Purchaser and the Contractor if closer tolerances are desired they shall be shown in the drawing.

8.12 All the steel sections used in the fabrication must have mill test certificate clearly indicating the specification to which the steel conforms and whether steel is killed and normalized. All the cast mark numbers/ heat mark numbers, shall be recorded along-with the number of plates in a register as soon as the plates are received in the workshop. Whenever the steel is received without any test certificate, a sample test piece from plate of each cast mark number is to be cut and sent for testing. Only when it is established that the plates are of required specification, these shall be processed for cutting.

8.13 Use of steel of any quality other than those mentioned above would require the prior approval of the Engineer.

## **9. Pins and Expansion Rollers**

9.1 Pins and Expansion Rollers shall be made from steel conforming to IS:2004(Class3steel).

9.2 Expansion rollers may, alternatively be turned from approved carriage and wagon axles. Only axles manufactured after 1931 shall be used for the manufacture of rollers. USFD test shall be conducted to ensure freeness from internal flaw. Test pieces shall be left as an integral part of the roller with the stamp of the supplier on it so that the Accepting Authority can cut-off the test pieces and check if required.

## **10. Steel Castings**

10.1 Steel casting shall comply with IS:1030 for normal temperature zone and to IS:4899 for use at low temperature zone.

## **11. Bronze Plates**

12. Bronze plates shall be of phosphor bronze complying with IS:1458 Class I.

## **13. Maintenance of Records by Fabricators**

13.1 The records of fabrication shall be maintained in the registers.

## **14. Manufacture**

14.1 The whole work shall be representative of the highest class of workmanship. The greatest accuracy shall be observed in the design, manufacture and erection of every part of the work to ensure that all parts will fit accurately

together on erection. For manufacture of the components of all spans to be made strictly interchangeable, approved set of same jigs and assembly fixtures shall be used. The tolerances in manufacture shall be in accordance with as shown in **AppendixII of IRS Specification for Bridge Fabrication and Erection of steel girders serial No.B1-2001**. The Contractor shall state which of the following alternative methods of manufacture he/she intends to adopt.

- i) The whole of work to be erected complete and pieces marked to place.
- ii) All spans to be made strictly inter changeable as specified in clause 33.

**14.2** The Contractor shall maintain a master steel tape of approved make for which he/she has obtained a certificate of accuracy from any National Test House or Government recognized institutions competent to do so.

### **15. Templates**

**15.1** The templates throughout the work shall be of steel. The template shall be used for marking of cutting material and as well as profile machining for girders of railway loading. Templates shall be used for marking of drilling holes in steel structures other than girder of Railway loadings. In case where actual materials from a bridge have been used as templates for drilling similar pieces the Inspecting Officer will decide whether they are fit to be used as part of the finished structure.

### **16. Flattening and Straightening**

**16.1** All steel materials, plates, bars and structurals shall have straight edges, flat surfaces and be free from twist. If necessary, they shall be cold straightened or flattened by pressure before being worked or assembled unless they are required to be of curvilinear form. Pressure applied for straightening or flattening shall be such as it would not injure the material and adjacent surfaces or edges shall be in close contact or at uniform distance throughout.

**16.2** Flattening and straightening under hot condition shall not be carried out unless authorized and approved by the Inspecting Officer.

### **17. Planning and Shearing**

**17.1** Except where otherwise indicated, cutting of all plates and sections shall be affected by shearing or sawing. All edges shall be clean, reasonably square and true. Wherever possible the edges shall be cut in a shearing machine, which will take the whole length of the plate in one cut.

**17.2** Should the inspection find it necessary, the cut edges shall be ground afterwards.

**17.3** Planning or machining of the edges or surface shall be carried out when so specified in the contract drawings or where specifically ordered by the Engineer. Where machining is specified, the plates or all sections shall be cut in the first instance to such a size so as to permit not less than 3mm of metal being removed from each sheared edge or end, in the case of plates or sections of 12mm or less

in thickness and not less than 6mm of metal being removed in the case of plates and sections exceeding 12mm in thickness.

**17.4** The butting ends of all booms and struts where spliced shall be faced in an end milling machine after members have been completely fabricated. In the case of compression members the face shall be machined so that the faces are at right angle to the axis of the members and the joint when made, will be in close contact throughout. At the discretion of the Inspecting Officer, a tolerance of 0.4mm may be permitted at isolated places on the butting line.

## **18. Flame Cutting**

**18.1** Flame cutting by mechanically controlled torch/ torches shall be accepted both in the case of mild steel and high tensile steelwork. Provided the edge as given by the torch is reasonably clean and straight, plates may be cut to shape and beams and other sections cut to length with a gas cutting torch, preferably oxyacetylene gas should be used.

**18.2** All flame cut edges shall be ground to obtain reasonably clean square and true edges. Drag lines produced by flame cut should be removed.

**18.3** Unless machining has been specifically provided for, special care is to be taken to ensure that ends of all plates and members are reasonably in close contact and the faces are at right angles to the axis of the members and joints, when made, are also reasonably in close contact.

**18.4** Use of multi-head flame cutting machine having multiple oxyacetylene torches is desirable for higher productivity and reducing the distortion due to cutting operation. Plasma-Arc cutting method can also be employed. This process offers less heat input causing less distortion.

## **19. Drilling and Sub-punching**

**19.1** All holes shall be drilled but the Contractor may, if he/she so prefers sub-punch them to a diameter 6mm less than that of finished holes, e.g. a punched hole which is to be drilled out to 25mm in diameter shall not exceed 19mm in diameter at the die end. When the rivet holes are to be sub-punched, they shall be marked with a centre punch and made with a nipple punch or preferably, shall be punched in a machine in which the position of the hole is automatically regulated. The punching shall be so accurate that when the work has been put together before drilling, a gauge 1.5mm less in diameter than the size of the punched holes can be passed easily through all the holes. Holes for counter sunk heads of rivets, bolts or screws shall be drilled to the correct profile so as to keep the heads flush with the surface. Holes for countersunk heads of rivets, bolts or screws shall be drilled to the correct profile so as to keep the heads flush with the surface.

**19.2** No sub-punching shall be allowed in the main truss members of open-web girders.

**19.3** Holes for turned bolts should be 1mm under drilled in shop and should be reamed at site to suit the diameter of turned bolt.

**19.4** Where the number of thicknesses 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 thoroughly bolted together.

**19.5** The steel bushes shall be case hardened by an approved process and checked for diameter after the heat-treatment. The bores of bushes shall initially have a tolerance of -0mm, 0.1mm. The tolerance shall be checked from time to time and when the bores exceed a tolerance of, -0mm, +0.4mm, the bushes shall be rejected. For this purpose, go and no-go gauges are to be used. Tolerances for checking jigs from master plates shall be +0mm-0.13mm.

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

## **20. Parts in Contact**

**20.1** All steel work intended to be riveted or bolted together shall be in contact over the whole surface.

**20.2** Drifts as shown in **Fig. 2 of IRS Specification for Bridge Fabrication and Erection of steel girders serial No.B1-2001** may be used for drawing light members into position but their use on heavy members should be restricted to securing them in their correct positions

**20.3** No extent that holes are distorted.

**20.4** Drifting to enlarge unfaired holes is prohibited. The holes that will have to be enlarged to admit rivets should be reamed provided the Engineer permits such reaming after satisfying himself about the extent of inaccuracy and the effect of reaming on the soundness of the structure. The Purchaser retains the right to reject all steel work if the holes are not properly matched.

## **21. Making of Joints**

**21.1** Cleaning of permanent contact surfaces:-Surfaces which will have permanent contact shall be removed of paints and mill scale down to bare metal, clean and dried and immediately a coating of zinc chrome red oxide priming to IS:2074 shall be applied. Care shall be taken to see that all burrs are removed and no surface defects exist before the parts are assembled.

**21.2** Bolting and Drifting:- Only barrel drifts as per **Fig. 2 of IRS Specification for Bridge Fabrication and Erection of steel girders serial No.B1-2001** shall be used in erection. They may be used for drawing light members into position; but their use on heavy members shall be restricted to securing them in their correct position. Any apparent error in shop work, which prevents the assembling and fitting up of the parts by the proper use of these drifts, shall be investigated immediately. As all work is rigidly inspected in the manufacturers work before dispatch, these difficulties should not arise and the cause should

Be first be sought in the use of incorrect components or the transposition of a correct part. It is usually important that parts should be correctly handled. Should error still persist, the matter shall be immediately reported to the Engineer who will decide what action is to be taken. No reaming shall be undertaken without the written authority of the Engineer, except for the under drilled holes meant for turned bolts. If approved, the Contractor shall supply, at his/her own expense, any special rivets that may be required. Copies of all correspondence relative to there course to reaming and the use of over-size rivets shall invariably be sent by the Engineer for information to the inspector at concerned.

**21.3** Joints shall normally be made by filling not less than 50% of the holes with service bolts and barrel drifts in the ratio of four to one. The service bolts are to be fully tightened up as soon as the joint is assembled.

**21.4** Special methods of erection other than described in **Appendix III of IRS Specification for Bridge Fabrication and Erection of steel girders serial No.B1-2001**. In cases where the joints have to withstand stresses arising from special method of erection, provision is to be made to take the whole stress that will or may occur. Cylindrical drifts and turned bolts shall be used to withstand such stresses and no reliance is to be placed on the service bolts for this purpose. Upto maximum of 40% of the holes of each member of the joint are to be filled with drifts and balance of strength required is to be attained with turn bolts. The position and number of the drifts and bolts will be intimated by the Engineer. The condition of clause 20.1 must be observed and the bolt fully tightened up as soon as the joint is made.

**21.5** Where the manufacturing of girders has been, the erection shall be done in accordance with **Appendix III of IRS Specification for Bridge Fabrication and Erection of steel girders serial No.B1-2001**. However, if the Contractor desires to adopt any other method of erection, he/she shall submit the scheme and obtain the approval of the Engineer. It shall be ensured that when in position, the girder has the camber as per drawing.

**21.6** Emergency Jointing:- In the event of an emergency arising such as the staging is in danger of being carried away by floods before the riveting can be completed, the joints shall be made secure by filling 40% of the holes with cylindrical drifts and equal number with service bolts fully tightened.

## **22. Erection and Equipment**

**22.1** The Contractor shall provide at his/her own cost all tools, machinery, equipment and erection material necessary for the expeditious execution of the work and shall erect the structural steel and iron work, in every respect as covered by the contract and in accordance with the drawings and specifications.

**22.2** If any labour, material, plant staging haulage and storage facilities are to be provided by the Purchaser, details of such items and the conditions under which these are to be supplied shall be clearly specified in the contract agreements. In the absence of any such provisions in the agreement, the Contractor shall make his/her own arrangement for such items.



**22.3** Before starting the work, the Contractor shall advise the Engineer fully as to the method he/she proposes to follow and the amount and character of equipment he/she proposes to use, which shall be subjected to the approval of the Engineer. The approval of the Engineer shall not be considered as relieving the Contractor of the responsibility for the safety of his/her method or equipment or from carrying the work in full accordance with the drawings and specifications.

**22.4** All temporary work shall be properly designed and substantially constructed for the loads, which it will be called upon to support. Adequate allowance and provision of a lateral forces and wind loads shall be made according to local conditions and ensure that support shall not settle during erection.

**22.5** Careful and periodical inspection of plants shall be made by the Contractor to ensure that all tackle, ropes, chains and other important lifting gear and machinery are in good order and fit for service and well up to the capacity for which they are required.

**22.6** When chains are used for lashing, care must be taken to protect the edges of members to avoid the marking and distortion otherwise caused.

**22.7** Span erected upon staging shall be supported upon suitable blocks, which shall ensure that the girders shall be at the correct elevation and alignment when completed. If other methods of erection be adopted where staging in situ is not employed, special means shall be used to ensure this.

**22.8** The method used for lifting and slinging flexible members shall be brought to the notice of the Engineer and shall be subject to his/her approval.

**22.9** Temporary bracing shall be provided to take care of stresses from erection equipment or other loads carried during erection.

### **23. Bearings and Anchorages**

**23.1** Bed plates shall be set to required level and fixed accurately in position by giving full and even bearing by setting them on a layer of cement sand and cast iron chips as approved and directed by the Engineer.

**23.2** The Contractor shall drill the holes where necessary and set the anchor bolts. The bolts shall be set accurately and fixed with cement grout or any other grouting material as approved by the BBJ / Railway Engineer completely filling the holes.

### **24. Rivets and Rivetting**

**24.1** The dimensions on the drawings referred to the diameters of the rivet holes and their finished rivets. The rivet holes shall be 1.5mm greater than the diameter of the rivet bars used. The rivets shall be made to IS:1929. The shanks of the undriven rivets shall be made of a length sufficient to fill the holes thoroughly and form the head. The clearance i.e. the difference in diameter between the rivets measured under head before being heated and the rivet hole shall not be

Less than 0.75mm. Before riveting is commenced, all works shall be properly bolted so that the sections rivetted are in close contact throughout. Rivets shall completely fill the holes and shall be machine driven by means of pressure or percussion riveters of approved design.

**24.2** All rivets shall be properly heated to straw heat for the full length of the shank, firmly backed and closed. The head of the rivet, particularly in long rivets, shall be heated more than the point and in no case shall the point be heated, more than the head. Sparking or burnt rivets shall not be used. Where it is impossible to back up by normal method of holding up, 'double gunning' may be resorted to. Alternatively pneumatic holding device may be used.

**24.3** Gauges for rivet dimensions and contours shall be provided by the Contractor for the use of the Inspecting Officer.

**24.4** Rivets when driven shall completely fill the holes, have the heads concentric with the shanks and shall be in full contact with the surface. Driven rivets when struck sharply on the head with the 110-gm. Rivet testing hammer, shall be free from movement or vibration.

**24.5** While riveting built-up member's great care should be exercised to ensure that the set of holes for field rivets in each flange of the built-up member, is aligned dead-square in relation to that in the other flange and not 'aberrated'. Use of assembly fixtures shall be made to ensure this.

**24.6** All loose and burnt rivets and rivets with cracks badly formed, eccentric or deficient heads shall be cut out and replaced. Permissible deviation of driven rivets shall be as per **Appendix IV of IRS Specification for Bridge Fabrication and Erection of steel girders serial No.B1-2001**. Rivets shall also be cut out when required for the examination of the work. Actual method of cutting out shall be approved by the BBJ / Railway Engineer. Recupping and caulking shall in no circumstances be resorted to.

**24.7** Riveting shall not be started until such time as the Engineer has personally satisfied himself that the alignment of the girders is correct, the verticals plumb laterally, the camber according to that shown on the camber diagram with camber jacks screwed tight, all the joints and cover plates well up, service bolts tight and field rivet holes coinciding. Special care should be taken that service bolts are frequently re-tightened as the riveting proceeds.

**24.8** All field rivets shall be tested as directed by the BBJ / Railway Engineer.

**24.9** Where practicable all riveting shall be done by pneumatic or hydraulic riveting machine. The working pressure to be employed when using pneumatic or hydraulic tools shall be approved by the BBJ / Railway Engineer. Hand riveting shall only be done when sanctioned by the Engineer. In such cases, means shall be adopted to ensure the rivets being used in their entire length so as to fill the rivet holes completely, the snap being used only to give the correct form of head.

**24.10** When all the rivets of joints have been finally passed, they shall be painted as under.

- a) One coat of ready mixed zinc chrome primer to IS:104 followed by one coat of ready mixed paint red oxide zinc chrome primer to IS:2074
- b) Finishing coat as per clause 39

## **25. Field Rivets, Bolts, HSFG Bolts, Nuts and Service Accessories**

**25.1** The work is to include supply of all units, bolts, HSFG Bolts, nuts, washers etc. required to complete erection at site with an allowance for wastage etc. of 12.5% of the net number of field rivets, bolts and washers required subject to a minimum number of five in each item.

**25.2** The Contractor shall be responsible for supplying site rivets/ HSFG Bolts of approved length. The length of such rivets/HSFG bolts shall be verified by snapping a few rivets/ HSFG bolts of each length in the presence of the Inspecting Officer. In the case of rivets with long grips (with grip exceeding 6 times the diameter) specimen rivets on the test piece shall be cut to see if the holes are totally filled even though the rivets are tight under the usual hammer tests.

**25.3** Black hexagonal bolts (Service bolts) with nuts and ordinary platter's washers and drifts for use in the erection of the work shall also be supplied at 60% (45% bolts and 15% drifts) of the number of field rivets per span in each size (this includes wastage). The Purchaser may however, specify a reduction in the quantities of service bolts etc. if more than one span of each type is ordered.

## **26. Smithed Work**

**26.1** All joggles shall be performed by pressure. Craned sections or knees can be formed by forging or by gas cutting and welding by any approved electric arc process. Any bending, forging, cutting or welding shall be carried out in such a manner as not to impair the strength in the metal. Forging shall be annealed as indicated in the drawing.

**26.2** If drop forging through dies is resorted to, excessive forging in one operation shall be avoided. Where necessary, a series of intermediate stage dies shall be manufactured and used.

## **27. Welding**

**27.1** Welded construction work shall be carried out generally in accordance with the provisions of Indian Railway Standard Welded Bridge Code and subject to further specifications given in the following paragraphs.

**27.2** All welds should be done by submerged-arc welding process either fully automatic or semi-automatic. Carbon dioxide welding or manual metal-arc welding may be done only for welds of very short runs or of minor importance or where access of the locations of weld do not permit automatic or semi-automatic welding.

**27.3** Except for special types of edge preparation, such as single and double 'U' single and double 'J' the fusion edges of all the plates which are to be joined by welding may be prepared by using mechanically controlled automatic flame cutting equipment and then ground to a smooth finish. Special edge preparation should be made by machining or gouging.

**27.4** Welding procedures:-The welding procedure shall be such as to avoid distortion and minimize residual shrinkage stresses. Properly designed jigs should be used for assembly. The welding techniques and sequence, quality, size of electrodes, voltage and current required shall be as prescribed by manufacturers of the material and welding equipment. The Contractor should submit full details of welding procedure in proforma given at **Appendix-V of IRS Specification for Bridge Fabrication and Erection of steel girders serial No.B1-2001.**

**27.5** Site welding should not be undertaken except in special circumstances with the approval of the Chief Bridge Engineer. Site welding should be confined to connections having low stresses, secondary members, bracings etc.

**27.6** Manual metal arc welding may be done taking adequate precautions as per IS:9595 and under strict supervision.

## **28. Sequence of Welding and Weld Pass**

**28.1** For fabrication of welded composite girders, channel shear connectors shall be welded on top flange plate prior to assembly of I-section. This facilitates correction of any distortion of flange plate developed during the welding of channel shear connectors.

**28.2** In making a typical I-section four fillet welds are to be made. The welding sequence to be followed is indicated by number 1 to 4 as shown in the **Fig. 3 of IRS Specification for Bridge Fabrication and Erection of steel girders serial No.B1-2001.**

**28.3** Whenever a square butt weld in a 10 or 12 mm thick plate is required to be made, the sequence to be adopted is shown in **Fig.3 of IRS Specification for Bridge Fabrication and Erection of steel girders serial No.B1-2001.**

## **29. Bolts, Nuts and Washers**

**29.1** Bolts, Nuts and Washers shall be in accordance with the following specifications:-

(i) Black hexagonal bolts to IS:6639 and Nuts to IS:1363.

(ii) Precision and turned bolts with nuts and hexagonal screws to IS:1364.

(iii) Plain washers to IS:2016 and IS:5369.

(iv) Spring washers-IS:3063.

(v) Taper washers-IS:5372 and IS:5374.

**29.2** Manufacture, workmanship, Marking, Packingetc. For Bolts and Nuts shall comply with the requirements of IS:1367.

**29.3** Where the head and nuts bear on timber, square washers having the length of each side not less than three diameters of the bolt and the thickness not less than one quarter of the diameter shall be provided. Steel, wrought iron or malleable cast iron taper washers shall also be provided for all heads and nuts bearing on beveled surfaces.

**29.4** For black bolts a clearance (difference in diameter) of 1.5mm for all sizes of bolts shall be allowed.

**29.5** Where turned bolts are required they shall be carefully turned and shall be parallel throughout the barrel. Holes for turned bolts should be 1mm under drilled in shop and should be reamed at site to suit the diameter of the turned bolts.

**29.6** The following limits of tolerances, shall be permitted upon the diameter of the shank of turned bolts and of the holes which they are to fit:

Limit of tolerance	Shank of bolt(mm)	Hole(mm)
High	0.000	+0.125
Low	-0.125	0.000

**29.7** The shank of each turned bolt shall be of such a length that it is in full contact with the work, throughout, the screwed portion being made at least 1.5mm less in diameter than the shank or to suit the next smaller size of screw thread. The shank portion shall be joined to the threaded portion by a 45° chamfer within the thickness of the washer. Washers with perfectly flat faces should be provided with all turned bolts.

**29.8** The washers under the nut shall have a hole of 1.5mm larger in diameter than the shank of the bolt and shall have a thickness of not less than 6mm so that the nut, when screwed up, shall not bear on the shoulder of the bolt.

## **29.9 Supply of High Strength Friction Grip (HSFG) Bolts**

### **29.9.1 Reference Codes:**

- (i) IS1367 (Part6)–1994 (reaffirmed2004)–Mechanical Properties and test methods for nuts with specified proof loads
- (ii) IS1367 (Part8):2002–Prevailing Torque type Steel Hexagon Nuts–Mechanical and Performance Properties.
- (iii) IS1367(PartXII):1983(reaffirmed2001)–Phosphate Coatings for Threaded Fasteners.
- (iv) IS3757–1985(reaffirmed2003)–Specifications for High Strength Structural Bolts.
- (v) IS4000:1992–High Strength Bolts in Steel Structures–Code of Practice.
- (vi) IS6623:2004-High Strength Structural Nuts-Specifications
- (vii) IS6649:1985-Specification for Hardened and Tempered Washers for High Strength Structural Bolts and Nuts.

**29.9.2 Hierarchy of Codes:**The hierarchy of codes shall be as follows:

- (i) Provisions of IRS codes.
- (ii) Where IRS codes are silent, relevant IS codes.
- (iii) Where both IRS and IS codes are silent, relevant EN codes.

**29.9.3 Definition:** HSFG bolts are high strength structural bolts which have been tightened such as to induce predefined tension in the bolt shank. Provisions in this Code apply to non–galvanized Bolts of dia.M12 to M36 only.

**29.9.4 Types of Bolts:** For the purpose of HSFG connections, only high strength structural bolts of two property classes:8.8 and 10.9 can be used. Bolts shall conform to IS 3757. The bolts shall have the following characteristics

(i) **Identification:** The property class of bolts (8.8 or 10.9) shall be embossed or indented as 8S or 10S respectively on the top of head along with the manufacturer's identification symbol. Alternately, marking '8.8S' or '10.9S' are also acceptable. The suffix 'S' here denotes that the bolt is high strength structural bolt with a large series hexagon.

(ii) **Length:** The length of bolt shall be chosen such as to hold the steel members in position, with provision for the nut, washer(s) and some projection beyond the bolt. Along with the overall length of the bolt, the thread length has to be specified. At least 4 full threads shall remain clear between the bearing surface of the nut and unthreaded part of the shank further, minimum one full thread pitch must protrude from then after tightening.

(iii) The minimum length of bolt shall be worked out on the basis of maximum grip length (covering ply thicknesses and all washers) plus an additional allowance as per table 1 of IS:4000.

(iv) Maximum grip length of all plies, including packings and packing washers, shall not exceed 10 times the nominal diameter of the bolt.

(v) **Surface Finish:** All bolts shall be supplied with coating consisting of zinc phosphate that is used in conjunction with suitable oil or rust preventive type as per IS 1367 (Part XII).

29.9.5 **Nut:** Each bolt shall be tightened using a high strength nut, conforming to IS 6623. The nut has to be strong enough to be able to impart the necessary torque to the bolt and also withstand the force during the life of the structure. Further, the threads in nut shall be matching with the threads in the HSFG bolt and the nut shall be free running on the threads of the HSFG bolts. Nuts shall have following characteristics:

(i) **Property Class:** For HSFG bolts, the property classes to be used are 8 and 10 as specified in IS1367 (Part6), suitable for bolts of property class 8.8 and 10.9 respectively. Normal height of nut shall be more than 0.8 times the nominal bolt diameter.

(ii) **Identification of Nut:** The nuts have the following markings:

(a) Manufacturer's identification symbol.

(b) Property class, marked as '8S' or '10S'. (The suffix 'S' denotes a high strength structural nut with a large series hexagon.) Alternately, '8.8 S' or '10.9 S' are also acceptable. The marking shall be either on the top or the bottom face of double chamfered nuts and shall be either indented or embossed on non bearing surface of washer faced nuts.

(iii) **Surface finish and coatings of Nut:** All nuts shall be supplied with coating consisting of zinc phosphate that is used in conjunction with suitable oil of rust preventive type as per IS: 1367 (PartXII).

- (iv) **Position of nut in bolt:** Nuts shall be provided in bolts preferably as follows:
  - (a) **In girder web:** Towards outside of the girder.
  - (b) **In flanges:** Towards bottom (Except when in composite construction).
  - (c) **In composite construction:** Towards inside of concrete.
  - (d) **In bracing:** Towards the rolled section side so that the space for rotation of the nut is not readily available.
  - (e) Where **Tapered washer** is used, the nut shall preferably be on the other side.

29.9.6 **Washer:** Annular rings which are provided between the bolt head/nut and the members being joined are called washers. Washers for HSFG bolts shall conform to IS 6649. The washers have the following characteristics:

**(i) Types:** Three types of washers have been specified in IS 6649, clause 2:

- a) Type A: Plain hole circular washers.
- b) Type B: Square taper washers for use with channels (60 taper)
- c) Type C: Square taper washers for use with I-beams (80 taper)

**Identification:** Type A washers shall be identified by provision of two nibs (small projections) and manufacturer's identification symbol in indented character. The type B and C washers shall be identified by the type identification symbol, B or C and the manufacturer's identification symbol.

**(ii) Categories of washers:**

a) **Plain washer:** Plain washers are used as per provisions of clause 28.10.2 where other types of washers are not suitable. HSFG bolts shall be provided with minimum one washer.

b) **Packing washers:** If the bolt is longer than required, plain washers may be used as packing washers also. **However, the maximum number of packing washers shall be limited to 3, with maximum total combined thickness of 12 mm.**

c) **Tapered Washer:** Where the angle between the axis of bolt and the joint surface is more than 3 degree off normal, a tapered washer shall be used against the tapered surface. Non rotating surface shall preferably be placed against tapered washer.

d) **Direct Tension Indicators (DTI):** The Direct Tension Indicators are special type of washers with projections which get pressed when tension is applied. The pressing of projections to required level indicates that the required tension has been applied in the bolts. DTIs have multiple projections, between which the feeler gauge is to be inserted to check if the bolt has been sufficiently tightened or not. The projections shall be kept in the direction of nut/head of bolt and not towards member.

**(iii) Calibration of Direct Tension Indicator:** Before the DTI are brought to site, the same shall be tested in the presence of engineer. Three nos. bolts of similar diameter and property class as to be used in the work shall be taken and installed with DTI. The installation procedure to be followed shall be similar to the one given for plain washers. On full tightening, the projections on DTI washers shall meet the requirements of checks specified after second stage tightening using DTIs. Alternately, calibrated load cells may be used to check the calibration of DTI washer. **Only the DTIs which satisfy the calibration shall be brought to site for work.**

**(iv) Surface Finish:** All washers (except Direct Tension Indicators i.e. DTIs which may have any surface finish, as specified by manufacturer, with condition that the surface finish shall be compatible with the metallurgy of the steel structure and the HSFG bolt/nut) shall be supplied with coating consisting of zinc phosphate that is used in conjunction with suitable oil of rust preventive type as per IS 1367 (Part XII).

#### **29.10 Fabrication and Assembly of High Strength Friction Grip (HSFG) Bolts**

**29.10.1 Holes for HSFG Bolts:** Normal holes in the steel members being connected by the rivets shall be used for HSFG bolts also, subject to the following:

- (a) **Making of holes:** The holes shall be made by drilling only.
- (b) **Nominal Diameter of Hole:** The nominal diameter of hole shall be 1.5mm more than the bolt diameter for less than 25mm bolt and 2mm more than the nominal diameter of the HSFG bolt for larger diameters.
- (c) **Oversize Holes:** In case the bolts are to be provided in existing structure, the maximum size of hole shall not exceed  $1.25 \text{dord} + 4\text{mm}$  whichever is less.

#### **29.10.2 Number of washers and their fixing:**

- (i) DTIs are very good method of ensuring that the bolts are tightened properly, and this method of tightening shall be preferred over the method with plain washers. Hence DTI washers shall be preferably used. If there is some problem with availability of DTIs, plain washers may be used for installation of HSFG bolts after approval of SAG officer in-charge of the work.
- (ii) The DTIs used shall be the ones which are compatible metallurgically and also suitable for the bolts of property class 8.8 and 10.9. Suitable markings identifying the bolt manufacturer, property class of DTI and its diameter shall be engraved suitably on the DTI.

#### **(iii) Number of washers to be provided:**

- (a) Two washers shall be provided, one against head and one against the nut.
- (b) **One DTI shall be used in one bolt.** In case DTI is being provided, the same will count as one washer i.e., one DTI and one plain washer shall be provided.



(c) DTIs shall normally be provided below the head of the bolt (with projections towards bolt head) in case nut is rotated. In case the bolt is to be rotated, DTI shall normally be provided under nut (with projections towards nut). In case other side is not accessible for measuring projection gap in DTI, the DTI may be provided under nut which is being rotated. In this case, an additional washer shall be provided on the DTI side to protect the projections from damage due to the abrasion during bolt tightening.

**29.10.3 Surface preparation for steel interface before providing HSFG bolts:**

The steel interface between the plies which form a joint having HSFG bolts shall have special surface preparation so that sufficient slip factor is available. The surface preparation shall be as assumed by designer in design, based on slip factor specified in Table XIII of Steel Bridge Code. The following surface preparation are recommended:

(i). **New construction:** The interface between the plies which are connected together by the HSFG bolts shall be “ Aluminum metalized without any over coating”.

(ii). **Existing structures:** The interface of plies which are to be included in the HSFG bolts shall be cleaned by wire brushing/flame cleaning equivalent to the surface specified in IRBM para 217,1(b),(i) to (iv). The surfaces shall be cleaned to remove all loose rust and paint layers (Only isolated patches of coatings/rust can remain). If, however, in existing structures, rivets are to be replaced by bolts but no surface preparation is possible, the slip factor shall be suitably reduced as per Table XIII of Steel Bridge Code.

**29.10.4 Personnel For Tightening:** The tightening of HSFG bolts is a technical procedure. Only trained personnel who understand the procedure shall carry out the installation of HSFG bolts. Before any person is deployed for installation, his knowledge of the procedure for tightening shall be checked and if found satisfactory, a competency certificate shall be issued by an engineer not below the rank of ADEN or equivalent. The competency certificate once issued shall be valid for six months. Any person deployed for installation of HSFG bolts must possess a valid competency certificate.

**29.10.5 Procedure for tightening:** Bolts shall be tightened so as to impart bolt tension as specified in para 7.12.6 of IRS Code Of Practice For The Design Of steel Or Wrought Iron Bridges carrying Rail, Road Or Pedestrian Traffic. The following steps shall be followed for tightening of bolts:

(i) The holes shall be brought in alignment by using drifts etc. such that the bolt threads are not damaged during insertion of bolts. Drifting shall not distort the metal or enlarge the holes.

(ii) The members being joined shall be held in position by insertion of few HSFG bolts (tightened to first stage (as defined in para 28.10.5) only). These bolts shall not be

Tightened to second stage as defined in para 28.10.5 till all the bolts in a joint are inserted and tightened to first stage.

(iii) After the alignment/ geometry of members is verified to be correct as per drawings, balance bolts shall be inserted and tightened upto first stage of tightening. The drifts inserted as above shall also be replaced by HSFG bolts one by one.

(iv) **Clearance between plies:** The final tightening shall not proceed until the gap between the plates has been closed. Residual gap, if any, shall be less than 2mm at edges. There shall, however, be no gap in the central portion. In case the central portion is not in close contact or gap at edges is more than 2mm, straightening of members may be done after opening out the bolts inserted and the entire procedure i) to iii) above shall be repeated.

(v) **Sequence of tightening:** During tightening of bolts also, the steel members can continue to deform and hence the tightening of subsequent bolts can lead to loosening of already tightened bolts. In order to minimize the loosening of already tight bolts, tightening in the two stages shall be done starting from the stiffest part to the free edges. Stiffest parts of joint are generally towards the centre of the joint.

#### **29.10.6 Procedure for Installation of HSFG Bolts Using Direct Tension Indicator:**

The tightening is done in two stages so that the bolts already tightened do not get loose when the subsequent to bolts are tightened. The procedure shall be as follows:

(a) **First Stage of Tightening:** As a first stage, all bolts in the joint shall be tightened to 'snug tight' condition in proper sequence for tightening. Snug tight condition means the nut is tightened using an ordinary wrench by an average worker, applying maximum force on the wrench. This stage is required to bring the plies in close contact.

(b) **Checks after First stage tightening:** After first stage of tightening, the joint shall be checked to see if the plies are in close contact and the clearances are not exceeded.

(c) **Second Stage of Tightening:** During the second stage of tightening, torque wrench is used to tighten the bolts until the indentations on the DTI indicate full tightening. The bolts shall be tightened in proper sequence of tightening.

(d) **Checks after Second stage tightening:** 0.40mm thick feeler gauge shall be used to check 100% of the bolts for proper tightening. If 0.40mm thick feeler gauge cannot be inserted in the space between indicator positions on a DTI, it is called a 'refusal'. If a 0.10mm thick feeler gauge cannot be inserted in the space between indicator positions on a DTI, it is called 'full compression of the indicator'. The joint/bolts shall be said to be properly tightened if the following condition is met with:

Number of indicator positions in DTI washer	Minimum number of feeler gauge refusals*
4	3
5	3
6	4
7	4
8	5
9	5
*No more than 10% of the indicators in a connection bolt group shall exhibit full Compression of the indicator.	

29.10.7 **Procedure for Installation of HSFG Bolts without DTI washers:** The tightening shall be done in two stages so that the bolts already tightened do not get loose when the subsequent bolts are tightened.

i. **First Stage Tightening:** In the first stage, a calibrated wrench with an accuracy of  $\pm 10\%$  shall be set to 75% of the torque computed for the complete tightening of the bolt. The torque computed shall be as per manufacturer recommendation, duly certified to impart the bolt tension specified in para 7.12.6 of IRS Steel Bridge Code. All the bolts in the joint shall be tightened to this torque in proper sequence for tightening. After checking all bolts after the first stage, permanent marks shall be made with suitable marker on the bolt as well as nut steel member to indicate the relative position of the two. The mark shall be such that the same shall be visible for inspection upto 1 year after the date of installation.

ii. **Checks after first stage:** After the first stage of tightening, following shall be checked:

a) The steel members that make up the plies of the joint with HSFG bolts shall be checked for proper contact as specified.

b) 10% bolts, subject to minimum 2 per joint shall be tried to be rotated with a separate calibrated torque wrench set at 75% of the proof load for the bolt. Any bolt turning by more than 150 during the check shall be rejected. If the improperly tightened bolts thus found are more than 5 but less than 1% of the total, another 10% of the bolts shall be checked. If the total improperly tightened bolts thus found exceed 1% of the total, the tightening procedure and personnel involved shall be reviewed, the torque wrench used for tightening shall be calibrated afresh and the entire lot shall be checked for tightness.

iii. **Second Stage Tightening:** The bolts tightened to first stage shall be turned by a further amount in proper sequence of tightening as specified below:

Total nominal thickness "t" of parts to be connected (including all packing and washers), d = dia of bolt	Further rotation to be applied, during the second stage of tightening	
	Degrees	Partturns
$t < 2d$	60	1/6
$2d \leq t < 6d$	90	1/4
$6d \leq t \leq 10d$	120	1/3

iv. **Checks after second stage tightening:** After the second stage of tightening, following shall be checked:

a) 100% bolts shall be checked and certified to have been turned through the requisite amount by verifying the permanent marks on the bolt and the nut/steel member.

b) 1% of the bolts, subject to minimum of 10 per size of bolts shall be checked for gross under-tightening as per procedure given in Annexure-D of IS 4000.

**Painting during initial installation:** In case of HSFG bolts with “Direct Tension Indicating” device, the final coat in field applied on complete structure may be applied on HSFG bolts also. In case part turn method of tensioning is used without “Direct Tension Indicating” device, the HSFG bolts shall not be painted and the permanent location marks made on the bolts shall be visible after 1 year of installation.

**Painting in service:** HSFG bolts shall be painted as per normal painting schedules and painting methodologies as specified in the Indian Railways Bridge Manual for the girder as a whole.

#### **Retensioning of bolts:**

i. The HSFG bolts are tightened beyond yield stress level and undergo plastic deformation once tightened fully. If the bolt is opened out after complete tightening, its length gets increased permanently as compared with the initial length. The initial few threads which transfer the load from the nut to the bolt suffer the maximum damage. **Therefore, a bolt completely tightened shall not be reused under any circumstances.**

ii. A bolt which has been snug tightened or partially tightened (tightened to first stage of tightening) and then opened out will not be considered to have been fully tensioned and reuse of such bolt will be permissible in the same or different hole, as required.

Specifications of torque wrench: Except for works of minor nature where number of HSFG bolts to be installed is very less, only mechanical torque wrenches (pneumatic, hydraulic, electronic etc.) shall be used for tightening of bolts. For small quantum of work, manual torque wrenches may be used with permission of site-in-charge.

Calibration of torque wrench: Calibrated torque wrenches, accompanied with a certificate to the effect, shall be brought to site. Torque wrenches shall be calibrated periodically at least once in a year to an accuracy of  $\pm 10\%$ . These shall be recalibrated in case of any incidence involving the wrench during use resulting in heavy impact (such as fall, mishandling etc.,) or if the joint is found to have been improperly tightened using the same. The procedure for calibration of torque wrench shall be as specified by the manufacturer.

#### **Connecting Pins**

All connecting pins shall be finished accurately to gauge and parallel throughout, straight and with smooth surface entirely free from flaws and of sufficient length to ensure that all parts connected thereby shall have a full bearing on the pin. They shall be turned to a smaller diameter at the end for the thread and driven to Place with a pilot nut, where necessary to preserve the thread.

### **30. Pin Holes**

**30.1** Pin holes shall be bored smooth straight and true to gauge and at right angles to the axis of the member. Boring shall only be done after the member has been riveted up and the diameter of the pin shall not be less than that of the hole by more than 0.5mm.

### **31. Bearing and Expansion Gear**

**31.1** All steel bed and bearing plates or plates over saddle castings shall be made perfectly level and all rivet heads on their bearing surfaces shall countersunk and dressed flush.

**31.2** The saddles, knuckle-bearers and roller bed - plates shall be planned on all bearing surfaces and elsewhere as indicated on the Contract Drawings and all bolt-holes shall be drilled. The bottom edge of ribs should be machined and welded to the bottom slabs after which the top edges of the ribs should be machined as a whole and the top plate welded. Subsequently the top and bottom surfaces should be machined to the specified tolerances as given in **Appendix VI of IRS Specification for Bridge Fabrication and Erection of steel girders serial No.B1-2001**. Generally in connection with the bearing gear all meeting surfaces including the sides of the roller frames, shall be machined, all bolts except anchor bolts turned and fitted, all washers faced, the rollers knuckles and pins polished to smooth surface and the whole finished in the style of first class machined work.

**31.3** Tolerances shall be as specified in **Appendix VI of IRS Specification for Bridge Fabrication and Erection of steel girders serial No.B1-2001** and shall be shown on the drawings.

### **32. Erection in Contractor's Works**

**32.1** The work shall be temporarily erected complete at the Contractor's Works for inspection by the Inspecting Officer, with the exception of such riveting as has to be done at site, so that accuracy of fit and perfection of workmanship may be assured. The work shall be put together with sufficient numbers of parallel drifts or turned bolts or both to bring the pieces into place. When so erected all holes left to be filled at site shall be so fair that a parallel gauge turned to a diameter 0.8 mm less than that of the hole, of a length equal to the depth of the hole, can be passed through them without difficulty. No drift shall be used anywhere in the work larger in any part than the hole in which it is to be driven. Holes for turned bolts, which have been 1 mm under drilled in shop, should be reamed at site by the erecting agency.

### **33. Interchangeability**

**33.1** Every span is to be temporarily erected complete in Contractor's works adopting the method of giving camber as explained in clause 34 and all parts as marked to their place, unless the whole of the work is made completely interchangeable by the use of steel jigs and hard steel bushes controlled by

master gauges, in which case the first span must be completely erected to test the accuracy of the templates. Further spans or parts pan assemblies built from parts selected at random by the Inspecting Officer shall be erected from time to time to check the accuracy of the work as the Inspecting Officer may require.

**33.2** If the work is considered interchangeable by the Inspecting Officer a simplified scheme of marking will be permitted, i.e. all pieces which are identical shall bear one distinguishing mark irrespective of the span to which they belong. Should the interchangeability not to the satisfaction of the Inspecting Officer, the whole of the spans must be erected complete and all parts marked to their place without additional charge. The tenderers must state in their tenders whether they intend to adopt complete interchangeability or not.

**33.3** Under special arrangement with the Purchaser, it shall be permissible for approved portions of the work to be dispatched before complete erection of the first span, provided the Contractor satisfies the Inspecting Officer that such portions of the work are strictly interchangeable and will assemble correctly and accurately in the complete structure.

#### **34. Camber**

**34.1** In order to ensure that the fabrication and erection of main girders shall be such as

To eliminate secondary stresses in the loaded span, the nominal length (i.e.the lengths which will give no camber) of member shall be increased or decreased by the amount shown on the camber diagram supplied by the Purchaser.

**34.2** For setting of the angles of intersection of the chords and web members and also for templating the gusset, full size of panels with nominal lengths of the members, shall be used. Similarly, the machining of all chords butts shall be to suit the nominal outline as defined in clauseNo.34.1.

**34.3** The procedure for erecting the span at Contractor's work shall be as specified. The site riveting holes shall be riveted or bolted and drifted as specified in **Appendix III of IRS Specification for Bridge Fabrication and Erection of steel girders serial No.B1-2001.**

**34.4** When supported on blocks or staging's, the girders shall be erected to the camber specified in the fabrication drawings according to which the girders have been manufactured. A camber diagram indicating the relevant height of each panel point when erected on blocks at the manufacturing works shall be supplied by the Engineer.

**34.5** The cambering of the main girders along with pre-stressing, when all panel points are supported on the blocks or staging's, shall be carried out in accordance with Appendix 'A' of Steel Bridge Code.

**34.6** Special methods of erection will require special erection drawings approved by the Engineer, which must not be deviated from.

**34.7** In the case where the girders are erected on yielding supports such as a service span, due allowance shall be made for the anticipated yield when the camber blocks are set out.

**34.8** Frequent checks shall be made of the camber of girders during erection and care taken to see that the camber as per drawing is obtained when the girder is completely assembled. When span is supported on ends and intermediate supports are removed the dead load camber shall be recorded and entered in bridge register. This will provide the reference to compare the camber checked during technical inspection to ascertain the loss of camber.

**35. Testing**

**35.1** The Inspecting Officer shall be empowered, at his/her discretion to make or have made under the supervision, any of the tests specified in the specifications mentioned herein In addition to such other tests as he/she may consider necessary, at anytime upto the completion of the contract and to such an extent as he/she may think necessary to determine the quality of all materials used therein. In doing so, he/she shall be at liberty under Any reasonable procedure, he/she may think fit to select, identify, have cut-off and take possession of test pieces from the material before, during or after its being worked up in to the finished product.

**35.2** He shall also be empowered to call for a duly authenticated series of mechanical tests to be obtained from the maker for this materials used in the work and to accept the same in lieu of other tests to the extent he/she deems fit. The Contractor shall supply the material required for the test pieces and shall also prepare the test pieces necessary.

**35.3** The test shall be carried out by the Contractor, for which Contractor shall provide all facilities including supply of labour and plant. Inspecting officer may at his/her discretion direct the Contractor to dispatch such tests pieces as he/she may require to the National Test House or else whereas he/she may think fit for such testing purposes.

**36. Check on Tests Made at Contractor's Work**

**36.1** The Inspecting Officer may at his/her discretion, check test results obtained at Contractor's work by independent tests at National Test House.

**36.2** The Inspecting Officer shall at all times be empowered to examine and check the working of the Contractor's plant before and after using it. Should the Contractor's plant be found, in the Inspecting Officer's opinion, unreliable, he/she is empowered to cancel any tests already carried out in this contract and have these tests carried out at any National Test House or elsewhere, as he/she may think fit.

### **37. Analysis**

**37.1** The Contractor shall supply authenticated copies of analysis of any materials used in the contract when required to do so by the Inspecting Officer who shall be empowered to accept them to the extent he/she thinks fit. In addition to the above samples may, at the Inspecting Officer's discretion be subjected to complete analysis at the National Test House or elsewhere as the Inspecting Officer may determine, the cost of the same to be borne by the Purchaser.

### **38. Inspection-General**

**38.1** The Inspecting Officer shall have free access to the works of the Contractor at all reasonable times and shall be at liberty to inspect the process of manufacture at any such time and to reject in whole or part, any work or material that does not conform to the provisions of this Specification and may order the same to be removed, replaced or altered at the expense of the Contractor. All gauges and templates necessary to satisfy the Inspecting Officer of the complete interchangeability of parts must be supplied by the Contractor free of cost.

### **39. Oiling, Painting and Metalizing**

**39.1** No part of the work shall be painted or coated, packed or dispatched, until it has been finally inspected and approved by the Inspecting Officer. Dry Film Thickness shall be measured by elcometer or any other approved method.

**39.2** When so specified by the Purchaser, the whole of the work except machined surfaces shall be given protective coating using one of the systems of painting or metalizing given in clauses 39.2.1 to 39.2.4. Prior to the application of protective coating, the surface of work shall be carefully prepared removing mill-scale, rust, etc. using wire brushes, sand or grit blasting as stipulated and approved by the Purchaser.

**39.2.1** For all locations, for all types of new steel girder bridges (including all components) the protective coating by metalizing with sprayed aluminum as given in the **Appendix VII of IRS Specification for Bridge Fabrication and Erection of steel girders serial No.B1-2001** followed by painting as per painting schedule given below may be applied:

- (i) One coat of etch primer to IS:5666.
- (ii) One coat of zinc chrome primer to IS:104 with the additional proviso that zinc chrome to be used in the manufacture of primer shall conform to type 2 of IS:51.
- iii) Two coats of aluminum paint to IS:2339 brushing or spraying as required. One coat shall be applied before the fabricated steel work leaves the shop. After the steel work is erected at site, the second finishing coat shall be applied after touching up the primer and the finishing coat if damaged in transit.

**39.3** Surfaces which are inaccessible for cleaning and painting after fabrication shall be applied one heavy coat of zinc chrome red oxide priming to IS:2074 before being assembled for riveting/welding.

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



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

**39.6** For site painting the whole of the steel work shall be given the second finishing coat after finally passing and after touching up the primer and finishing coats if damaged in transit.

#### **40. Name Plate**

**40.1** A neat casting bearing the name of the Contractor, the place and year of manufacture, drawing number, the contract number and the standard of loading to be specified by the Purchaser shall be bolted conspicuously on each span. The drawing of the name plate shall be approved by the Engineer.

#### **41. Erection Mark**

**41.1** Every portion of the work shall be distinctly stenciled with paint with letter size not less than 10 mm for guidance in the erection in the field, and stamped with the letters specified in the drawings. In the case of non-interchangeable work, the system of marking shall be in accordance with the drawings prepared by the tenderer and approved by the Purchaser.

#### **42. Packing**

**42.1** All projecting plates or bars shall be kept in shape by timber or angle bars spiked or bolted to them, and the ends of the chord lengths, end posts and plate girders at the time of shipping, joints shall be protected and stiffened so as to prevent damage or distortion in transit as the Inspecting Officer may direct.

**42.2** All threaded ends and machined surfaces are to be efficiently protected against damage in transit. The parts shall be sent out in lengths convenient for transport.

**42.3** All straight bars and plates except small pieces are to be sent out in convenient bundles temporarily riveted or bolted together or bound with wrought iron or suitable wire as the Inspecting Officer may direct. All rivets, bolts, nuts, washers, plates under 300 mm square and small articles generally are to be packed separately for each span in cases each weighing, when full, not more than 350kg, or in strong petroleum casks, or in barrels approved by the Inspecting Officer. If not entirely filled by the contents the space left shall be closely packed with woods having or other suitable material. Bolts and rivets of different sizes shall be separately packed in bags, each bag having a label indicating its contents. A list of the contents shall be placed in the top of each case or cask.

**42.4** In the case of imported material all cases shall be made of 32 mm boards with ends nailed with 90 mm wire nails strengthened by battens and 38 mm x 1.6 mm (No. 16 BG) hoop -iron and made thoroughly secure for transit to India. All casks shall be in sound condition, and if not entirely filled by the contents the space left shall be closely packed with wood-wool

or other suitable material. The heads shall be firmly secured by means of hoops in the usual way, and in addition each head shall be further secured by a strong wooden batten and not less than two strips of 1.6mm(No.16 BG) hoop-iron passing over the head and nailed to the staves on both sides. The hoop-iron shall be long enough to pass over two hoops on each side of the cask and be nailed in such a manner that the hoops cannot slack back. Bolts and rivets of different sizes shall be packed in a separate canvas bags, each bag having a label indicating its contents. End field holes to be bolted in case of members having split in plate and channels.

#### **43. Dispatch or Shipping Marks**

**43.1** Each package, case or bundle is to have clearly stenciled on it in good oil paint the address as stated in the order of contract, gross and net weight description of contents and such marks as may be required by the Purchaser must be shown against each item in the invoice. The Contractor is to provide necessary stencil plates for marking. Every piece of bundle shall be marked and in the case of material (shipped to India) all cases or casks shall be clearly cut or branded, not merely painted, with their net and gross weights and with such shipping marks and other particulars as the Inspecting Officer may direct and each bundle shall also have a metal label securely attached with wire stamped with similar marks. The marking shall be done with thick oil paint and in such a manner that it cannot be washed off or obliterated.

#### **44. Loading**

**44.1** All trucks or wagons are to be loaded to as near their full capacity as is consistent with safe transport. While loading the material in wagon, truck or trailer, care should be taken that heavier material is loaded first and lighter material is kept on top so that lighter material is not damaged due to heavy weight. While transporting the material by road, adequate safety precautions shall be taken as per extant instructions.

**44.2** The Contractor shall apply all dunnage and lashing required to hold the material securely in position free of charge.

**44.3** While handling any girder or girder component it shall be ensured no damage to material takes place in the form of dent/cut mark etc. Wooden blocks, rubber pads shall be used to avoid direct contact between materials to be handled and handling equipment.

#### **45. Weight of Steel Work for Payment**

**45.1** Any steel work the weight of which differs by more than 2.5% from the calculated weight determined from the nominal weight of the sections shall be liable to rejection.

**45.2** Payment shall be made on the tendered weight to be calculated in accordance with the nominal weight of the sections as specified on the contract drawings. An addition in weight for welds/HSFG Bolts and rivet heads should either be specified in the schedule or be made as follows:

- a) 3% in case of riveted or composite (riveted/bolted and welded) work; and
- b) 1% in case of purely welded work.

**45.3** Should the actual weight fall short of the calculated weight by more than 2.5%, the material if accepted, will be paid for the actual weight only. Should the actual weight exceed the actual calculated weight, payment will be made for calculated weight only.

**45.4** No separate payment shall be made for the items mentioned in clause 24.

**45.5** In the event of a dispute arising as to the weight of a portion of steel work, a weighment shall be made in the presence of the Inspecting Officer.

#### **46. Quantities**

**46.1** In case where the estimated quantities are given with the schedule, it must be understood that the Purchaser will not be responsible for their accuracy and if the Contractor makes use of them in preparing his/her tender, he/she does so at his/her own risk, as he/she will not be entitled to make any claim or demand nor to raise any question whatsoever, on account of any error or miscalculations in or misunderstanding of the said quantities, as these are given for the convenience of the Purchaser.

#### **47. Tracings and Printings**

**47.1** Excepting in the case of standard spans fabricated without any modifications to the standard drawings the Contractor shall supply free of charge, one set of neatly executed tracing on linen. They shall be fully dimensioned and contain all erection marks, notifications as to the colour the work has been printed, the name of the Contractor and any alterations from the contract drawings, which may have been made in executing the work. The drawings shall conform to standard sizes as given in IS:962 and shall not exceed AO size. The drawings shall not be folded but rolled outwards on a roller, in addition to three sets of full size copies on strong paper made by an approved process.

#### **48. Rivets and Bolts Lists**

**48.1** The Contractor shall also supply, without charge, three complete lists of the rivets, bolts, HSFG bolts, service bolts, washers and drifts required for erecting the work at site, showing the parts of the work to which the various rivets and bolts belong and having each item marked so as to indicate the particular case in which it will be found.

#### **49. Photographs**

**49.1** If required by the Purchaser the Contractor shall also supply without charge, two sets of large well-executed, unmounted photographs of the first span of each description of plate girder or truss bridge when erected, taken from two points of view and showing the erection marking as clearly as possible Photographs of rolled beam, trough girder or trough plate girder bridges will not be required.

## **50. Attestation of Tracings etc.**

**50.1** The tracings, photographs and lists shall be examined and signed by the Inspecting Officer. They shall be supplied with the first installment of the work delivered.

## **51. Deviations from this Specification**

**51.1** Should a tenderer desire to depart in any respect from the provisions of this Specifications either on account of manufacturing practice or for any other reasons, he/she must do so in an alternative tender which may not be considered, with a covering letter explaining in detail each and every departure he/she proposes to make from the Specification.

**51.2** Manufacturer's standard specification may be submitted but all discrepancies must be carefully drawn attention to, both in covering letter and in appendices to be annexed to the specification.

**51.3** The intention is to adopt manufacturer's standard equipment as far as possible but these standards must in all respects comply with the conditions of this Specification regarding safety from break-down, output, capacity, performance etc.

## **52. Alterations in Work**

**52.1** The Contractor shall not in any case or in any circumstances have authority to make any alterations in, modifications of, substitution for, addition to, or omission of work or any method or system of construction, unless an alteration order in writing directing such alteration, modification, substitution, addition, omission or change shall have been given by the Purchaser prior to the commencement of the work or part of work nor shall the Contractor be entitled to any payment for or in respect of any such alteration, modification, substitution, addition, omission or change may have been actually made and executed and no course of conduct shall be taken to be a waiver of the obligation and conditions hereby imposed.

**52.2** All altered, modified, substituted, additional and changed work, labour and materials and all omitted work shall be valued by the Purchaser on the basis of the rates specified in the schedule.

## **53. Elastomeric Bearings:**

Elastomeric bearings are to be supplied as per the Design of UIC -772-2R and testing shall be done as per IRC-83-1987 part-II with latest correction slips. Materials used in manufacture of bearings shall be confirmed to the specification indicated in IRC Code. Contractor has to submit the manufactures test certificate bearing the information contained in appendix-3 of IRC. In addition to this, physical testing shall be done either in IIT, DGS&D or any other Govt. Institution as indicated by Engineer-in-charge. Fixing of the bearings to precast concrete surface may be done by application of epoxy resin adhesive to interface, after specified surface preparation. The specification of adhesive material workmanship and Contract shall be approved by the Engineer.

Supplying, Acceptance inspection & Testing, and Installation of Elastomeric Bearings will be also govern by para 22.3 of Indian Railways Unified Standard Specifications (Works and Materials) 2021.

### **GUIDELINES ON FABRICATION OF STEEL GIRDERS**

The fabrication is governed by the provisions of;

- i) Indian Railway Standard specification for fabrication and erection of steel girder bridges and locomotive turn-tables.(B1-2001).
- ii) Indian Railway Standard Code of Practices for metal arc welding for structural steel bridges carrying rail cum road or pedestrian traffic (Adopted 1972 Revised 2001).

Engineer of contractors should also have good understanding of various provisions of above Railway codes other related codes and Guidelines on Fabrication RDSO-BS-110.

### **ITEM REQUIRING ATTENTION BY RAILWAY FIELD ENGINEERS AND CONTRACTORS & ENGINEERS DURING FABRICATION OF STEELGIRDERS**

#### **A. Approved Drawing to be used for fabrication:**

Field/Workshop Engineer associated with fabrication should have all the relevant drawings, Codes & Specifications with latest Correction Slips prior to the start of work. On the basis of structural drawings, fabrication drawings should be prepared by fabricator. Plate Girder Drawings to be checked for intermediate stiffeners whether riveted or welded.

#### **B. Quality Assurance Programme (QAP) of Steel Girder Fabrication:**

To ensure the proper quality of fabrication Quality Assurance Plan (QAP) is prepared. QAP must indicate stage wise manufacturing process covering various steps, tests, checks & their frequency, sampling plan, authority for grant of clearance etc. for all activities from inspection and testing of raw material to trial assembly and erection. The QAP must cover following aspects.

1. Brief Details of project
2. Contract Agreement No.
3. Loading Standard
4. Governing Specification
5. Drawing references
6. Roles and responsibilities of various agencies involved in fabrication, erection & inspection.

A sample QAP for 30.5m welded open web girder is given at **Annexure-I of Guidelines on Fabrication of Steel Girder BS-110 issued by RDSO B&S Directorate.**

QAP is to be scrutinized and approved by the inspection agency. In case of welded girder it is to be done by RDSO, as per prevailing orders.

Field Engineer should ensure that work is carried out strictly as per the approved QAP and no deviation takes place from QAP. All the stages should be studied in detail, prior to start of work.

**C. Scrutiny & Approval of Welding Procedure Spec. Sheet (WPSS) (final approval to be done by RDSO):**

WPSS is process sheet indicating plate/section used, welding process, type of joint, welding consumables quality, welding parameters, acceptance standard, tests applicable etc. Field Engineer should ensure that welding is carried out as per approved WPSS. It is to be ensured that welding consumables to be used are from approved source and a proper record of their consumption is maintained. A sample Performa for record keeping of consumables is enclosed as **Annexure –II of Guidelines on Fabrication of Steel Girder BS-110 issued by RDSO B&S Directorate.**

**D. Welding Procedure Qualification Records (WPQR) (final approval to be done by RDSO):**

WPQR is the document indicating approval of various welders who are to be deployed for carrying out welding work for fabrication. It contains Name of the welder with photograph, qualification, experience, qualification tests and records for each welding process and joint, welding parameter. Tests are conducted by RDSO Official from M&C Directorate before qualifying the welders and then approval is granted through WPQR. Field engineer should ensure that welding is done only by approved welders and no deviation takes place.

**E. Raw Material and Gauge Certification**

Inspection of Raw Materials:- Passing of raw material is done on the basis of visual inspection and lab test for mechanical properties, chemical composition, ultrasonic examination, Charpy Impact Test, lab test report etc. Rivets and other consumables like paint etc. should also be got tested from NABLL as per relevant codes/specification.

All the required test should be got done through independent NABL Labs and compared with the mill test results given by the supplier before passing the material for use.

Material test certificate register must be maintained by fabricator as per Annexure available in IRS: B1-2001 (appendix-I, Performa-7) and signed by railway representative as well as fabricator.

All angle/channel, rolled section to be used for open web girder fabrication shall be checked for rolling tolerance as stipulated in IS: 1852.

In addition to above visual inspection shall be done to ensure that steel is free from surface defects like pitting, laminations, imperfect edges, twist, other harmful defects etc. and recorded in the register.

**F. Item requiring attention before Fabrication of Girder.**

**F1.** Inspection of Layout on template floor—Field engineer has to ensure that the Template floor is level. Nominal and camber layout are drawn with the calibrated steel tape. The certificate of calibration from a authorized agency should be kept in record. For squareness, diagonal measurements are also checked. It should be remembered that tape should not be changed during the various stages of measurement. Running measurement should be recorded with along tested tape having minimum length suitable for half span/full span measurement as per the case. 4lbs pull is to be applied for stretching the tape. Suitable device should be used for this purpose.

**F2.** Inspection of Jigs, Fixtures and Master Plates—Master Gussets should be checked on nominal layout and transfers of all inter section line/points to be done with great care and accuracy. If gussets are symmetrical then 1/4<sup>th</sup> or half hole marking is to be done and same will be transferred to complete the gusset marking. Dimensional Inspection of Jigs, Fixtures, and Master Plates used in manufacture of girder should be done very carefully to ensure accuracy.

It should be remembered that jigs of main members of the open web girders are fabricated on the camber length with the adoption of the field holes at nominal length layout through master gussets.

**F3.** Layout of joints is drawn as per drawing on 1:1 scale on a level ground to check for; i) Any infringement of rivets, adjoining edges etc.

ii) Position of holes in master plates for jigs as per layout.

iii) The bore of bushes shall initially have tolerances of - 0mm to + 1mm. Fairing of bushes with holes of master plate shall conform to tolerances of -0.13 mm using a 'GO' gauge of 0.13 mm less than hole diameter. Bushes of jigs during service should be maintained within acceptable limit (D+0.4mm) which shall be checked at regular intervals.

**F4.** Certification of Jigs, Fixtures and Master Plates—Stamping of Master Plates by the inspection official should be ensured prior to their use. The jigs should be checked by fabricator and field engineer from time to time for their wear and tear for maintaining accuracy during work.

**G. Item requiring attention during fabrication of girder: Field/Workshop**

**engineer should keep a watch and maintain proper record for-**

- (i) Ensuring Use of Approved Raw Material-Only raw material cleared originally to be used during fabrication.
- (ii) Ensuring use of Approved Welding Consumables-Type of consumables, source, quality, approval status, grade, suitability for fabrication as per WPSS etc. to be frequently checked and recorded.
- (iii) Ensuring use of Approved Welders- Checking of welders certificate, records, skill and procedure adopted for welding as per WPSS
- (iv) Ensuring use of Approved WPSS & Welding Parameters- Checking welding parameters and equipment used for correctness of joint preparation etc.

**Important Checks for Tack Welding:**

- i) Check that top & bottom flange plate are perfectly perpendicular with reference to web throughout the length of I Section.
- ii) Check the squareness i.e. 90° angle between flange & web of top and bottom flange plate to avoid out of squares flanges.
- iii) Check with filler gauge throughout the length of top & bottom flange connection for uniform contact throughout the web plate.

**Points requiring attention during full welding:**

- i) Thorough cleaning of tack welded member should be done with appropriate tool like wire brush, before shifting for full welding. Minimum width of 75mm throughout the length shall be cleaned to ensure that the surface is free from dust, mill scale, grease, oil and paint to ensure sound quality of weld.
- ii) Full welding shall be carried out in flat position with SAW process as per sequence mentioned in WPSS/WPQR using manipulator/special welding fixture.
- iii) The sequence of welding shall be shown in WPSS/WPQR marked as 1, 2, 3 & 4 in the order of welding.
- iv) The welding should be done in proper sequence.
- v) Minor welds/Inaccessible location welds shall be made by CO2 welding or other type of welding as per approved WPSS.

**Good Working practice for prevention of distortion in welded girders:** i) By pre-bending of flange plate of welded girder using appropriate fixture. ii) By clamping the flange plate to fixture.

(Fixture developed by MMR Workshop is given at **Annexure.III of Guidelines on Fabrication of Steel Girder BS-110 issued by RDSO B&S Directorate.**)

**Radiographic Exam of Butt Weld Joints**-Any butt welding provided as per approved WPSS should be subjected to radiographic testing by authorized agency only. The film



should be preserved for examination, sensitivity, defect interpretation and acceptance decision based on prescribed criteria.

**Ensuring use of Approved set of Jigs & Fixtures**-To permit the inter changeability of the components and ensure pre-stressing in open web girders and to avoid distortion, it should be ensured that only approved Jigs & fixture are used and proper clamping arrangement are provided in jigs/fixtures.

**H. Item requiring attention after fabrication of girder:** stacking of component should be proper and shipping mark is properly stenciled on component for identification.

**Field/Workshop engineer should ensure that:-**

While cutting the plates or other section the heat/cast mark should be transferred to all cut members while using these members for fabrication. Proper record of heat mark should be maintained/correlating it with the components of girder.

Visual Exam of Welds – Quality of weld, uniformity of weld bead, size of the weld, weld defects e.g. under cut, blowhole, porosity, spatter, crack etc. Should satisfy para 31 and Appendix C of welded bridge code.

Metallographic and NDT Exam of Fillet Welds - Macro etching on girder, run-on, run-off tabs for ensuring proper weld quality, Dye penetrate examination etc. should be arranged by fabricator, for independent inspection.

Structural and dimensional inspection-Dimensional check should be carried out by field engineer to ensure conformance to drawing dimensions including diagonal checks for squareness etc. before offering girders for final inspection.

**I. Trial Assembly:** for open web girder.

First span is always trial assembled to check whether fabrication process is proper or require any correction in jigs, workmanship or procedures to ensure regular quality output. Following important parameters are checked during trial assembly:-

**(1) Camber:**

Camber shall be checked while the girder is supported on the nodal points on camber jacks and after releasing jacks i.e. for residual camber with girder resting on bearing ends. The camber measurements should be done with appropriate leveling instrument:

**(2) Dimensional check:**

- i) Overall length
- ii) Bearing centers
- iii) Height
- iv) Truss center
- v) Center to center distance of rail bearers
- vi) Center to center distance of panel points
- vii) Squareness

- viii) Alignment of the girder
- ix) Fairing of holes
- x) Verticality
- xi) Infringement, if any
- xii) Butting of compression flange.

**(3) Component Inspection of first span-** Detailed inspection of dismantled components of trial erected span is carried out to see the integrity of components. There should not be any elongation of holes, tearing of edges or other defects after dismantling of trial assembly.

**(4) Component inspection of 2nd span onwards:-** Once fabrication process is found satisfactory i.e all steps from A to J are proved during trial assembly and its component inspection, then only components of 2nd span and onwards should be fabricated with the approved sets of jigs and fixture, the tested WPSS and WPQR as laid out in steps earlier. Field engineer should do the components inspection and ensure all record are available before giving final inspection call inspecting authority.

**Plate girder check.**

- i) Overall length
- ii) Bearing centers
- iii) Height
- iv) Girder center
- v) Squareness
- vi) Fairing of holes
- vii) Verticality
- viii) Infringement, if any
- ix) Butting of compression flange.

**L. Anti Corrosive Treatment-** Surface preparation, metalizing and or painting as per applicable painting schedule. Should be done as per provision given in para 39 of IRS:B1-2001. It should be ensured that paint are procured only through RDSO approved sources. The list of approved vendors by M&C Directorate of RDSO is available on website.

**M. Some important Dos & DON'TS are given here for guidance:-DOS-**

- Use proper fixtures and clamps to hold the members firmly at desired location while welding. The clamps and fixtures must be strong enough to prevent any distortion of the member while cooling of the welding joint. The clamps and fixtures are only to be removed when the joint is cooled to ambient temperature.
- Do the welding work in a warm and dry places so that rain water or other atmospheric elements may not come in contact while welding is in progress.

- While welding in very cold weather pre-heat the material before welding and apply post heating to prevent the weld joint from rapid cooling and develop stress raiser due to sudden contraction.
- Cross level of bearing plates in the welded plate girders should be checked properly for proper sitting over bed plate.
- To co-relate use of steel and welders in different members proper records should be maintained.
- Drilling of holes through approved set of jig particularly long members should be ensured. No fabrication should be done with unapproved jig.
- Drain hole in the portal girders at proper locations should be ensured.
- Fairing of holes and removal of drill burrs through initial assembly should be ensured.
- Proper edge finishing with grinding/special attention in top chord compression members butting by end milling should be carried out
- At site during the erection of girders particularly open web girders due and adequate care should be taken to achieve the required camber values.
- Camber Jacks should be provided at all the nodal points during trial assembly.
- Butting of compression members, X-levels of stringers and alignment of stringers to be checked properly in the trial erection.
- Application of paint on permanent contact surface should be ensured after proper surface preparation visual inspection is very important tool.
- The plates should be perfectly horizontal while drilling the holes to ensure horizontal verticality of holes.
- Steel with proper test certificate/ reports should be used. Commercially available steel in the market should not be used.
- Steel received from the rolling mills has generally punch heat mark numbers. These numbers should be legibly marked again with paint for easy identification. Heat mark numbers should be transferred to cut members with paints.
  
- Members of the open web girders should be fabricated on the camber length with the adoption of the field holes of nominal length.
- Consistency of weld quality is higher in Submerged Arc Welding Process and chances of human errors are also eliminated. Therefore, welding of the girders should be done by SAW process. Whenever not possible then only CO2 welding or MMAW may be adopted if provided in app. WPSS.
- Stage inspection during fabrication should be properly ensured to avoid rejection at later stage.
- Skilled and qualified welders, drillers, fitter should be deployed for welding drilling and marking works. The welder should be individually approved by authorized agency i.e. M&C Directorate of RDSO.

➤ Selection of Angles in fabrication of cross girders and stringers of open web girders requires special attention, drooping in angles either acute or obtuse should not be permitted. It will cause improper sitting of sleepers on the stringers.

**DON'T's-**

➤ Use of pitted/corroded material should not be done because it gives rise to concentration of stresses and results in poor fatigue strength.

➤ Tack welds in fabrication of riveted open web girders should be avoided.

➤ Do not hammer the distorted joints for rectification. It may lead to the development of cracks and failure of the joints.

➤ Do not do the welding in chilled weather, as due to sudden cooling of welded joints they are liable to be brittle and develop cracks. The joints may also suddenly fail under dynamic loading without any prior warning.

➤ Do not weld with un-controlled welding parameters, these will affect the quality of welding and make the joints weak and may yield in dynamic loading on the structure.

➤ Do not weld the joint haphazardly without following the proper welding sequence. This will lead to uncontrolled and irreparable distortion, of the proper geometry of the joint.

➤ Sharp notches in the member should be avoided.

## **ADDITIONAL SPECIAL CONDITIONS FOR SAFETY, LAUNCHING AND DELAUNCHING**

### **SAFETY RULES**

1. Suitable scaffolds should be provided for workmen for all works that cannot safely be done from the ground or from solid construction except for such short period work as can be done safely from ladders. When a ladder is used an extra labour shall be engaged for holding the ladder and if the ladder is used for carrying materials as well, suitable foot holds and hand-holds shall be provided on the ladder and the ladder shall be given an inclination not steeper than 1/4 to 1 (1/4 horizontal to one vertical).
2. Scaffolding or staging more than 3.5 meters above the ground or floor, swung or suspended from an overhead support or erected with stationary support shall have a guard rail properly attached bolted, braced and otherwise secured at least 1 meter high above the floor or platform or staging and extending along the entire length thereof with only such opening as may be necessary for the delivery of materials. Such scaffolding or staging shall be so fastened as to prevent it from swaying from the building or structure.
3. Working platform gangways and stairways should be so constructed that they should not sag unduly or unequally, and where the height of the platform or the gangway or the stairway is more than 3.5 meters above ground level or floor level, they should be closely boarded, should have adequate width and should be suitably fastened as described in the para above.
4. Safe means of access shall be provided to all working platform and other working places. Every ladder shall be securely fixed. No portable single ladder shall be over 10 metres in length while the width between side rails in swung ladder shall in no case be less than 300 mm for ladders up to and including 3.5 metres in length. For longer ladders this width should be increased by at least 20 mm for each additional metre of length. Uniform steps spacing shall not exceed 300 mm. Adequate precautions shall be taken to prevent danger from electrical equipment. No materials on any of the sites of work shall be so stacked or placed as to cause danger or inconvenience to any persons or the public. The contractor shall provide all necessary fencing and lights to protect the public from accident and shall be bound to bear the expenses of the defense of every suit, action or other proceeding at law that may be brought by any person for injury sustained owing to neglect of the above precautions and to pay any damages and cost which may be awarded in any suits, action or proceedings to any such persons or which may with the consent of the contractor be paid to compromise any claim by any such persons.
5. **Demolition:** Before any demolition is commenced and also during the process of the work:
  - a) All roads and open areas adjacent to the work site shall either be closed or suitably protected;
  - b) No electric cable or apparatus which is liable to be a source of danger over a cable or apparatus used by the operator shall remain electrically charged;
  - c) All practical steps shall be taken to prevent danger to persons employed from risk of fire or explosion or flooding;
  - d) No floor, roof or other part of the building shall be so overloaded with debris or materials as to render it unsafe.
6. All necessary personal safety equipment as considered adequate by the Engineer should be kept available for the use of the persons employed on the site and maintained in a condition suitable for immediate use, and the Contractor should take adequate steps to ensure proper use of equipment by those concerned.

#### **In addition,**

- a) Workers employed on mixing asphaltic materials, cement and lime mortar shall be

provided with protective goggle.

- b) Workers engaged in white-washing and mixing or stacking of cement bags or any materials which is injurious to the eyes shall be provided with protective goggles;
- c) Workers engaged in welding works shall be provided with protective goggles;
- d) Stone breakers shall be provided with protective goggles and protective clothing and seated at sufficiently safe intervals.

**Additional condition for safety at work site:-**

- (i) The contractor shall not start any work without the presence of railway supervisor or his representative and contractors supervisor at site.
- (ii) The Engineer in-charge shall approve the methodology proposed to be adopted by the contractor, with a view to ensure safety of trains, passengers and workers and he shall also ensure that the methods and arrangements are actually available at site before start of the work and the contractor's supervisors and the workers have clearly understood the safety aspects and requirements to be adopted/followed while executing the work.

There shall be an assurance register kept at each site. Which will have to be signed by both, i.e. Railway/ BBJ Supervisor or his representative as well as the contractor's supervisor as a token of their having assurance for safety.

**Safety at work site**

1.1 Before permitting the execution of certain works like earth work, supply of ballast for new or existing rail line, gauge conversation or laying of concrete sleepers and rails etc. where it is necessary to used road vehicle/machinery, Open lines Engineering – incharge (ADEN(Br) /Sr.DEN(Br) of Railway of the section shall ensure that he receives the prior intimation/Confirmation of the following aspects from Assistant Engineer/Assistant Officer in charge of the work of the executing agency i.e. construction, electrification, S&Tetc.

- 1.1.1 Name & address of the contractor assigned to execute the work.
- 1.1.2 Contractor's list of the number(s) of individual vehicle(s) names and license particulars of the driver(s) proposed to be used.
- 1.1.3 Information regarding location, during & timings during which the vehicles are planned to be applied.
- 1.1.4 Training to supervisor/staff of contractor. Competency certificate to be issued by Assistant Engineer in charge of site.
- 1.1.5 Survey of site by supervisor of contractor & BBJ / Railway's supervisor to assess the precautions to be taken at site for working of trains and material required for protection.
- 1.1.6 Draw and advice to BBJ / Sectional Railways ADEN/SSE (Bridge) about the detailed planning of work including protection of track and safety measures proposed to be adopted.

- 1.2 Information as indicated in item 1.1.2 to 1.1.6 shall be obtained from contractor prior to the start of the work if the work is directly supervised by open line.
  - 1.3 BBJ and Railway should know the names of supervisors of construction organization/other organizations who are going to be in charge/ incharge of worksite.
  - 1.4 Before the start of work, the land strip adjacent to running track where road vehicle/machinery is to ply for the work shall be demarcated by line in advance at the appropriate distance from the center of existing track in consultation with railway supervisor.
  - 1.5 Barricading as per the given design shall be provided in full length at work area along the track at specified distances.
  - 1.6 The work site shall be suitably demarcated to keep public and passengers away from work area. Necessary signage boards such as 'Work in progress' etc shall be provided an appropriate locations to warn the public/passengers.
  - 1.7 Contractor should ensure that all the requisite measures have been taken before start of the work.
- 2.00 Measures to be ensured during the execution of the work
- 2.0** Contractor has to depute trained supervisors at work sites duly certified by ADEN/ In charge of the work.
  - 2.1** Drivers of vehicle have been briefed about the safety and precautions to be taken which moving/working close to traffic.
  - 2.2** The contractor shall not allow any road vehicle belonging to him or his suppliers etc. ply within 6 meters of center of running line without presence of Railway supervisor.
  - 2.3** Contractor shall ply road vehicles Only between Sunrise and Sunset. In case of emergency where it is necessary to work during night hours, sufficient lighting shall be ensure in the complete work area for the safety of public and passengers. Also additional staff shall be posted as necessary for night working.
  - 2.4** Wherever provided the engineering indicator boards shall be lit during night hours as per the provisions of P. Way manual.
  - 2.5** Contractor shall ensure that road vehicle/machinery ply in a way so that these do not infringe the line of demarcation.

**2.6** Look Out man shall be posted where necessary.

**2.7** In unusual circumstances, where operator apprehends infringement to track while working truck/machinery near running track, following action shall be taken.

a) The contractor/supervisor/vehicle operator immediately advises the situation to railway official and assists him in protecting the track.

b) Protection shall be done as done for other emergencies.

**2.8** Individual vehicle/machinery shall not be left unattended at site of work. If it is unavoidable and becomes necessary to stable the road vehicle/ machinery at plant near running track, these shall be properly secured against any possible roll-off and always be manned even during non-working hours.

**2.9** All temporary/ arrangement required to be made during execution of work shall be made in such a manner that moving dimension do not infringe. Necessary checks shall be exercised by site in charge from time to time.

**2.10** In case, work has been planned to be done within 6 M of center of track but at more than 3.5 M it shall be ensured that.

**2.11** Necessary precautions for protection of track have been taken and caution order issued to trains.

**2.12** Look out man has been posted along the track at a distance of 800 M from the location of work with red flag and whistle to warn the road vehicles regarding approaching trains.

**2.13** In case, work is planned to be done within 3.5M of centre line of running track, it shall be ensured that the work is done under block protection only and necessary safety precautions for protection as per Para No.810 and 819 of IRPWM are taken.

**2.14** While digging in station area, if any cable is found, digging should be stopped and concerned signaling/electrical staff should be informed immediately.

**2.15** Mobile phones or walkie Talkie sets where necessary should be provided at works sites.

**2.16** While inspecting the work site standard check list shall be used to ensure that all the requisite measures have been taken during the execution of the work.



3.0 Precaution required to be taken during execution of work requiring traffic blocks.

**3.0** Any work, when infringes the moving dimensions, shall be started only after the traffic block has been imposed and track protected

**3.1** At locations where night working is unavoidable, proper lighting arrangement should be made.

**3.2** Before closing the work the track shall be left with the proper track geometry so that the trains run safety.

**3.3** After completion of work, the released sleepers and fittings should be properly stacked from the track to be kept clear of moving dimensions.

**3.4** Block shall be removed only when all the temporary arrangement machineries, tools, plant etc have been kept clear of moving dimensions.

#### **4.0 Stacking of material along railway track**

**4.0** The sites for material stacking shall be selected in advance ensuring that no part of the stacked material would infringe the standard Moving dimensions. A plan of proposed stacking locations be made and signed jointly by an authorized Railway's representative and contractor's representative.

**4.1** The selected location shall be marked by lime in advance.

**4.2** Presence of an authorized railways representative unloading and stacking shall be ensured.

**4.3** The material shall be stacked such a height, which will not cause infringement to SOD in case of accidental roll off.

**5.0** Safety aspects to be observed while working in OHE area.

**5.1** No electrical work close to running track shall be carried out without permission of railway representative.

**5.2** A minimum distance of 2m has to be maintained between live OHE wire and body part of worker or tool of metallic support etc.

**5.3** No electric connection etc. can be tapped from OHE

- 5.4** Authorized OHE staff should invariably be present when the relaying work or any major work is carried out,
- 5.5** Power block is correctly taken and 'Permit to work' is issued.
- 5.6** The structure bonds, track bonds cross bonds, longitudinal rail bonds are not disturbed and if disconnected for the work they are reconnected properly when the work is completed.
- 5.7** The track level is not raised beyond the permissible limit during the work.

Note: For items of barricading, Sign Board like "work in progress" walkie - Talkie sets, mobile phones, look out man etc, suitable provision may be incorporated in the tender conditions as per site requirement.

For "Safe working of contractors "Para 819 of IRPWM June 2020 shall be applicable

A large number of men and machinery are deployed by the contractors for track renewals, gauge conversions, doublings, bridge regirdering, rebuilding etc. It is therefore essential that adequate safety measures be taken for safety of the trains as well as the work force. The following measures should invariably be adopted:-

- (i) The contractor shall not start any work without the presence of BBJ / Railway supervisor at site.
- (ii) Wherever the road vehicle and/or machinery are required to work in the close vicinity of railway line, the work shall be so carried out that there no infringement to the Railway's schedule of dimensions. For this purpose, the area where road vehicles and or/ machinery are required to ply shall be demarcated and acknowledged by the contractor. Special care shall be taken for turning/ reversal of road vehicles/ machinery without infringing the running track. Barricading shall be provided wherever justified and feasible as per site condition.
- (iii) The look out and whistle caution orders shall be issued to the trains and speed restrictions imposed where considered necessary. Suitable flag men/detonators shall be provided where necessary for protection of trains.
- (iv) The supervisors/ workmen should be counseled about safety measures. A competency certificate to the contractor's supervisor as Performa annexed shall be issued by BBJ / Railway, which will be valid only for the work for which it has been issued.
- (v) The unloaded ballast/ rails/ sleepers/other P.way materials after unloading along the track should be kept clear off moving dimension and stacked as per the specified heights and distance from the running track.  
Supplementary site specific instruction, wherever considered necessary shall be issued by the Engineer in Charge of BBJ / Railway.

**6.0 General methodology required to be adopted for re-girdering of TOW Girder:**

**The tenderer(s) are supposed to develop & submit the complete details of scheme/work programme of their own and same shall be got approved by the BBJ and Railway.** The scheme should be developed from the following guidelines.

6.1 The Assembling, Erection, Cambering, drifting, HSFG bolting etc. shall be done outside the railway track.

6.2 After assembling, the girders are to be launched by side slewing method or any other method (approved by BBJ and Railway) after de-launching of existing old span outside the track in the same traffic block.

**Necessary scheme for launching and de-launching along with all temporary staging arrangements required for this work to be got approved from railway and reliability of all equipment, tools & plants to be ensured in field by BBJ / Railway representative.**

6.3 All safety measures for track protection, protection of OHE and other equipments / cables of S&T/ Power department should also be ensured during pre block/ main block activities. Girders after de- launching to be removed from river bed to clear water way before monsoon.

6.4 BBJ / Railway may arrange CC Cribs up to 200 nos, released wooden sleepers and second hand rails if available with railway (as per approved scheme of work) and the same is to be carted at contractors own cost from the place where the said material is available. The material shall be returned to the railway after completion of the work in good condition to the place from where picked up or as directed by BBJ / Railways representative.

7.0 Precaution to be observed during erection / assembly / launching of girders.

The work will have to be carried out in such manner so as to cause least obstruction to Railway traffic and also without jeopardizing the safety of moving trains. The successful tenderer shall also take all necessary precaution to ensure the safety of his workman / machinery at the site of construction. The BBJ / Railway will not be liable for any payment of compensation due to any mishap to the workman or machinery during the course of work. The work shall be planned in such a way so as not to cause any infringement to the moving dimensions laid down in the "Standard schedule of dimensions for broad gauge of Indian Railways" currently in force.

7.1 If there are some changes/ modifications in design, drawing as per site condition to complete the work successfully and contractor has to do the same under accepted rates and no extra claim of rates will be entertained on this account.

7.2 No work shall be allowed at work site without presence of BBJ / Railway representative.

7.3 The contractor shall maintain sufficient accuracy in the assembling and erection of every part of the work to ensure that all parts fit accurately together on erection.

7.4 The contractor shall maintain a master steel tape of approved make for which he has to obtain a certificate of accuracy from the Normal Test House calibrated under a tension of 1.8 Kg at 16.70 degree centigrade.

## **8.0 SPECIAL CONDITIONS FOR LAUNCHING OF GIRDERS;-**

8.1 Straightening and repairing minor damage of girder parts in transit and handling including petty repairs to fabricated materials.

8.2 All the permanent field connections for all the girders or some of the girders as per BBJ / Railways requirements and approved drawing & design to be done by riveting or by HSFG bolts of suitable size and necessary arrangements for using HSFG bolts of approved brand to be done by contractor.

8.3 The rates of this item also includes supplying and fixing of HSFG bolts of required size and barrel length along with nuts and DTI/ Plain washers as per detailed scope of work required for assembling of girders at site.

8.4 Preparation of ground / bed, providing & erecting temporary crib/trestle supports, platform and staging for assembling of new girders.

8.5 Use of Railway land required by the contractor(s) for assembling of girder etc. will be permitted to him/them free by BBJ /Railway, if available. The contractor will have to make his own arrangement for use of private land, outside Railway limit for due fulfillment of contract, directly with the land owners or local authority and to pay such rents if any as mutually agreed upon between them.

**8.6 The contractor shall submit his detailed launching scheme for assembling erecting and launching of girder within the guidelines given in scope and details of work and get it approved from BBJ and Railway.**

Railway will get sanction of Chief Bridge Engineer-ECOR/BBS as per extent rules. The work shall be done in conformity with the approved drawings. The rate shall include all temporary arrangements like preparation of river bed for assembly and erection/launching, staging, trestles, all T&P and machineries/cranes, labour, consumables etc. complete required for assembly and launching of girders, lowering and fixing properly on the bearings, including grouting of holes of anchor bolts with epoxy material and other works required for successful completion of erection and launching as per scheme approved by Railway. The rates include supply of HD bolts, drilling of abutment / pier and fixing of bolts.

**The entire work of launching and delaunching is to be done in same traffic and power block. Full Traffic and power block will be arranged on contractor's request and will be granted as convenience by BBJ / Railway.** Any defects noticed during the execution of the work shall be rectified or replaced by the contractor at his own cost till the satisfaction of the engineer in charge. The decision of the Railway or its inspection agency as to the existence of the defect manner in which the defective work has to be rectified or replaced shall be final and conclusive.

8.7 The BBJ / Railway reserves the right to reject the whole or part of the work executed which in the judgment of the BBJ / Railway, does not comply with the requirements of the specifications. The decision of the BBJ / Railway shall be final and conclusive for all purposes. The contractor shall make his own arrangements to procure all the equipment required for successful launching of girders like cranes, gantry, derricks, winches, tackles, pulleys, jacks, wire ropes, generators, compressors, tools and plant and machinery etc.

***Contractor should read carefully the above special conditions before quoting the rates.***

## SPECIAL CONDITIONS OF CONTRACT (TECHNICAL FOR 'H' beam SLEEPERS, PART-I)

1) The work covered in this tender is for Supply & fixing of new galvanised 'H' beam/Channel sleepers with all fittings and fixtures on specified Bridge.

2) The 'H' beam/Channel sleeper fittings shall conform to RDSO drawing no. RDSO/B-1636/4. (The mentioned drawing is tentative. Latest updated drawing of RDSO to be followed while execution of work)

3) Fabrication and Workmanship :-Fabrication, workmanship shall generally comply with current IRS specification with latest correction/ amendments thereof unless otherwise specified in special condition of this contract or as specially directed by the BBJ/ Railway Engineer in writing.

The Contractor shall submit test certificates conforming to appropriate standards of all steel material used for fabrications. All structural steel shall be free from rust, scales, laminations, cracks, fissure and other surface defects.

The workmanship and finish shall be equal to the best general practice in modern structural shops. The greatest accuracy shall be observed in the manufactures of every part of the work all similar shall be strictly inter-changeable.

### **NOTE :**

Only weldable steel conforming to IS: 2062/1992 Grade-B shall be used for 'H' beams/Channel sleepers. Steel for 'H' beams/Channel sleepers shall be procured only from those firms, which are established, reliable, indigenous and primary producers of steel having integrated steel plants (ISP) using iron ore as basic raw material and having in house iron rolling facilities, following by production of liquid steel and crude steel as per Ministry of steel guide lines e.g SAIL/TISCO/JINDAL/RINL etc. (As approved by the BBJ/ Railway Engineer in Charge).

However only certain isolated section of structural steel, not being rolled by ISPs, can be procured from authorized re-roller of ISP or authorized licensee of BIS having traceability system and who use billets produced by ISPs.

Record of establishing traceability of raw material to finished product shall be submitted to the BBJ/ Railway.

Before manufacturing channel section, concerned SSE(Bridge)/SSE(P.Way) or authorized B B J / Railway representative will inspect the lot of raw material/billets and give the clearance for manufacturing the channel section.

Purchase documents for procurement of raw material from SAIL/TISCO/JINDAL/RINL etc. shall be submitted to the BBJ / Railway and subject to fulfillment of specification of steel items of contract condition.

Following specifications shall be followed :-

- a) Indian Railway Steel Bridge Code as corrected up to date.
- b) Indian Railway welded Bridge Code 1972.
- c) Indian Railway Schedule of dimension for Broad Gauge-1939 (Reprinted in Metric units in 1973).
- d) IS:2062-1992-Gr-A, Specification for structural Steel standard quality.
- e) Indian Railway Specification B-1, 1979: Fabrication and erection of Steel Girder Bridges.
- f) IRS H-5 for rivets.
- g) IS:2155-1962 : Rivets for General purposes (Below 12mm diameter).
- h) IRS H-19, for bolts and nuts.
- i) IS: 102-1962, Ready Mixed Paint, Brushing Red Lead, Non setting priming.
- j) IS:2339-1963 : Aluminium paint for General purposes in dual container.
- k) IS: 123-1963 : Ready mixed paints, brushing, finishing Semi-gloss for General purposes to Indian Standard Colours Red Oxide.
- l) B.S.S.916 and/or IS:1963-1967 : Black Hexagonal Bolts/Nuts etc. black Hexagonal Bolts/Nuts and lock Nuts (6 to 39mm) and black Hexagonal Screws (dia 6 to 24mm).
- m) IS:800-1984.
- n) IS:1148-1973 : Hot Rolled Steel Rivet Bars for structural purposes.
- o) IS:2062-1992 : Steel grade-'B' for welded structures. The tenderer shall maintain a master steel tape of approved make for which he has obtained a certificate of accuracy from the National Laboratory.

Rolled materials before being laid off or worked, must be made straight if strengthening or flattening is necessary, it shall be done by method that will not damage the material. Sharp kinks and bends shall be rejected.

## **HOLING :**

Holes for rivets and bolts shall be drilled to conform to Clause 10 of IS:7215. All holes, except as stated here under shall be drilled to the required size or sub-punched 2mm. Less in diameters and reamed thereafter to the required size. Thickness of the materials for sub-punching shall not be greater than 16mm. All matching holes, for rivets or bolts shall register with each other so that a gauge of 0.8mm less in diameter than the holes can pass freely through the members assembled for levelling or bolting in the direction at right angle to such members.

All holes for turned and fitted bolts shall be drilled under sized by 1mm and after assembly reamed to a tolerance of +0.13mm-0mm unless otherwise specified. When the number of members to be rivetted in assembly exceeds three or the total thickness is 90mm or more the holes shall be drilled or reamed in position after assembly except when seal bushed jigs are used. The parts shall be firmly bolted together during such block drilling and taken apart from removal of burrs after drilling. Holes in purlin, side sheeting runners, packing plates and lacing bars may be punched full size, provided the thickness of the materials does not exceed 13mm. All punching and sub-punching shall be cleared and accurate and all drilling shall be free from burns. No holes shall be made by Gas Cutting process.

## **BOLTING :**

All turned and fitted bolts shall be carefully turned and shall be parallel throughout the barrel. The following limits of tolerance shall be permitted upon the diameter of the barrels of turned bolts and holes which they are to fit.

	<b><u>Barrel of bolts holes</u></b>
<b>Limit of Tolerance</b>	Max- 0.00mm+0.13mm
	Min- 0.13mm-0.00mm

The barrels of each turned bolts shall be of such a length so that it is in full contact with the work throughout the screwed portion, being made at least 1.6mm. Less in diameter than the barrel or to suit the next smaller size of metric screw thread. The barrel portion shall be jointed to the thread portion by a degree chamfer within the thickness of washer, unless otherwise specified. Faces of heads and nuts bearing on steel work shall be machined. All such bolts shall be provided with washers having a hole of 1.5mm larger in diameter than the barrel and thickness of not less than 6mm so that the nut, when tightened, shall not bear on the unthreaded body of the bolt. In all cases where the full bearing area of the bolt is to be enveloped, the threaded portion of the bolt shall not be within the thickness so the parts bolted together. The threaded portion of each bolt shall project through the nut by the least one thread. Tapered washers shall be provided for all heads and nuts bearing on beveled surface.

## **4. WELDING :**

**General :** The welding and welded work shall generally conform to IRS bridge code and subject to further specifications given in the following paragraphs.

Manual metal arc welding may be done only by welder possessing competency certificate or where access of the locations of welds do not permit automatic welding. All the welding to be done by submerged arc welding process either full automatic or semi automatic. The welding should be done by submerged welding process either fully automatic or semi automatic where specified by the Railway.

Except for special types of edge preparation such as single and double 'U' Single and double 'J' the fusion edges of all the parts which are to be joined by welding may be prepared by using mechanically controlled automatic flame cutting equipment and to be ground to a smooth finish special edge preparation should be made by machinery or gauging.

All welding work shall be done in shops and the layout and sequence of operation shall be so arranged as to eliminate distortion and shrinkage stress.

**ELECTRODES :** All Electrodes shall be kept under dry conditions. Any electrode with parts of its flux coating broken away or otherwise damaged shall be rejected.

Any electrode older than six months from the date of manufacture or older than the date of expiry as specified by manufacturer should not be used.

Welding Electrodes to be used in the work should conform to RDSO approved firm & quality only.

The Electrodes to be used shall conform to class A2 of IRSM-28 and wire for CO2 welding shall conform to class I of IRSM-46.

The Electrodes to be used in the work shall be of approved type & manufacture approved by RDSO.

**PREPARATION OF JOINTS :** The edge shall be prepared with an automatically controlled flame cutting torch correctly to the size and dimension of the groove prescribed in the design and shop drawing. In case of 'U' of grooved joints the edges shall be prepared with an automatic flame torch in two phases following and bevel out with grinding pass or by machining.

The welding surfaces shall be smooth, uniform and free from fine tears notches or any other defects which may adversely effect welding and shall be free of loose scale, slag rust, grease, paint, moisture or any other foreign material.

**WELDING PROCEDURES :** The welding procedure shall be arranged by the contractor to suit the details of the joints as indicated on the drawing and the position at which welding has to be carried out. Working procedure shall cover the following :-

- a) Type and size of Electrodes.
- b) Current and for automatic welding are Voltage.
- c) Length of run for Electrode, or for automatic welding speed of travel.
- d) Number and arrangement of runs in multi run welding.
- e) Position and set up of parts.
- f) Preparation and set up of parts.
- g) Welding sequence.
- h) Pre or post heating.
- i) Any other relevant information.

The welding procedure shall be so arranged that the distortion and shrinkage stress are reduced to a minimum and the welds meet requirement and quality specified, hereunder.

Any weld found defective shall be cut by using either chipping hammer or gouging torch in such a manner that adjacent material is not injured in any way.

Planning of the welds involving deformation of the surface wither during de-slugging operation or thereafter shall not be allowed.

Fusion faces and surrounding surface within 50mm welds of welds shall be free from all mill scale and free from oil paint or any substances which might effect the quality of the welds and impede the quality/progress of welding. They shall be free from irregularity which interfere with the deposition of specified size of weld or be the cause of defects.

All mill scale within 50mm., of welds shall be removed on welding either by picking followed by through power weld brushing or by other approved methods. If preparation or cutting of the fusion faces is necessary the same shall be carried out by shearing, chipping, gas cutting or flame gouging. Where no gas cutter or hand gouging is employed the below pipe or gouging blow pipe shall be properly guided.

**ASSEMBLY FOR WELDING :** Before taking of mass production of any type of sleeper the production of 20 sleepers shall be taken up and the dimensions thereafter shall be checked by means of a test track 13 Mtrs. long assembled at the Railway. The rails for linking of the steel track shall be made available free of charge by Railway at a point convenient to the Railways. Transport of the Rails and sleepers from this point to the contractor's workshop and returning the same to the point of collection shall be done by the contractor at his own cost. The parts to be welded shall be properly assembled and held firmly in position by means of jigs and fixtures prior to and during welding. Automatic sub-merged arc welding shall be employed for fabrication of welds 'H' beam/Channel sleepers wherever specified.

**ACCURACY OF FIT UP :** Parts to be fillet welded shall be brought into as close contract as practicable and the gap due to faulty workmanship or incorrect fit up shall not exceed 1.5mm. If greater separation occurs at any position the size of fillet weld shall be increased at such position by the amount of gap.

**JIGS & MANIPULATORS :** Jigs and manipulators shall be used where practicable and shall be designed to facilitate welding and to ensure that all welds are easily accessible to the operators.

#### **MINIMUM LEG LENGTH AND THROAT THICKNESS IN FILLET WELDS**

The minimum leg length of a fillet weld as deposited, shall not be less than the specified size. In no case shall a concave weld be deposited unless specifically permitted. Where permitted, leg length shall be increased above that specified, so that the resultant throat thickness remains the same as would have been by the deposition of a flat facased weld of the specified leg length.

**DE-SLAGGING :** After making each run of welding all slag shall be thoroughly removed and the surface cleaned.

**QUALITY OF WELDING :** The weld metal as deposited, including track weld is to be incorporated, shall be free from cracks, slag inclusion, porosity, cavities, and other de-position faults. The weld steel shall be properly fused with the present steel metal without undercutting or over lapping at the toes of the weld. The surface of the weld shall have a uniform consistent contour and regular appearance.

**WEATHER CONDITIONS** : Welding shall not be done under open weather conditions which might adversely effect the efficiency of the welding. It should be done only under a covered shed in a workshop.

**QUALIFICATION AND TESTING OF WELDERS** : The contractor shall satisfy the Engineer that the welders are suitable for the work for which they will be employed and shall produce evidence to the effect that welders have satisfactorily completed appropriate tests as prescribed in T.S.-877. The Engineer may at his own discretion order periodic tests of the welder and/or of the welder produced by them. Such tests shall be at the expense of the contractor.

**SUPERVISOR** : The Contractor shall employ a competent welding supervisor to ensure that the standard of workmanship and the quality of materials comply with the requirements laid down in the specifications.

**5) ERECTION MARKING** : Each fabricated member whether assembled prior to dispatch or not so assembled shall bear an erection mark which will help to identify the member and its position in respect of the whole structure to facilitate re-erection at site.

These erection marks shall be suitably incorporated in the shop detail and are action drawings.

## **6) CONTROL IN THE FABRICATION AND ASSEMBLY OF VARIOUS STRUCTURE :-**

**Criteria for Testing** : The contractor shall conduct test in accordance with following norms.

- a) Visual examination 100% (One hundred percent).
- b) Mechanical Test.
- c) Dye Penetrate Examination.

### **TESTS :**

**a) Visual Examination** : The contractor shall conduct the visual examination and measurement of the external dissension of the weld for all joints. Before examining the welded joints surface area close to it on both side of the weld for a width not less than 20mm, shall be cleaned of slag and other impurities. Examination shall be done by a magnifying glass which has a magnification power of 10 and measuring instrument which has an accuracy of +0.1 mm or by weld gauges. Welded joints shall be examined from both sides.

The contractor shall examine the following during the visual checks.

- a) Correctness and shape of the welded joint.
- b) Incomplete penetration of weld metal.
- c) Influx.
- d) Burns.
- e) Un-welded craters.
- f) Under cuts.
- g) Cracks in welded parts and heat effected zones.
- h) Porosity in welds and spot welds.
- i) Compression in welded joints and a result of electrode while carrying out contact welding.
- j) Displacement of welded elements.

The contractor shall document all data as per sound Laboratory practices.

**b) Mechanical Test** : The Contractor shall carryout various mechanical tests to determine weldability, the metal alloyability, nature of break, correct size and type of electrodes, degree of pre-heat and post-heat treatment etc. The type, scope and sample of various mechanical tests shall be determined in agreement with the Engineer. The number of tests conducted shall depend on the results obtained to satisfy the Engineer that the correct type and size of electrode, degree of pre-heating and post-heating and weldability of different metal are being followed.

**c) Dye Penetrate Examination** : All welds as desired by Engineer will be examined by dye penetrates for detection of discontinuities as per IS:3658-81, IS:12889-89 and RDSO's Specification No. MRC/NDT/4/91/APPD.

**7) Inspection and testing of fabrication** : The Engineer shall have free Access at all reasonable times to the Contractor's works where the fabrication of steel work is carried out and shall be afforded be all reasonable facilities by the Contractor for satisfying himself that the fabrication is being under taken in accordance with the provisions of the drawings and specifications.

The Contractor shall continuously inform the Engineer of the progress in fabrication as and when the individual pieces get ready for inspection. The Contractor shall give a minimum of three working days notice to the Engineer for inspection of the individual pieces.

Unless directed other-wise, inspection shall be made at the place of manufacture prior to dispatch by an authorized representative of BBJ / Railway. Should any structure found not to comply with any of the provisions of this specification it shall be liable for rejection. No structure or part of the structure, once rejected shall be re-submitted for inspection/test, except in cases where the Engineer considers the defect as rectifiable.



Defects which may appear during fabrication shall be made good with the consent of an according to the procedure laid down by the Engineer. All gauges and templates necessary to satisfy the Engineer shall be supplied by the Contractor. The Engineer, may at his discretion, check the test results obtained at the Contractors works by independent tests at this Government Test House or elsewhere and should the material so tested be found to be unsatisfactory the costs of such tests shall be borne by the Contractor.

**8) Marking, Packing and despatching :** Each piece shall be distinctly marked before delivery in accordance with the approved marking diagram and shall bear such other marks as will facilitate erection. For easy identification at site a small distinguishing mark shall be painted on each and every number before dispatch from fabrication shop. The fabricated steel work shall be dispatched by the Contractor in such portions as may be found convenient for erection or as ordered by the Engineer to meet the time schedule.

All projecting plates or bars and all ends of numbers at joint shall be stiffened, all straint bars and plates shall be bundled, all screwed ends and machined surfaces shall be suitable packed and all rivets bolts, nuts, washers and small loose parts shall be packed separately in boxes so as to prevent damage or distortion during transit.

**9) Template :** Templates need throughout the work shall be of steel packed in such cases as the inspecting officer may consider necessary.

**10) Supervision of work :** During the entire progress of the work the contractor shall have a competent supervisor in personal charge of the work. All works shall be done by skilled competent workmen.

**11) Fixing of 'H' beam/Channel Sleepers at site :**The 'H' beam/Channel Sleepers shall be provided on the nominated bridges by the contractor.

**Working in the vicinity of Railway Track :** All works, which may affect the safety of Railway working, shall only be done under traffic block and written authority and also under the direct supervision the Engineer-in-charge at site of his authorized representative for the said bridge. The Contractor shall in consultation with the BBJ / Railway Engineer decide the sequence of work required to be done for efficient provision of 'H' beam sleepers.

The gauge, level , alignment of the track shall be adjusted by the Contractor suitably as per satisfaction of the Engineer, and as per tolerances laid down in Indian Railway Permanent Way Manual for New Track.

12. The fabricator's name & Drg. No. should be indicated on all 'H' beam/Channel Sleepers suitably on a plaque fixed on the web of the 'H' beam/Channel sleeper at one end.

13) Galvanised 'H' beam/Channel Sleepers are to be supplied and fixed to the girders on nominated bridges in Khurda Road division. The existing track on the bridge is to be dismantled including guard rails running rails and bridge timbers. The track is to be re-linked over the 'H' beam sleepers with the same running and guard rails by the fittings and fixtures supplied by the Contractor.

14) Works has to be executed in the running traffic condition or under the traffic blocks. This will be made available as per the convenience of the BBJ / Railway depending on the position of the trains. Block and caution orders will be taken and cancelled by the authorized BBJ / Railway officials only. Released U/S small fittings, steel channel sleeper/Bridge timbers and worn out rails (if any) etc will have to be transported by the contractor to the nearest stoe depot of Railways PWI/BRI at his own expenditure.

15) Dip-lorries for the transportation of the materials will be supplied by the BBJ / Railway as per the convenience on realization of admissible hire charges.

16) Carrying of materials and protection of Dip lorries by trained staff will have to be done by contractor ensuring safe running of traffic under the supervision of Railway representative.

17) Contractor has to arrange for adequate number of skilled workers and competent supervisors for the execution of this work, their safety during dismantling, transporting and linking of the track over the girders will be the sole responsibility of the contractor.

18) Serviceable materials released from dismantling of the track should be properly accounted and kept in the custody of contractor for re-use. Unserviceable materials will be made good by the BBJ / Railway ( For rails, F/bolts Fish plates etc.).

19) Materials supplied free by the BBJ / Railway to the contractor will not form part of the value of the contract entered into and will fall outside the purview of the price variation clause.

20) All the mild steel fittings and fixtures have to be galvanised at the contractors cost before use.

**The above conditions are read/understand and accepted by me/us with the rates offered by me/us as above.**

## SPECIAL CONDITION OF CONTRACT FOR 'H' beam SLEEPERS-(PART-II)

1)(a) The rate of H-Beam sleepers of Sch-A is inclusive of trial assembling and fixing minimum 10 sleeper (selected at random) on a nominated bridge. The large scale manufacturing is to be taken up only when satisfactory performance will be obtained on trial.

(b) The supply of 'H' beam sleeper shall be accompanied by excise gate pass issued by Excise Authority.

2) **Payment schedule** : Galvanized 'H' beam/Channel sleepers and its complete fittings and fixtures.

a) On arrival of galvanized 'H' beam/Channel sleepers with all matching fittings for the numbers of sleepers received at Bridge works site (duly passed by inspecting officials and supported by relevant test/inspection certificate) - **80%**.

b) Fixing of 'H' beam/Channel sleepers on the girder after taking out the existing bridge timbers or steel channel sleepers and painting the sleeper set by one coat of ready mixed paint zinc chromate priming to IS:104 which will be supplied by the contractor and completion of linking of running and guard rails over the 'H' beam/Channel sleeper with all fittings and fixtures in correct gauge, level and alignment as per IRPWM and transportation and stacking of the released materials (small fittings, bridge timbers, worn out rails etc.) to the nearest stores depot of Railways PWI/BRI - **20%**.

3) Galvanising of Steel 'H' beam/Channel Sleepers with M.S. fittings shall be done by hot dip process of thickness 100+5 microns with Zinc conforming to IS:869-77 and IS:2628-85.

4) Fixing of all elastomeric pads must be done by Epoxy adhesives approved by BBJ / Rly's supplied by contractor at his cost.

5) For all the supplied items the contractor has to give one Indemnity Bond and has to keep the items in safe custody by deputing day and night Watchman up to the completion of the work. BBJ/ Railway will have no responsibility on this account for theft, damage, loss etc. Payment will be entertained accounting the materials fitted and fixed on the running lines.

6) Out of two holes for hook bolts on one side of sleeper will be made in the work shop along with the fabrication of the 'H' beam/Channel sleepers and the holes on the other side will be drilled on actual measurement at site to ensure correct alignment of track after final assembly on the bridge.

7) Painting of the galvanized surface advertantly damaged due to transportation, if any, welding and drilling holes at site will be done as advised below.

(Care should be taken during the transportation, loading unloading, etc. to ensure that no damage is done to the galvanising. However, galvanized surfaces inadvertently damaged, should be painted as detailed below).

a) Application of one coat of ready mixed paint zinc chromate priming to IS:104, followed by one coat of ready mixed paint red oxide zinc chrome priming paint to IS:2074 of minimum 20 microns dry film thickness (each coat) as priming coats on an approved surface.

b) Application of two coats of paint aluminium conforming to IS:2339 with minimum 15 microns dry film thickness (each coat) as covering coats as per the approval of the Engineer-in-charge.

### **8) INSPECTION :**

a) The finished 'H' beam/Channel sleepers which are inspected and passed for the work by the nominated BBJ and Railway Officials, should only be brought to the work site by the contractor. The inspection shall be in two stages :-

i) Before galvanizing (to check up the quality of fabrication as per Spl. Condition of Contract Part-II.)

ii) After galvanizing (to check up the quality of galvanizing as per Spl. Condition of Contract Part-II.)

b) Necessary dye penetration test should be conducted for all welding while passing the fabrication. Engineer in charge will issue necessary Inspection Certificate as a proof of passing the 'H' beams/Channel sleepers after his inspection. Materials including P.Way fittings will be utilized at site only after receipt of the inspection certificate by inspecting officials.

c) Materials shall be dispatched to site of work by the Contractor in full sets i.e., 'H' beam/ Channel sleepers with all matching components fittings complete. The matching components steel fittings/zero toe load fastenings will be supplied duly inspected and passed by RITES/RDSO as the case may be and rubber fittings shall be purchased only from RDSO approved vendors only and should be supplied duly inspected and passed by RITES/RDSO/Railways representative in sealed gunny bags. The contractor will have to arrange for BBJ/ RITES/RDSO/ Railway's representative inspection at their own cost and will be responsible for furnishing all test certificate during the dispatch of fittings.

9) The work after completion should be maintained for a period of 08 (eight) months. Any defect notice during this period will be rectified by the contractor at his own cost failing which the same will be rectified by the BBJ / Railway Administration and the cost will be recovered from the security deposit of the contractor. The security amount will be refunded after successful completion Of maintenance period including a monsoon and certified by BBJ / Railway Engineer-in-charge.

10) The tenderer should mention the place /workshop where they are intended to manufacture or galvanize the 'H' Beam / Channel sleeper and fittings.

**SPECIAL CONDITION APPLICABLE TO THE CONTRACT- (Metalizing)**

- 5.1 No break in the Rates permitted.
- 5.2 No compensation towards any accident what so ever will be paid by the BBJ/ Railway and the same be borne by the contractor.
- 5.3 The Contractor is advised to inspect the Bridge Site and the approaches, working conditions, water supply etc. and system of transport before quoting the rates.
- 5.4 Time is essence of the contract and the work has to be carried out and completed as per the accepted schedule. Before commencing work the contractor shall submit a time bound programme for execution of the work indicating there in clearly the operation to facilitate the BBJ / Railway's for arranging the necessary traffic blocks.
- 5.5 The Contractor shall ensure that no damage is caused to Rly's signaling and transistorize cables, communication lines electrical devices etc.
- 5.6 The materials to be supplied and used in the work shall be as per the ISI Standards and approved by the Engineer-in-charge at site.
- 5.7 I) The Contractors should place order on any approved reputed manufacturer for supply of paint to IS specification. The paint should be supplied by the manufactures in properly labeled sealed drums.
- II) Each batch of paint supply should be supported by ISI Certificate, Data sheets issued by the manufactures.
- III) Before undertaking the work on a particular bridge, the quantity of paint collected by the contractor at site and passed should be adequate for completion of at least one span, so that the work is not left half-way due to shortage of paint.
- IV) For chemical analysis of paint, random samples from a batch should be collected by the BBJ/ railway authority personally. The samples thus obtained should be labeled properly and sealed. One of the samples should be sent to a recognized testing Laboratory (i.e either of any reputed Govt. Engineering College/NIT/IIT/Govt. Testing Laboratory or CMT/KGP/S.E.Rly or NTH/Alipore/Kolkata) by BBJ/ railway authority and acknowledgement obtained. The test certificate issued by the laboratory should indicate the references of receipt slip, number etc. The other sample should be sent to the divisional office where the same will be reserved carefully.
- V) Paint to be used for the work shall be tested lot wise at contractor's own expenses. Only after the paint is tested O.K, the paint be allowed /used in this work.
- 1) Paint wash Primer.IS-5666-1970.
- 2) Ready mixed paint zinc chromate priming to IS:104,
- 3) Ready mixed paint red oxide zinc chrome priming paint to IS:2074
- 4) Paint Aluminium to IS : 2339.
- In case of any doubt regarding use of approved quality/standard paint, the BBJ/ Rly. Reserves the right to have the same tested in recognized testing laboratory, as and when required, at contractor's own expenses.
- 5.8 The Rates quoted by the tenderer must hold good till the completion of work and shall not be subjected to escalation due to increase in local market rates of materials and labour. No claim on this account what so ever shall be entertained at any state including the extended period.
- 5.9 The rates quoted shall take into account the precautions and special arrangements necessary for execution of works on water spans where ever necessary etc. with least disruption of traffic. No extra payments on this account will be admissible under any circumstance BBJ/ Railway will have to arrange for traffic blocks during shifting of sleepers only to the extent considered, sufficient for the works by the BBJ/ Railway. The contractor will not be entitled for any compensation if there be any delay in arrangements of blocks and block period be of shorter duration as considered by the contractor.
- 5.10 The metalizing will be done also at site at locations specified by the BBJ/ Railway. The contractor shall not dispute in this regard. Painting with contractor's paints, as per specifications, will be provided on the metalized surface.
- 5.11 **For the purpose of payment for metalizing and painting the area will be calculated based on the superficial areas of the finished steel work, without allowing any extra for the rivet heads and without making any deduction for rivet**

- 5.12 The metalizing shall be carried out with aluminum metal as per the specifications attached. The surface, after preparation shall be got approved by the Engineer before the work of metalizing is commenced. All the labour, materials and equipment for metalizing including surface preparation, and the measuring equipment required for carrying out inspections as per the specification shall be provided by the contractor at his own expense. The rates quoted shall, therefore, be all inclusive.
- 5.13 The work will be inspected by the Engineer or his representative from time to time, for which necessary facilities shall be afforded by the contractor. All the equipment for inspection and measurement as contained in these specifications shall be provided by the contractor at his own expense and no additional payment will be made for the above. Based on the results of his inspection, the Inspecting Officer will issue the necessary inspection certificates in acceptance of the work, for each completed span as may be decided by him.
- 5.14 Payments will be made to the contractor on bills submitted duly supported by Inspection Certificates. The opinion of the Engineer as to whether the work has been completed satisfactorily or not shall be final and binding on the contractors and they shall arrange to carry out such rectification measures as required by the Engineer, and for this no extra payment will be made.

**5.15 Specification for surface preparation and metalizing will be as below and the rate for metalizing is inclusive of these specifications.**

- 5.15.1 The surface shall be free from grease, bituminous materials, dust or other foreign matter and shall provide an adequate key for the subsequent sprayed metallic coating. This may be achieved by flame or by sand blasting. This surface shall be cottoned by blasting with suitable abrasive grittier by other suitable means, and shall be comparable in roughness with a reference surface produced as below :-

The basic metal shall be a flat of steel not less than 8mm thick and having a Diamond Pyramid Hardness of 180/220. An unbroken surface shall be grit blasted in accordance with the details given below until a uniformly rough clean surface has been attained and maintained without visible change for at least 25% of the total blasting time.

Abrasive	: Chilled iron grit No.G.24 in accordance with BS-2451.
Air Pressure	: Not less than 2.109 Kg per Sqcm
Nozzle Diameter	: Not exceeding 12 mm.
Nozzle Position	: At right angles to an approximately 22.5 Cm. form the surface.

- 5.15.2 The equipment shall be of the conventional force feed or pressure type. Nozzle size shall be such that a pressure not less than 5.273 Kg/Cm<sup>2</sup> is maintained at the last generator. Centrifugal blasting equipment can be used, in which case only angular steel grit should be used and abrasive velocity must be equivalent to that produced with force feed or pressure type machine at 5.273 Kg/Cm<sup>2</sup>.
- 5.15.3 If paint, oil or bituminous materials are present, they may be removed by blast cleaning with fine sand prior to the final blast preparation. The abrasive once used for cleaning heavily contaminated surface should not be reused even though re-screened.
- 5.15.4 For force speed pressure type ballast machines any of the following may be used :-
- 1) Washed, Salt-free, angular, silica sand or crushed granite free of sulphur etc., which tend to break down and remain on the surface in visible quantity, (Mesh size 20 to 30 with a minimum of 40% retained in 20 mesh screen).
  - 2) Angular steel grit, reasonably sharp and clean having a mesh size of G.25. Old grit which is rusty and worm shall not be used.
  - 3) Aluminium oxide (Mesh size 12 to 36 with minimum of 40% retained on a 24 mesh screen).

**5.16 METALYSING PROCESS:**

- a) The sprayed coating shall be applied as soon as possible after surface preparations. The wire method shall be used for this purpose, the diameter of the wire being 3 mm or 5 mm. The composition of the aluminum to be sprayed shall be preferably in accordance with B.S: 1475 Material 1-B (99.5%) aluminium otherwise as per IS:739.
- b) Clean dry air at a pressure of not less than 4.218 Kg per Sq cm shall be used. The minimum thickness of metal coating applied shall be 115 microns and average thickness 150 microns.
- c) The specified thickness of coating shall be applied in multiple layers, not less than two. The surface after spraying shall be free from uncoated parts or lumps of loosely spattered metal.
- d) At least one layer of the coating must be applied within 4 hours of blasting and the surface must be finished to the specified thickness within 8 hours of blasting.

### **5.17 PAINTING OF METALIZING SURFACE:**

The following system of painting should be done on the metalizing surface to give an even shade with approved quality of brushes to the satisfaction of the Railway.

- 1) As soon as metalizing is completed and certified by Railways as satisfactory within 4 hours one coating wash primer to I.S. 5666-1970 is applied.
- 2) Painting of new members with one coat of ready mixed paint zinc chromate priming to IS:104.
- 3) Painting of new steel member(after completion of riveting work) with one coat of ready mixed paint red oxide zinc chrome priming paint to IS:2074 and two coats of Alluminum paint (IS:2339).

The rate for metalizing shall include painting as per the above specification and no extra in rate will be allowable under any circumstances.

### **5.18 INSPECTION AND TESTING:**

The metal coating shall be inspected for thickness by means of an approved magnetic thickness gauge (Elcometer). The calibration of the gauge should be checked against a standard of similar thickness within an accuracy of 10 percent.

Finishing coat of painting:

(a) After the metalizing, any oil, grease etc. should be removed by through wash with a suitable thinner and allowed to dry for 15 minutes. The painting may be applied by brush or by spray. The first coat shall be wash primer to SSPCPT-353T or Etch primer to IS:5666.

(b) The second coat shall be one coat of ready mixed paint zinc chromate priming to IS:104, followed by one coat of ready mixed paint red oxide zinc chrome priming paint to IS:2074. The zinc chrome should conform to type 2 of IS:51. The 3rd and 4th coats shall be alluminium paint to IS:2339.

The checking of the matter shall be made by the following method.

A soft brass shim free from burrs is kept contact with the grit blasted surface of the base metal prior to it is being sprayed. Provision shall be made for keeping the brass shim in close contact with base metal at the point of measurement. The readings taken by using the Elcometre should be compared with the thickness of the brass shim as measured by micro-meter.

Using a straight edge and a hardened steel scribe which has been ground to a sharp of 30 Points, two parallel lines shall be scribed at a distance apart equal to 10 times of an average thickness. In scribing the two lines, enough pressure shall be applied on each occasion to cut through the coating to the base metal in a single stroke. If at the second cut any part of the coating between the lines breaks away from the basic metal, it shall be deemed to have failed in the test. Articles which have been rejected shall have the defective sections blasted & cleaned off of sprayed metals prior to respraying.

**One electronic digital elcometer to be supplied by the contractor to the BBJ/ Railway for measuring the thickness of matalised surface and painting surface.**

### **5.19 Precautions to be taken while inspecting metalized girders:**

The use of testing hammers for rivet testing, or any other operation shall not be resorted to since these can damage the metalized coating. Any loosened of the rivets in bracings etc. may be detected from visible signs such as the appearance of rust under the rivet head.

## SPECIAL NOTE

- 1** The fabrication and erection of steel girders shall be done in accordance with Indian Railway's standard specification. For fabrication and erection of steel girder bridges and locomotive turn table indicated in Serial No. B-1-2001, Steel bridge code, other relevant IR specifications and IS specifications, approved drawings and designs etc.
  
- 2** As far as possible, BBJ Administration will make all efforts to provide necessary traffic and the power blocks as per the actual requirement and as decided by Engineer-In- Charge. No claim on account of not providing traffic and power block will be entertained.
  
- 3** If Metalizing is done on the new/ replaced steel members, necessary deduction for painting to be made as per USSOR-2021 as the above items includes painting.