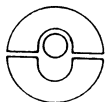


INTERNATIONAL



UNION OF RAILWAYS

U I C CODE

Leaflet to be classified in Volume :

VII - WAY AND WORKS

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2nd edition, 1-1-83

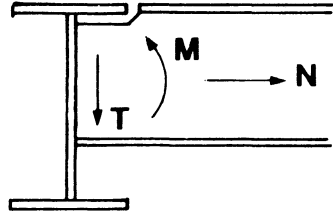
RECOMMENDATIONS
FOR THE CONNECTION OF RAIL BEARERS
TO CROSS GIRDERS
FOR STEEL RAILWAY BRIDGES

(Reprint, 1-11-1990)

1 - INTRODUCTION

The connection between rail bearers and cross girders must withstand all loads to be transmitted. These usually include :

- the shear stress T (or vertical reaction),
- the moment of continuity M ,
- the longitudinal force N .



Remarks :

- a) The moment M is generally hogging (upper flange subjected to tensile stresses) the sagging moments are often negligible;
- b) The longitudinal force N is generated by the transfer to the rail bearers of part of the load from the main girders. For a simply supported girder, N will be :
 - a compressive stress for a deck span;
 - a tensile stress in the opposite case.

The tensile stress may be considerable if :

- the rail bearers are near the bottom level of the main girders;
 - the rail bearers are effectively connected to the main girders (for example rigid bracing to transfer braking forces to the ends of the deck, or continuous deck plate (ballasted or unballasted), linking the main girders and rail bearers.
- c) Braking and traction forces must also be taken into consideration

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2 - COMPONENTS OF THE CONNECTION

There are 4 components in the connection :

- 1 - The component which connects the web of the rail bearer to that of the cross-girder : angles or welded end plates, then riveted (or bolted).

Main function : to transmit T .

This component on its own has a poor resistance to M and N forces (rivets or bolts subjected to tension).

- 2 - The top flange cover plate.

Function : to transmit M and N .

- 3 - The bottom flange cover plate.

Function : to transmit N ; it is not necessary to transmit the moments, since the sagging moment is almost always insignificant.

- 4 - The supporting bracket, or gusset plate.

Functions : additional safety for transmitting T ; aid to erection and adjustment.

From an analysis of the forces which the connection must withstand, it may be deduced that components 1 and 2 are always necessary since the T and M values are always high.

Component 3 becomes necessary when a considerable longitudinal tensile force occurs.

Component 4 is not strictly necessary if the other components are sufficient to transmit the forces with a satisfactory degree of safety, otherwise this part is also required.

3 - CLASSIFICATION

The advantages and disadvantages of the various types of connection described in the Appendices are given.

Class 1 -Connections with top flange cover plates only.

1.1 - Top flange of rail bearer at the same level as top flange of cross girder.

1.1.1 - Riveted (or bolted) connection.

Example : see Appendix 1 for the upper part of the connection, Appendix 5 for the lower part.

1.1.2 - Mixed connection : end plate welded, then riveted (or bolted).

Example : see Appendix 2 and Appendix 6 (2 alternatives).

1.2 - Top flange of rail bearer on a lower level than top flange of cross girder.

1.2.1 - Riveted (or bolted) connection.

Example : Appendix 3 and Appendix 5.

1.2.2 - Mixed method : end plate welded, then riveted (or bolted).

Example : Appendix 4 and Appendix 6 (2 alternatives).

Class 2 : Connections with top and bottom flange cover plates.

2.1 - Top flange of rail bearers at the same level as top flange of cross girders.

2.1.1 - Riveted (or bolted) connection.

Example : Appendix 1 and Appendix 7 (2 alternatives).

Special case with cross girder and rail bearer of same height (N.S.) given in Appendix 13 for information purposes.

R**2.1.2 - Mixed method**

Example : Appendix 2 and Appendix 8 (2 alternatives).

2.2 - Top flange of rail bearer at a lower level than top flange of cross girder.

2.2.1 - Riveted (or bolted) connection.

Example : Appendix 3 and Appendix 7 (2 alternatives).

2.2.2 - Mixed method

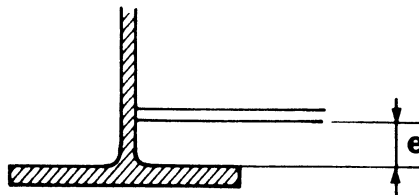
Example : Appendix 4 and Appendix 8 (2 alternatives).

4 - RECOMMENDATIONS**4.1 - Design**

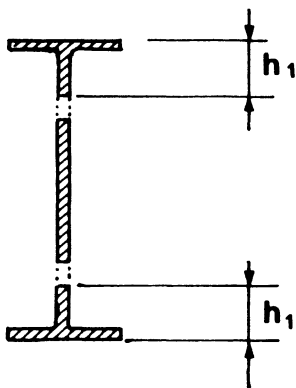
«Class 1» connections are used when the direct tensile force in the rail bearers is low. Otherwise, «Class 2» connections must be used.

A supporting bracket (or gusset plate) is advisable where the bottom flanges of the rail bearer and the cross girder are not on the same level.

The gap between the bottom flanges of the rail bearer and cross girder must always be ≥ 50 mm.



Openings in cross girders should not be placed too close to the flanges. Distance h_1 should be at least 150 mm, and the underside of the rail should be at least 50 mm above the top flange of the cross girder.



Cut-away sections in the upper part of rail bearers must be rounded with a minimum radius $r \geq 15$ mm. This is obtained by drilling beneath the web/flange transition fillet of the rolled steel section, as shown in Appendix 9. Each cut-away section must be finished by grinding to remove any notch effect.

For welding the rail bearer to the end plate, a double V butt weld seems preferable to a fillet weld; the latter is, however, also permissible.

4.2 - Calculation

In principle, the connection forms a complex whole which should be designed as a unit for the most unfavourable combinations of T , M and N .

The calculations can however usually be simplified as follows :

a) *Class 2 - Top and bottom flange joint cover plates*

- Component 1 is checked for the maximum shear force,

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- the dimensions and fasteners (rivets, bolts) for Components 2 and 3 will be calculated in relation to M and N, assuming that :
- M is resisted by two forces, one applied at the level of the top flange joint cover plate, and the other at the level of the bottom flange cover plate.
- N is distributed between the 2 flange cover plates.

b) Class 1 - Top flange cover plate only

Two cases can be envisaged :

- 1 The force N is negligible : the method described in a) remains valid, although the lower force in the couple, resisting M, is assumed, as a simplification, to be situated at the level of the bottom flange of the rail bearer.
- 2 The force N, although not high, is not, however, negligible : the method laid down in a) must be adapted by special examination of the transmission of N, particularly its influence on Component 1.

NOTES :

The attention of the designer is drawn to the notch effect caused by cutting away sections at the end of the rail bearer.

It is necessary to check the stresses in the rail-bearer web in the whole area around the cut-away sections to take account of the notch effect and to limit them in accordance with the recommendations in Leaflet 778-1.

The stresses in mixed connections are also to be limited in accordance with the same recommendations.

5 - DECKS WITH AN ORTHOTROPIC SLAB

This chapter will be published later on.

6 - REMARKS ON THE DRAWINGS OF CONNECTIONS SHOWN IN THE APPENDICES

6.1 - The connections are designed for bridge decks with rail bearers that have the same centre-line as the rails of the track. If this is not the case, the forces may be centered on the rail bearers by a centering bar added to reduce the stresses caused by the load being off-centre (Appendix 10). This centering bar may also be welded on the rail-bearer flange.

6.2 - If necessary, to facilitate erection, a packing may be added in the web joint (see Appendix 11).

6.3 - The drawings show the example of a track laid on timber sleepers.

6.4 - In view of the effect of the rolling tolerances on the geometry of the sections, it is essential :

- to measure the ends of the rolled section forming the rail bearers with a gauge, if necessary, to check that the top flange of the girder is perpendicular to the web, so as to ensure a perfect match of the top flanges of rail bearers and cross girders when they are assembled;
- due to the tolerances allowed on the height of the rolled section, to allow for holes to be drilled on site according to requirements, so as to ensure a close fit of the top flange cover plate, which should moreover be bolted into place first of all (Appendix 12). The bottom flange cover plate or supporting bracket will be fitted last with holes to be drilled according to requirements.

It should be noted that such additional operations can be avoided if a trial erection is carried out beforehand in the workshop, whenever this can be specified.

6.5 - The drawings are to be adapted in cases where the cross girders and rail bearers are fabricated by welding (see Appendix 11).