

10. Rails and Accessories

The crane runway rails should be regarded as an important part of the crane installation because they can influence the operation of the crane(s). Refer to Part 1 of AS 1418 for the procedure in selecting the appropriate size and material for the crane rail, although the crane manufacturer should nominate the sizes. Crane rails are normally of a 'squat' design minimising the effects of torsion generated by lateral loads but they are not locally manufactured. Railway type rails are less advantageous because they are relatively high and this tends to increase the effect of torsion. Good thing about these rails is that they have a hardened running surface for longer service. Even so, rails for Heavy Duty cranes need to be replaced several times in the life of the runway.

The current practice of using rectangular bars welded directly to the top flange should be viewed as solving a part of the problem. The main idea put forward is that such bars can act compositely with the girder and thus save steel. They also reduce local torsion problem because their height is only a fraction of the rail height. The structural designer should be aware of their drawbacks: the rail joints occur at the supports giving hard knocks as the wheel passes over. In standard rails the splice in the rail would be positioned at least 1 m of the span distance away from the columns. Secondly, welded rectangular bars cannot be easily replaced when they are worn out. Thirdly such rails cannot be moved in service to obtain better alignment and therefore the whole girder must be able to be repositioned.

10.1. Rail splices and expansion joints

Ideally the rail should have flush joints for smooth running of the crane. Crane runways classified as S5 to S9 should be provided with welded rail splices so as to minimise the maintenance problems. Bolted rail splices can be used for lower class runway systems where impacts over the rail gaps are of little consequence. Continuously welded rails are preferable but they do require specialised welding process such as the 'narrow gap' process or Thermit welding

Where bolted splices are used they should be staggered on opposite runways in order to minimise the impact. The bolted joints should not coincide with the girder ends/splices. Figure 38 shows the main features of crane rail splices.

Rail expansion joints in the rails need only be provided at crane runway expansion joints, usually 150 to 200 m apart. Expansion joints are usually scarfed at 25 degree to the rail centreline. Scarfed joints provide a relatively smooth transition from one rail to the next, but they are not long lasting because the rail is weakened at the joint. To prevent the rail creep in the long direction, it is necessary to provide a shear key halfway between the rail joints.

10.2. Rail fixings

Rails must be restrained from lateral movement and uplift by clips or hook bolts. Lateral restraint is required to prevent sliding of the rail under lateral wheel reactions. Uplift restraint prevents the rail to raise ahead of the approaching wheel (bow wave effect). Some designers advocate longitudinal restraint. It is only required midway between the rail expansion joints.

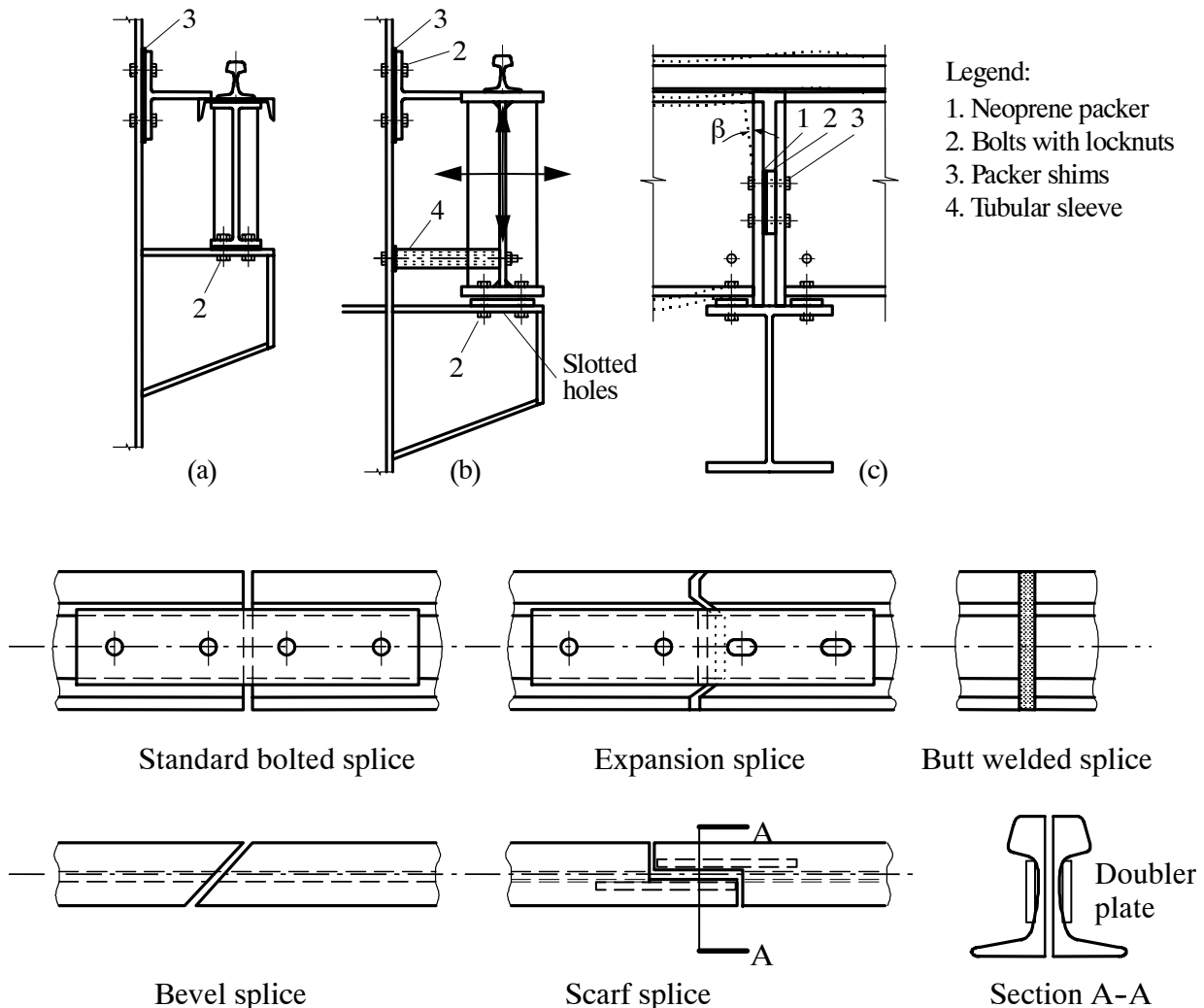


Fig 38. More bearings and crane rail splice details

The rail fixing clips should therefore be designed to provide a reliable lateral and uplift restraint to the rail. In addition, the clips should provide a means of adjusting the lateral rail alignment and permit ease of re-railing when the rails become worn out. With respect to the longitudinal restraint to the rail, there are two methods: longitudinally fixed, and floating. The longitudinally fixed type is obtained by clamping the rail down onto the top flange so as to prevent a situation where during breaking the crane causes the rail to slide and thus starts to travel obliquely. The floating type rail clips are used in conjunction with the proprietary resiliently bedded rail systems having sufficient friction resistance to avoid rail creep (reference 41, 65, 79). The most common type of rail fixings are illustrated in Figure 39.



Crane Runway Girders

Limit States Design

Second Edition 2003



AUSTRALIAN STEEL INSTITUTE
(ABN)/ACN (94) 000 973 839

Branko Gorenc

Contents

1. Introduction	1
2. Runway & Crane System	2
2.1. Crane types	3
2.2. Crane runway girders	5
2.3. Monorail beams	7
2.4. Building columns and frames	8
3. Classification of Cranes and Runways	9
3.1. Reason for crane classification	9
3.2. Utilisation Class – Global design	9
3.3. Local Utilization class	10
3.4. Multiple Cranes	10
3.5. Structural Class v/s Group Class	11
3.6. Duty Classification	11
4. Crane Loads	12
4.1. Load determination	12
4.2. Load combinations	12
4.3. Dynamic factors	14
4.4. Long travel acceleration forces	14
4.5. Wind on crane and hoisted load	15
4.6. Buffer impact	16
4.7. Oblique travelling	16
4.8. Approximate load determination	17
5. Structural Analysis	19
5.1. Global load effects	19
5.2. Analysis for global loads	19
5.3. Curved monorail beams	22
5.4. Girder cross section	22
6. Design Procedure	24
6.1. Design for strength	24
6.2. Torsion	25
6.3. Torsion Capacity by rigorous method	25
6.4. Lateral stability of the runway girder	26
6.5. Box Sections	26
6.6. Design for fatigue resistance	27
6.7. Local load effects in the top flange region	27
6.8. Web stiffeners	33
6.9. Lateral restraints at columns	34
6.10. End stops	35
6.11. Monorail beams	36

7. Design for Fatigue Resistance	40
7.1. General	40
7.2. Stress analysis	40
7.3. Number of stress cycles	41
7.4. Fatigue Verification by AS 4100	42
8. Deflection Limits	43
9. Detail Design	45
9.1. Detailing practices	45
9.2. Bolted connections	45
9.3. Welded joints	45
9.4. Splices in simply supported runways	46
9.5. Avoidance of lamellar tearing	46
9.6. Web stiffeners	47
9.7. End bearing stiffeners and bearing details	48
9.8. Crane columns and corbels	50
9.9. Longitudinal Bracing	51
10. Rails and Accessories	52
10.1. Rail splices and expansion joints	52
10.2. Rail fixings	53
10.3. Resilient bedding strips	54
10.4. Painting	54
11. Materials, Fabrication, Workmanship and Tolerances	55
11.1. Materials	55
11.2. Workmanship	55
11.3. Welding top hat sections	56
11.4. Tolerances	56
12. Inspection and Maintenance	57
13. Numerical Example	58
14. Glossary	67
15. References	69

List of Figures

Fig 1.	Types of overhead running cranes	3
Fig 2.	Types of crane drives	4
Fig 3.	Runway Static System	6
Fig 4.	Monorail beam and cranes	7
Fig 5.	Relation between building frame and the runway	8
Fig 6.	Inertial forces	15
Fig 7.	Buffers and Buffer impact	16
Fig 8.	Oblique travel forces	17
Fig 9.	Crane wheel loads	18
Fig 10.	Frame / runway relation	19
Fig 11.	Bending moment envelope and influence lines	20
Fig 12.	Global analysis for vertical and torsional loads	21
Fig 13.	Curved monorail beam	22
Fig 14.	Types of cross section	23
Fig 15.	'Top Hat' (a) and lipped sections (b)	23
Fig 16.	Localized effects in the top flange area	27
Fig 17.	Web crushing (AS4100 method)	29
Fig 18.	Buckling of the web panel due to patch load acting in the plane of the web (AS 4100 method)	30
Fig 19.	Transverse bending of web due to torque	31
Fig 20.	Transverse bending of top flange	32
Fig 21.	Elastomeric strips reduce transverse bending of flange	33
Fig 22.	Web stiffeners	34
Fig 23.	Lateral movement and rotation at girder bearing	35
Fig 24.	Forces on end stops	36
Fig 25.	Monorail bottom flange stresses	37
Fig 26.	Comparison of Becker(15) vs BHP plots for C_z under the wheel load	38
Fig 27.	Stress range vs number of stress cycles for normal stress and shear stresses (excerpt from AS4100)	42
Fig 28.	Deflection limits	44
Fig 29.	Rail meandering in practice	44
Fig 30.	Bolted intermediate web stiffeners	45
Fig 31.	Welded girder splices	46
Fig 32.	Web stiffener details	47
Fig 33.	End bearing stiffeners	48
Fig 34.	Bearings	49
Fig 35.	Unsatisfactory bearing details	49
Fig 36.	Types of supporting columns	50
Fig 37.	Longitudinal Expansion due to temperature and bracing of crane columns.	51
Fig 38.	More bearings and crane rail splice details	53
Fig 39.	Common rail fixings	54
Fig 40.	Soft bedding of rails	54
Fig 41.	Welding access to 'top hat' welds	56
Fig 42.	Applied Loads	58
Fig 43.	Section and Girder Dimensions	58
Fig 44.	Forces from trolley acceleration	59