

GUIDELINES ON FABRICATION OF STEEL STRUCTURE OF FOOT OVER BRIDGES

1.0 Introduction :

Foot over bridges over the Indian Railways are used by pedestrian traffic to cross the Railway track safely.

1.1 Specification for steel:

i) IRS BI – 2001 (Fabrication Specification) Para 8.1 stipulates as under:

“IS:2062 Grade “A” as rolled semi-killed or killed shall be used for foot-over-bridges and other structures subjected to non-critical loading.”

ii) The rolling and cutting tolerances shall be in accordance with IS:1852.

1.2 Flattening and Straightening of steel:

IRS BI – 2001 (Fabrication Specification) Para 15 stipulates as under:

“15.1 All steel materials plates and structural 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 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.

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

1.3 Cutting of steel:

IRS BI – 2001 (Fabrication Specification) Para 17 stipulates as under:

“17.1 Flame cutting by mechanically controlled torch/torches shall be accepted. Provided the edge as given by the torch is reasonable 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.

17.2 All flame cut edges shall be ground to obtain reasonably clean square and true edges. Draglines produced by flame cut should be removed.”

1.4 Approval of Quality Assurance Plan (QAP):

Stagewise manufacturing process from raw material indicating various steps, test checks and their frequency, sampling plan, authority for grant of clearance, stage like templating and lay out of foot over bridge, fixture/jig manufacturing, drilling of component/welding of component initial assembly, final finishing, final inspection, surface preparation and painting etc. are clearly shown and signed by manufacturer, indenting Railway authority and approved by competent authority.

1.5 Lay out :

- i) The layout of structure on template floor is the most important operation in fabrication. It is essential that the template floor is perfectly level with adequate lighting arrangement. Steel flooring is desirable, as it would also minimize variation in dimensions due to temperature changes. The marking tools and instruments like square, divider, punches, steel scriber should be of good quality.
- ii) Calibrated tape for measurement of lay out must be used.

1.6 Jigs and fixtures :

Jig is the device used in the mass production to locate the job and guide the tool for drilling etc. While a fixture is a simply a device for holding the work in true shape during processing.

The use of steel templates, jigs and fixtures is preferable to help in achieving economy, increasing production, reducing man power, reducing human errors, increasing accuracy and eliminating special match marking.

1.7 Drilling of holes :

Quality of fabrication shall be improved if jigs are used during fabrication. Drilling of the component may be done through jigs. All burrs left by the drill and sharp edges of the holes shall be removed.

1.8 Welding Process and Positions :

- i) Welding shall be carried out in accordance with the approved welding procedure, specifications by approved welders, processes and positions. Proforma for welding procedure specification and welding procedure qualification records are enclosed as Annexure-I and II.

- ii) All welding should be preferably done in flat position (horizontal). Welding should be done as per drawing ensuring proper size of weld. Over size welding may lead to excessive heat affected zone which may lead to failure of material. Welding should be carried-out in a warm and dry place so that the rainwater or other atmospheric elements may not come in contact while welding is in progress.
- iii) Electrodes shall conform to Class A2 of IRSM-28 and wire for CO2 welding shall conform to Class 1 of IRSM-46.
- iv) All consumable shall be stored and handled with care and in accordance with the manufacturer's recommendations.

1.9 Riveting :

- i) Before riveting is commenced the permanent surface of components shall be painted with two coats of red oxide zinc chrome priming to IS 2074.
- ii) IRS BI – 2001 (Fabrication Specification) Para 23 stipulates as under:

“23.1 The dimension 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 rivet 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 0.75 mm. Before riveting is commenced, all works shall be properly bolted so that the section riveted are in close contact throughout. Rivet shall completely filled the holes and shall be machine driven by means of pressure or percussion riveters of approved design.

23.2 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 be heated, more than the head. Sparking or burnt rivets shall not be used. Whereas it is impossible to back up by normal method of holding up, 'double gunning' may be resorted to. Alternatively pneumatic holding device may used.

23.3 Gauges for rivet dimensions and contours shall be provided by contractor for the use of the Inspecting Officer.

23.4 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.

23.6 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 Annexure-III. Rivets shall also be cut out when required for the examination of the work. Actual method of cutting out shall be approved by the Engineer. Recouping and caulking shall in no circumstances be resorted to.

23.8 All field rivets shall be tested.

- iii) All defective rivets and loose rivets shall be marked on their heads with paint and promptly replaced. Rivets in any components should be tested 100% in shop by a responsible supervisor and maintain the record of the same.

1.10 Final Cutting and Finishing of component :

Final finishing of length, profile and notches etc. it is accomplished by accurate marking with the help of templates, measurement and gauge wherever necessitates and then by gas cutting (Chipping, grinding) as the case may be. Excessive metal is normally chipped off or gas cut (more than 3 mm) and the exact finishing or profiling is achieved by fine and accurate grinding.

1.11 Inspection Stages :

- (a) Before fabrication
- (b) During fabrication
- (c) After fabrication

(a) Before Fabrication :

- Quality Assurance Plans shall be prepared and got approved.
- Raw material such as channels and plates etc. to be inspected as per specification mentioned against each items and rolling Mark Certificates.
- Lamination, piping, pitting rolling defects and Straightness of material to be checked before fabrication.

- Consumables such as, rivets, welding electrodes and paints etc. are as per standard specification.
- Welding Procedure Specifications need to be approved.
- Welders approval as per Welding Procedure Specification.

(b) During Fabrication :

- Layout, jigs and fixtures and profile to be checked.
- Welding by qualified welders as per approved WPSS.
- Welding parameters are to be set & checked during welding.
- Riveting by qualified and skilled personal with approved work instructions.

(c) After Fabrication :

- Verify rolling Mark number of steel sections used for fabrication, from Certificate issued by manufacturer. Check the register maintained by firm.
- Surface defects shall be checked visually.
- Quality of welds with respect to specified sizes, length and any visual defects.
- Quality of rivets to be checked visually and with the help of riveting hammer.
- Dye Penetration Test for Welds
- Leading dimensions i.e. overall length, hole dimensions, end finishing etc. shall be checked. For this purpose detail measurement sheet shall be prepared for.

1.12 Connection Details :

Some of the connection details commonly used in fabrication of FOB has been shown as Annexure-IV.

ANNEXURE-I
(Ref. Clause 26)

1. Proforma for Welding Procedure Specification Sheet

Name and address of Fabricator:
Welding procedure specification No.

- 1.0 Weld joint description :
- 2.0 Base Metal :
- 3.0 Welding Process :
- 4.0 Welding position :
- 5.0 Welding consumables :
- 5.1 Electrode/wire Class :
Dia :
Drying method :
- 5.2 Flux Class :
Dia :
Drying method :
- 5.3.1 Shielding gas :
- 6.0 Base Metal preparation :
- 6.1 Joint design details :
(Give sketch showing arrangement
of parts, welding groove details, weld
passes & their sequence etc.)
- 6.2 Joint preparation :
- 7.0 Welding current : Type :
Polarity :
- 8. Welder qualification :
- 9. Welding parameters and technique:
- 9.1 Welding Parameters :

Weld Pass No.	Electrodes/ wire dia. (mm)	Current (amp)	Arc Voltage (volt)	Wire feed speed (m/min)	Travel speed (m/min)	Electrical stick out (mm)	Gas flow rate (litre/min.)
1	2	3	4	5	6	7	8

- 9.2 Welding sequence and technique :
(Give sketch showing sequence
and direction of welding).
- 10.0 Provision of run in and run-off tabs:
- 11.0 Cleaning of weld bead before laying next weld bead:
- 12.0 Root preparation before welding other side of groove weld:
- 13.0 Preheating and inter pass temperature:
- 14.0 Peening:
- 15.0 Post weld treatment:
- 16.0 Rectification of weld defects:
- 17.0 Inspection of weld:
- 18.0 Any other relevant details

Prepared by
Signature _____
Designation _____
Date _____
(for & on behalf of Fabricator)

ANNEXURE-II

1. Proforma for Welding Procedure Qualification Record

Name and address of Fabricator

- 1.0 Description of Weld :
- 2.0 Welding procedure specification no. :
- 3.0 Name of welder :
- 4.0 Date of preparation of test piece :
- 5.0 Dimensions of test piece :
- 6.0 Base Metal :
- 7.0 Welding Process :
- 8.0 Welding position :
- 9.0 Welding Current : Type :
- Polarity :
- 10.0 Weld joint design details :
- 11.0 Welding consumables :
- 11.1 Electrode/wire Class :
- Dia :
- Brand :
- 11.2 Flux Class :
- Type :
- Brand :
- 11.3 Shielding gas :
- 12.0 Welding parameters :

Weld Pass No.	Electrodes/ wire dia. (mm)	Current (amp)	Arc Voltage (volt)	Wire feed speed (m/min)	Travel speed (m/min)	Electrical stick out (mm)	Shielding gas flow rate (lit/min.)
1	2	3	4	5	6	7	8

13.0 Preheating and interpasstemperture:

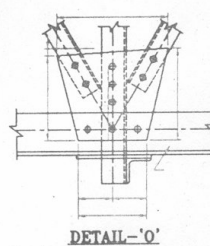
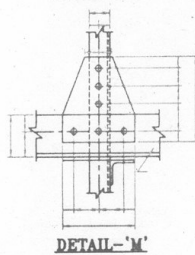
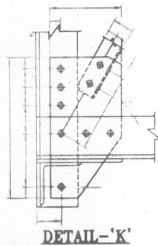
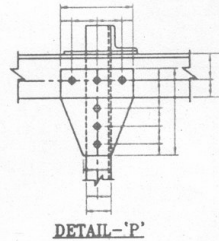
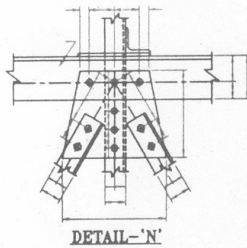
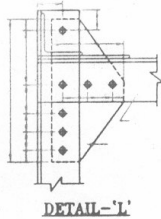
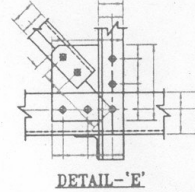
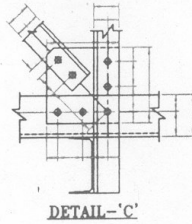
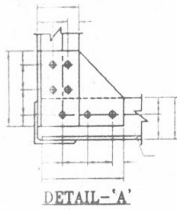
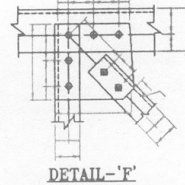
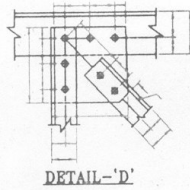
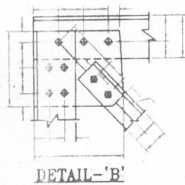
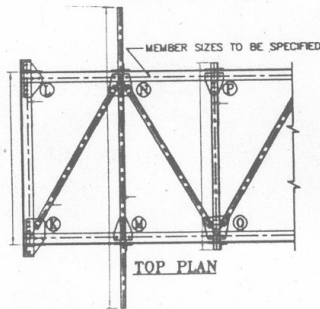
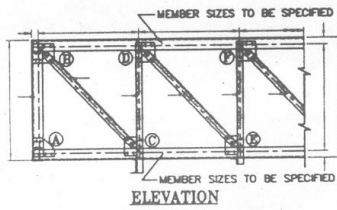
14.1 Results of Qualification Tests:

Test	Specimen No.		Result
	1	2	
Non-destructive tests			
i) Visual examination:			
ii) Dye penetrant test:			
ii) Magnetic particle test:			
iv) Radiographic/Ultrasonic test:			
Destructive tests:			
i) Macro-examination:			
ii) Hardness survey:			
ii) Fillet weld fracture test:			
iv) Transverse tensile test:			
	Tensile strength		
	Yield Stress		
	Location of fracture		
v) All-weld tensile test:			
	Tensile strength		
	Yield Stress		
	Elongation %		
vi) Guided bend test:			
	Root bend test		
	Face bend test		
	Side bend test		
vii) Any other tests			

Signature _____
 Designation _____
 Date _____
 (for & on behalf of Fabricator)

PERMISSIBLE DEVIATIONS FOR DRIVEN RIVETS

Sl. No.	DESCRIPTION OF DEVIATIONS	SKETCH	TOLERANCE
1	SHANKING OR SHIFTING OF THE HEAD UNDER THE KNOCKS OF HAMMER.		NOT ALLOWED
2	CAULKING OF THE HEAD		NOT ALLOWED
3	IMPROPER BEARING OF THE HEAD ON THE ELEMENT WHILE RIVETTING ALONG THE ENTIRE CONTOUR OF HEAD.		NOT ALLOWED
4	IMPROPER BEARING OF THE HEAD ON THE ELEMENT WHILE RIVETTING ALONG THE ENTIRE PART OF CONTOUR OR RIVET.		NOT ALLOWED
5	PRESENCE OF CRACKS IN THE HEAD.		NOT ALLOWED
6	NOTCH IN THE HEAD.		2mm
7	SHIFTING OF HEAD FROM THE AXIS OF RIVET.		$b \leq 0.1d$
8	BAD SHAPE OF HEAD ALONG THE PART OF CONTOUR OF RIVET.		$a+b \leq 0.1d$
9	BAD SHAPE OF HEAD ALONG THE ENTIRE CONTOUR OF RIVET.		$a+b \leq 0.1d$
10	HEAD OF REDUCED DIMENSION.		$a+b \leq 0.1d$ $c \leq 0.5d$
11	CROWN NEAR THE HEAD		NOT ALLOWED
12	NOTCHING OF STEEL BY SNAP.		NOT ALLOWED
13	UNEVENNESS OF THE SURFACE OF THE HEAD		$a \leq 0.3 \text{ mm}$
14	OBLIQUE RIVETTING		DEVIATION UP TO 3% OF THICKNESS OF JOINT ELEMENTS BUT NOT MORE THAN 3mm



- NOTE:-
1. ALL DIMENSIONS SHOWN BY ARROWS SHOULD BE SPECIFIED.
 2. MEMBER SIZES SHOULD BE SPECIFIED AS MARKED BY ARROWS.
 3. RIVET SIZES SHOULD BE SPECIFIED.

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No. CBS/FOB

Dated -03-2008

- I. Director, IRICEN, Pune-410001.
- II. Principal Chief Engineer:
1. Central Railway, Mumbai CST-400 001.
 2. Eastern Railway, Fairlie Place, Kolkata-700 001.
 3. East Central Railway, Hazipur-844 101.
 4. East-Coast Railway, Bhubaneshwar-751 016.
 5. Northern Railway, Baroda House, New Delhi- 110 001.
 6. North-Central Railway, Allahabad-211 001.
 7. North Eastern Railway, Gorakhpur-273 001.
 8. North-Western Railway, Jaipur-302 001.
 9. Northeast Frontier Railway, Maligaon, Guwahati-781 011.
 10. Southern Railway, Park Town, Chennai-600 003.
 11. South Central Railway, Rail Nilayam, Secunderabad-500 371.
 12. South East Central Railway, Bilaspur-495 004
 13. South Eastern Railway, Garden Reach, Kolkata-700 043
 14. South-West Railway, Hubli-580 023.
 15. Western Railway, Mumbai-400 020.
 16. West-Central Railway, Jabalpur-482 001.
- III. Executive Director Civil Engg(B &S), Railway Board, Rail Bhavan, New Delhi-01.

Sub: Guidelines on Fabrication of Steel Structure of Foot Over Bridges.

Ref: Railway Board's letter no. 2004/CE-I/BR/Domibivali dated 24-10-07.

RDSO has developed guidelines on Fabrication of Steel Structure of Foot over Bridges. These guidelines are being sent for information and necessary action please.

DA: As Above (Total 9 pages)..

(Piyush Agarwal)
Executive Director (B&S)
For Director General