

GUIDELINES FOR JOINT DETAILING USING STEEL HOLLOW SECTIONS RHS/SHS IN FOOT-OVER- BRIDGES

1.0 Introduction

Railways have been doing the design of Foot-over-Bridges using conventional steel sections such as angles/ channels and plates etc., extensively to cater to the specific requirement of width, length of span and number of staircases. Rectangular and Square Hollow sections (RHS & SHS), being manufactured by reputed firms, conforming to IS:4923 have not been used for steel structures in Railways.

The rectangular and square hollow sections have excellent properties with regard to buckling and lateral stability which leads to simpler structures with lesser number of joints, moreover direct joining by one section into another. This eliminates the need of gusset plates.

The smooth and uniform profile, with rounded corners, help in providing a smooth coating of paint and also in enhancing the aesthetic look of the structure.

2.0 Use of RHS and SHS in FOB Design

In order to make use of the inherent advantages available in closed structurals, it has been attempted to evolve a design of FOB using the RHS and SHS.

The following typical drawings of FOB have been prepared and the same are being issued for the preliminary guidance of Railways.

- | | | |
|-------|----------------------------------|---------------------|
| i) | General arrangement: | Drg. No.CBS-0021 |
| ii) | Details of top chord joints : | Drg. No.CBS-0021/1 |
| iii) | Details of top chord joints : | Drg. No.CBS-0021/2 |
| iv) | Details of bottom chord joints : | Drg. No.CBS-0021/3. |
| v) | Details of bottom chord joints : | Drg. No.CBS-0021/4. |
| vi) | Staircase and precast RCC slab: | Drg. No.CBS-0021/5 |
| vii) | Details of roofing : | Drg. No.CBS-0021/6. |
| viii) | Material list : | Drg. No.CBS-0021/7. |

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3.0 Jointing and connections

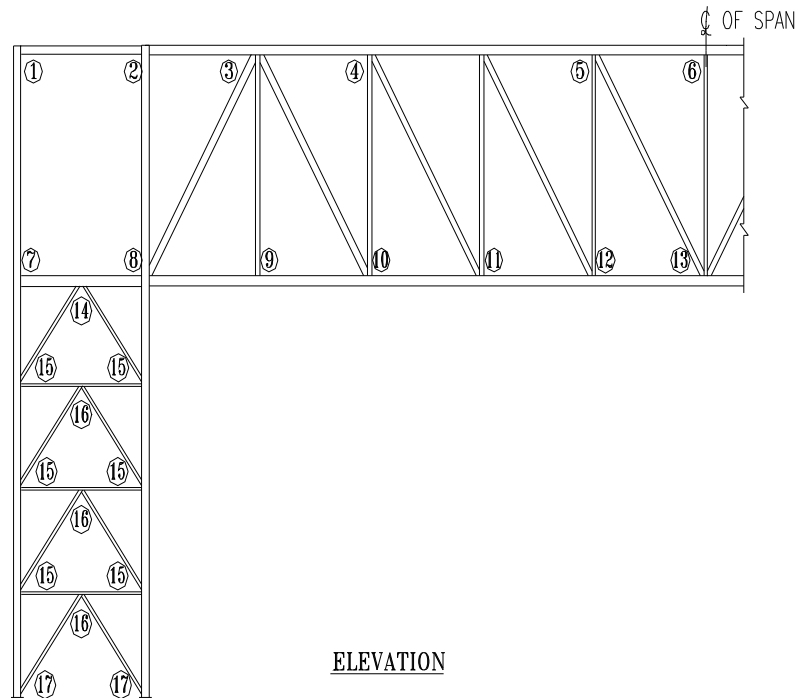
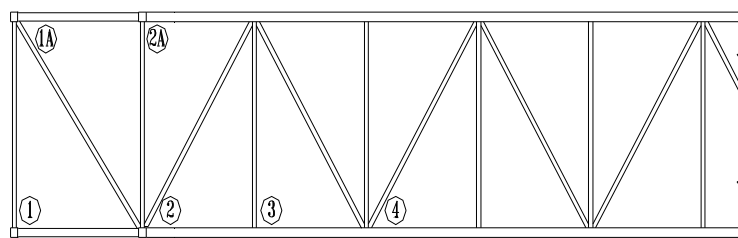
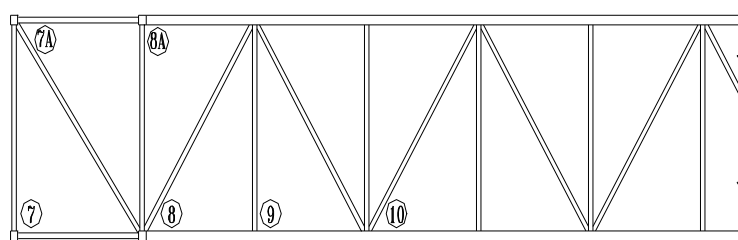
Fabrication and erection in the case of RHS and SHS is faster due to ease of jointing. These structurals by jointing get automatically sealed by other connecting members or else have to be sealed by additional closing plates to prevent any internal corrosion.

The following types of joints have been considered in the design:

- i) N-type joint (Detail 5, Elevation in Drg. No. CBS-0021/1)
- ii) K-type joint (Detail 4, Top Plan in Drg. No. CBS-0021/1)
- iii) Knee joint (Detail 1, Elevation in Drg. No. CBS-0021/1)
- iv) Gap joint (Detail 14, Elevation in Drg. No. CBS-0021/2)
- v) Overlap joint (Detail 16, Elevation in Drg. No. CBS-0021/2)
- vi) Vierendeel joint (Detail 6, Elevation in Drg. No. CBS-0021/1)
- vii) Shop splice joints (Drg. No. CBS- 0021/1)
- viii) Strengthened splice (Drg. No. CBS-0021)
- ix) Field bolted splice (Drg. No. CBS- 0021/4)
- x) Connection of bottom chord to main column (Detail 8 in Drg. No. CBS-0021/3)
- xi) Connection at cut-off points for easy transportation/ erection (Detail 10 in Drg. No. CBS-0021/3)

The Schematic Diagram depicts joints identified for detailing of Top chord joints, Bottom chord joints and Column bracings. Detailed explanation, for the identified important joint numbers 1,4,5,6,8,10,14 and 16, has been given in following paras.

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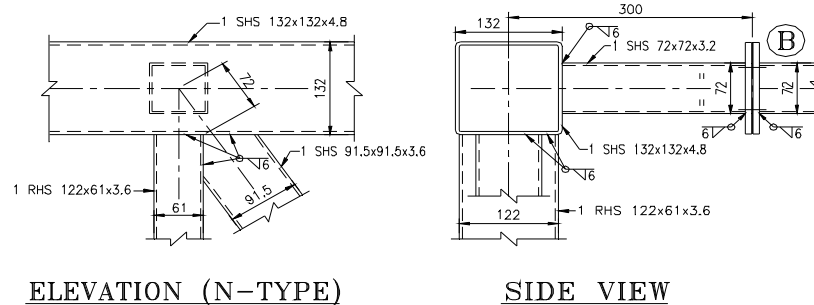
SCHEMATIC DIAGRAM

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4.0 Joint Details

4.1 N-Type Joint

N-type joint is formed as per the adopted configuration, for connecting web members to top and bottom chords. In the schematic diagram, Joint Nos. 4, 5, 10,11 & 12 (elevation) are N-type. Typical details of one of the joints (No. 5) are given below:

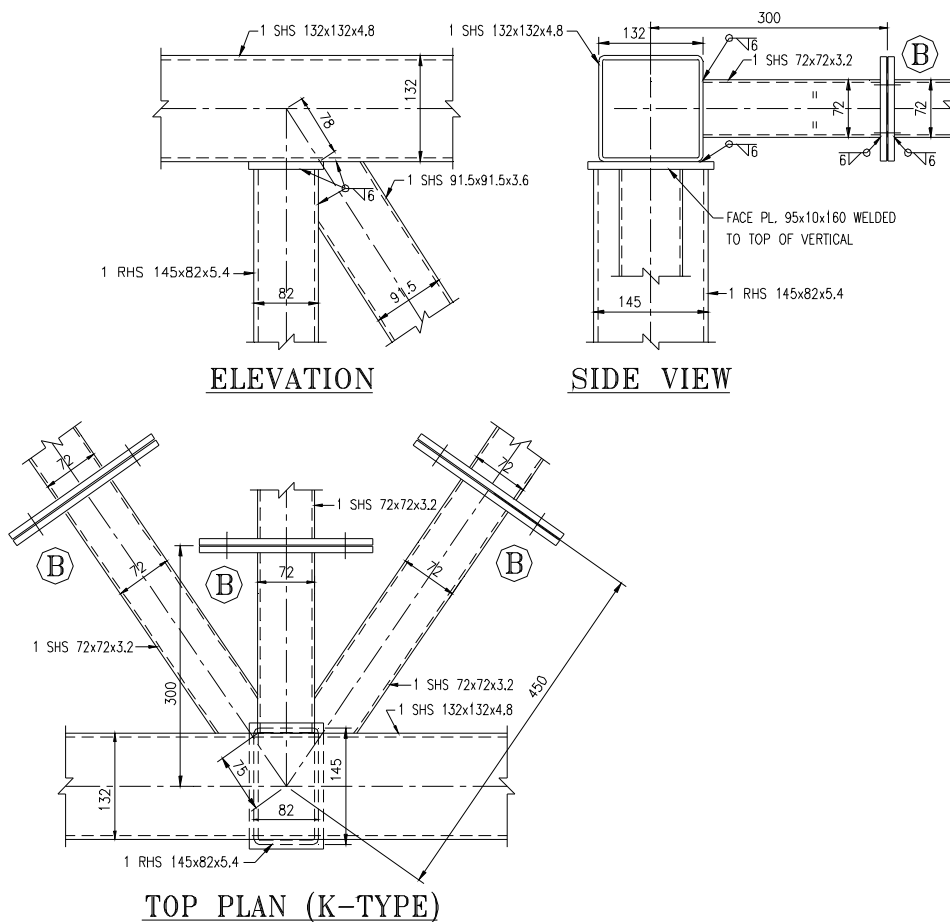


- In this joint, first the vertical member is put in place and directly welded to top and bottom chords.
- Afterwards, the other inclined diagonal member, with suitable double cuts at the ends, is directly welded to top and bottom chords and also to the vertical.
- These connections, of vertical and diagonal members to top and bottom chords directly, help in eliminating the gusset plates thus resulting in automatic sealing of member ends. Direct jointing, of vertical and diagonal members to top and bottom chords, eliminates gusset plates. For details, refer Detail 5 as given in Drawing No. CBS-0021/1.

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4.2 K-Type Joint

This type of joint is formed when the centroidal axis of horizontal member and two lateral bracings meeting with the central axis of top chord. Joint No. 2, 4,8 & 10 (Plan in the schematic diagram represents this type).



- i) In the above details as shown in Elevation and Side view, the verticals have more width than the width of top and bottom chords. In order to ensure proper welding at the joint, steel plates are welded to both the ends of verticals, then these are welded to top and bottom chords.

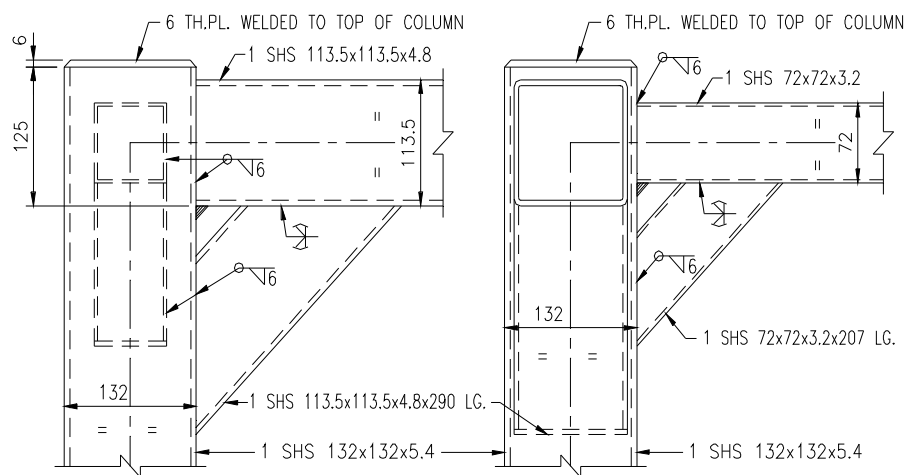
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- ii) The plates welded to both ends of verticals will not only result in effective sealing of the members but also prevent the corrosion of internal surfaces. This will ensure proper welding of verticals with the chord members.
- iii) In the above detail, as shown in plan, it is K-Joint with central horizontal member connecting both the top chords at their ends. In this joint, the horizontal member is firstly welded to top chords and afterwards the diagonal members with suitable double cuts at their ends are directly welded to top chords and horizontal member.
- iv) This arrangement of joint is the simplest and most economical. For other top chord joints, refer detail 4 in Drawing No. CBS-0021/1.

4.3 Knee-Type Joint

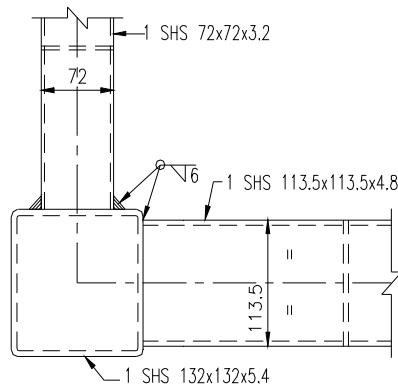
This type of joint is used for increasing the stability of connection between vertical and top chord. Joint No. 1 is Knee-type joint.

- i) In welded knee-joint as shown above, the top chord is directly welded to



ELEVATION (KNEE TYPE)

SIDE VIEW



PLAN

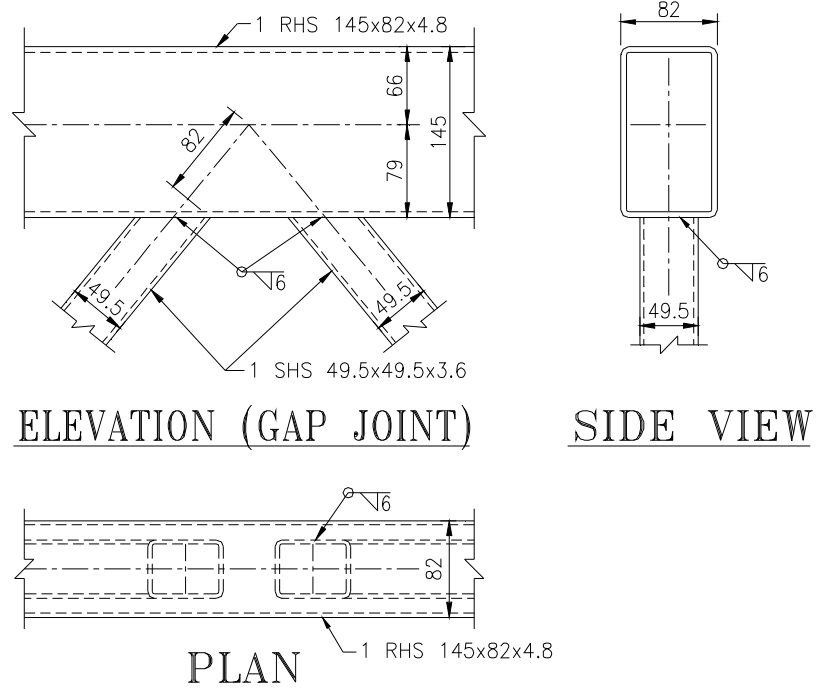
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the main column and then a suitably cut haunch is welded to the vertical and as well as to the chord member for better stiffening.

ii) For other top chord joints, refer detail 1 in Drawing No. CBS-0021/1.

4.4 Gap Joint

When two smaller sections are to be joined with a bigger section, a gap between two smaller sections remains. When the intersection of centroidal axes of two smaller size members lies in the centroidal axis of larger size member i.e. bottom boom of landing, this type of joint is formed.



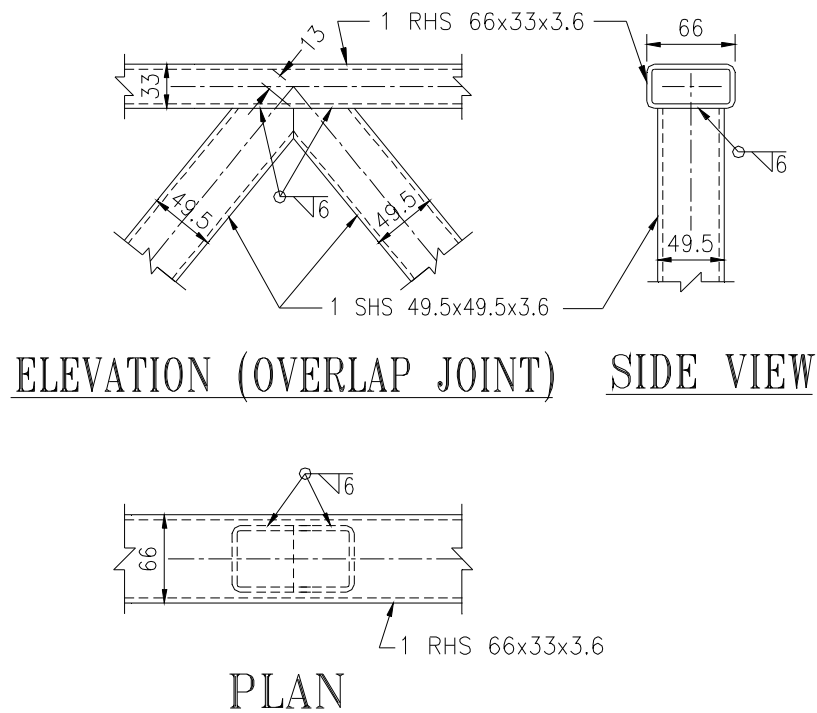
i) In this arrangement, single cut bracings are directly welded to floor beam. This joint is used in the column bracings.

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- ii) For details, refer Joint 14 in Drawing No. CBS-0021/2.

4.5 Overlap Joint

This type of joint is used in elevation for connecting three smaller size members so that two members are in close touch with each other and also the intersection of their centroidal axes lies on the axis of third member.

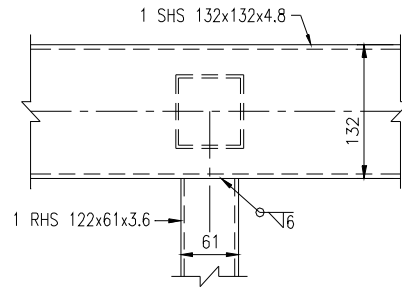


- i) In this arrangement, both the diagonal bracing members have double cut at the ends and directly welded to horizontal bracings. This is a symmetrical layout.
- ii) For details, refer joint 16 in Drawing No. CBS-0021/2.

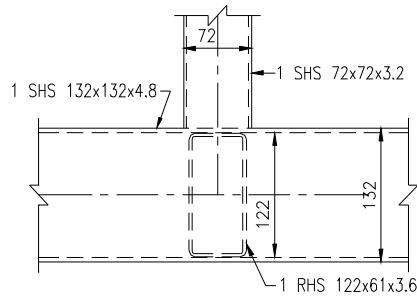
4.6 Vierendeel Joint

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In this type of joint the vertical member is directly welded to the top chord by fillet weld.



ELEVATION



PLAN

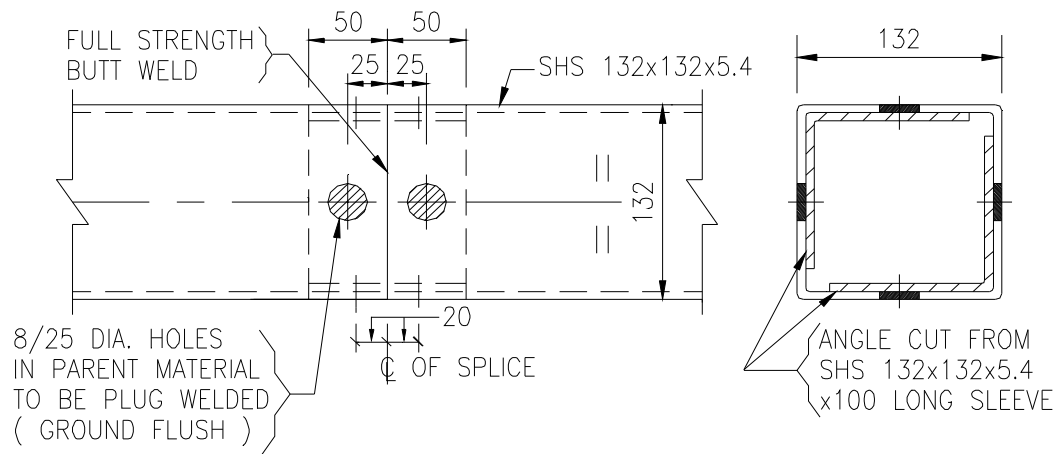
- i) In this type of Vierendeel joint the width of the vertical member is less than the chord members. This is a most suitable joint.
- ii) For details, refer joint 6 in Drawing No. CBS-0021/1.

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5.0 Splice Joints

The details of splice joints with relevant sketches have been illustrated.

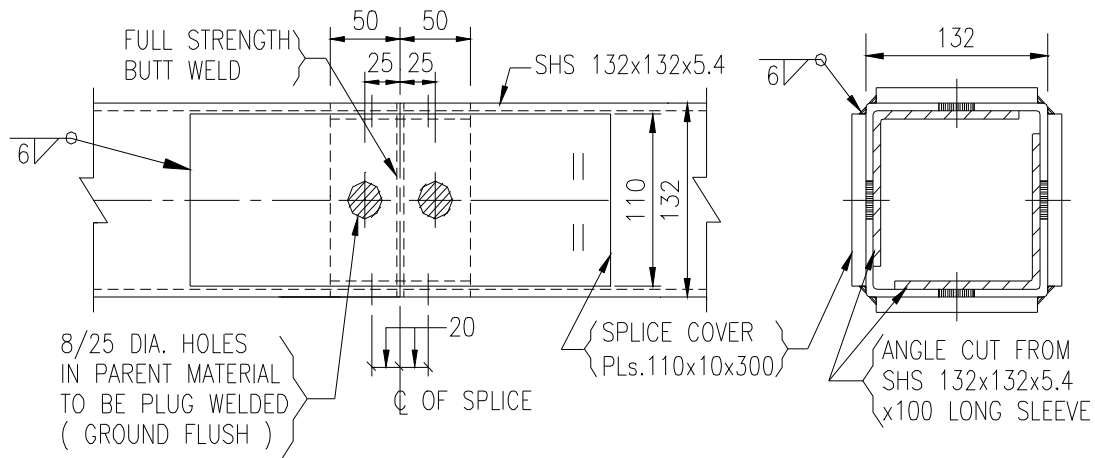
5.1 Shop Splice



- i) The maximum rolled length of the closed structurals (RHS/SHS) presently available, is 6.25 m.
- ii) In the case of fabricated length required is more than 6.25m the splice joint shall be provided in the shop as per typical details of splice shown above.
- iii) In the case of shop splice, it is required that the two non-holed angle cuts are placed inside the main section to be spliced which has two holes to be plug-welded and ground-flush on each face.

5.2 Strengthened Splice joint

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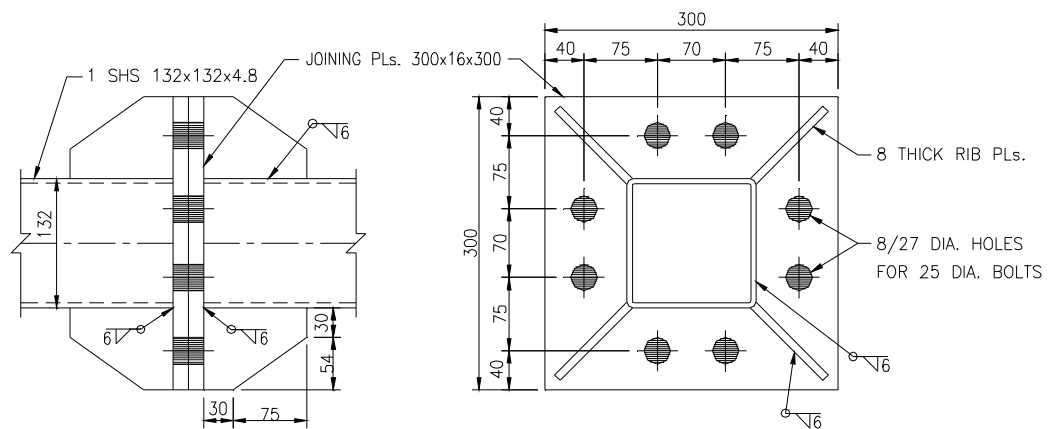
Shop Splice Joint, applicable for Top and Bottom Chords, has been strengthened by providing additional cover plates with more safety cushion so as to augment the strength of splice joint wherever required with suitable modifications to the Splice Joint described at 5.1.

5.3 Field Bolted Splice

For easy transportation, the length of chord members has been limited from 11.5 m to 12.0 m which is to be subsequently spliced in the field.

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The elevation girders fabricated in workshop are in two parts and the same are required to be transported to the site for final assembly / erection. These parts are to be connected by bolted splice in the field as per the details shown below.



BOLTED SPLICE IN FIELD FOR TOP AND BOTTOM CHORDS

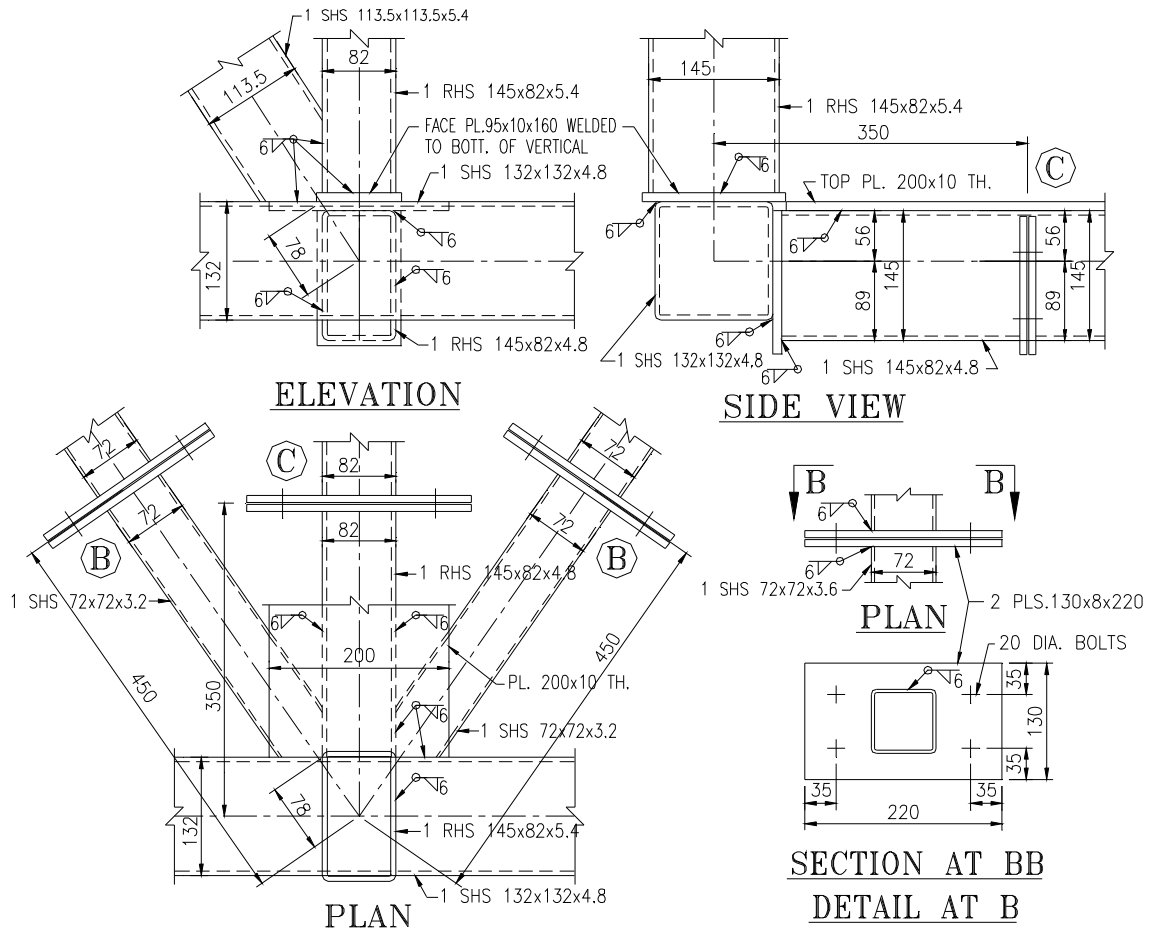
- i) In the case of bolted splice which is done in the field, one pre-holed plate which is welded to each face in the workshop is used for splicing/connecting the section and bolting is done keeping them in hole-matching position.
- ii) In making site joints, bolts should be dipped in thick red lead paint before insertion in the holes.

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For details, refer detail 8 in Drawing No. CBS-0021/3.

6.1 Connection at Cut-Off Points



- i) In the above detail as shown in Plan and Side View, joint details have been formulated for easy handling and transportation/erection. Cut-off points, to have short pieces of bottom lateral bracings and deck beam, are selected so as to keep the minimum projection from centre line of joint. These short pieces are welded to the inner vertical flanges of the top and bottom chords in the workshop.

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- ii) At cut-off points 8 mm thick plates are welded to short pieces as well as to longer pieces and both the plates are joined by 20 mm dia. bolts at the site during erection.
- iii) For details of other bottom chord joints, refer detail 10 in Drawing No. CBS-0021/3.
- iv) In the above details, the deck beams have more width than the width of bottom chords. In order to ensure proper welding at the joint, steel plates are welded to both ends of deck beams. Then the deck beams are welded to inner faces of bottom chords. The plates welded to both ends of deck beam will effectively seal the members and prevent the corrosion of internal surfaces.
- v) This type of connection makes it easy in handling as well as in transportation of fabricated members to site.

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7.0 Welding Details

The following points are to be kept in view while detailing welding:

- i) All fillet welds are of size 6 mm continuous except where otherwise shown.
- ii) All open ends of hollow sections after fabrication if any, should be sealed to prevent corrosion of internal surfaces by welding a 6 mm thick plate.
- iii) At the joints where hollow structural member is directly welded to the other member, should be properly sealed around by fillet or butt welding as the case may be, to ensure that there is no seepage of water through the welded junction of the members.
- iv) Care is to be taken in welding the hollow section with double cuts at the ends, so that they can be properly butt against the adjoining members. This will ensure to prevent the seepage of water into the members with double cuts.
- v) As far as possible, site welding should be restricted to absolutely minimum.
- vi) Fabrication work shall invariably be carried out by CO₂ welding only, however, manual metal arc welding can be done in the case of welding at site.
- vii) The approved quality of electrodes and technique of welding shall be as per current specification IS: 9595.
- viii) The components to be welded are held together and should be arranged so that the shrinkage can take place easily during welding.