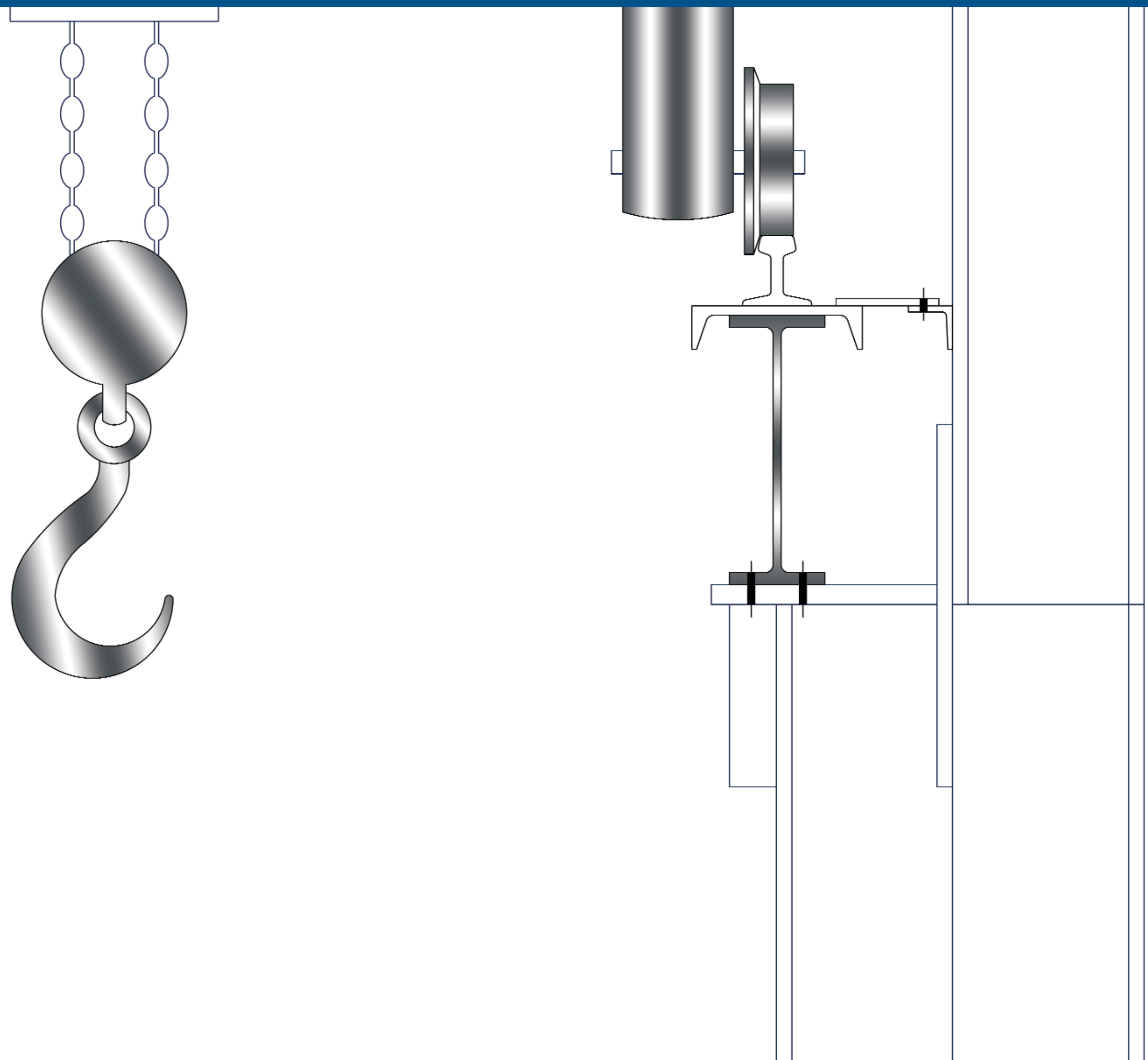
Steel Design Guide 7

Industrial Buildings

Roofs to Anchor Rods

Second Edition



The W27×94 w/C15×33.9 is adequate based on LRFD check.

Calculations also show a W24×131 beam to be adequate using an LRFD design.

Use a W30×94 w/ C15×33.9 or a W24×131. The W24×131 plain beam would be the most economical solution.

It should be noted that the *ASD Specification* currently does not have a comparable increase in allowable concentrated load for the web sidesway buckling check when flexural stress in the web is less than 0.6 F_y. Therefore, there is an inconsistency in the two specifications (ASD and LRFD) with the *ASD Specification* providing more conservative criteria. Although it is generally not recommended that ASD and LRFD design criteria be mixed, since web sidesway buckling is an independent limit state, it seems reasonable that crane runways designed using ASD procedures can be checked using LRFD equations for web sidesway buckling. For the examples presented, the W27×94 w/C15×33.9 would work for the ASD design if the LRFD web sidesway buckling equations were used.

18.2 Plate Girders

Plate girder runways can be designed in the same manner as rolled sections, but the following items become more important to the design.

1. Plate girder runways are normally used in mill buildings where many cycles of load occur. Since they are built-up sections, fatigue considerations are extremely important.
2. Welding stiffeners to the girder webs may produce a fatigue condition that would require reduction in stress range (Reemsynder, 1978). Thickening the girder web so that stiffeners are not required (except for the bearing stiffeners which are located at points of low flexural stress) may provide a more economical solution. However, in recent years, numerous cases of fatigue cracks at the junction of the top flange of the girder and the web have been noted. These cracks have been due to:

    a. The rotation of the top flange when the crane rail was not directly centered over the web. (See Figure 18.2.1.)

    b. The presence of residual stresses from the welding of the flange and stiffeners to the web.

    c. Localized stresses under the concentrated wheel loads.

The presence or absence of stiffeners affects problems a. and c. If intermediate stiffeners are eliminated or reduced, the problem of eccentric crane rail location becomes more severe. If intermediate stiffeners are provided, full penetration welds should be used to connect the top of the stiffener to the underside of the top flange. At the tension flange the stiffeners should be terminated not closer than 4 times nor more than 6 times the web thickness from the toe of the web-to-flange weld.

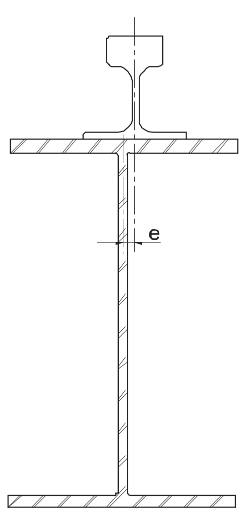


Fig. 18.2.1 Rail Misalignment

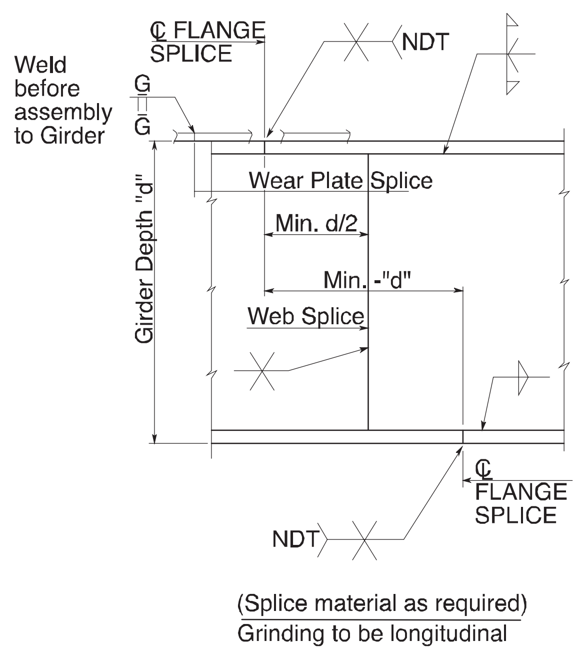


Fig. 18.2.2 Girder Splice

1. Never weld crane rail to girder.

2. Clamp, screw or bolt all attachments to crane girders to avoid fatigue problems.

3. All modifications and repair work must be submitted to engineering for review and approval before work is done.

18.8 Crane Rails and Crane Rail Joints

The selection of rail relates to crane considerations (basically crane weight) and is generally made by the crane manufacturer. Once this decision is made, the principal consideration is how the rail sections are to be joined. Several methods to join rails exist but two currently dominate.

The bolted butt joint is the most commonly used rail joint. Butt joint alignment is created with bolted splice plates. These plates must be properly maintained (bolts kept tight). If splice bars become loose and misaligned joints occur, a number of potentially serious problems can result, including chipping of the rail, bolt fatigue, damage to crane wheels, and as a result of impact loading, increased stresses in the girders. Girder web failures have been observed as a consequence of this problem.

The welded butt joint, when properly fabricated to produce full strength, provides an excellent and potentially maintenance free joint. However, if repairs are necessary to the rails, the repair procedure and consequently the down time of plant operations is generally longer than if bolted splices had been used. The metallurgy of the rails must be checked to assure the use of proper welding techniques, but if this is accomplished the advantages can be significant. Principal among these is the elimination of joint impact stresses, existent in non-welded rail construction, resulting in reduced crane wheel bearing wear.

Rail joints should be staggered so that the joints do not line up on opposite sides of the runway. The amount of stagger should not equal the spacing of the crane wheels and in no case should the stagger be less than one foot.

Rail misalignment is the single most critical aspect of the development of high impact and lateral stresses in crane girders. Proper use and maintenance of rail attachments is critical in this regard. Rail attachments must be completely adjustable and yet be capable of holding the rail in alignment. Because the rails may become misaligned regular maintenance is essential to correct the problem.

One aspect of crane rail design is the use of crane rail pads. These are generally preformed fabric pads that work best with welded rail joints. The resilient pads will reduce fatigue, vibration and noise problems. Reductions in concentrated compression stresses in the web have been achieved with the use of these pads. Significant reductions in wear to the top of the girder flange have also been noted. With the exception of a few patented systems, the pads are generally not compatible with floating rail installations since they can work their way out from under the rail. Also prior to using a pad system careful consideration to the cost benefits of the system should be evaluated.

19. CRANE RUNWAY FABRICATION AND ERECTION TOLERANCES

Crane runway fabrication and erection tolerances should be addressed in the project specifications because standard tolerances used in steel frameworks for buildings are not tight enough for buildings with cranes. Also, some of the required tolerances are not addressed in standard specifications.

Tolerances for structural shapes and plates are given in the Standard Mill Practice section of the *Manual of Steel Construction* published by AISC. These tolerances cover the permissible variations in geometrical properties and are taken from ASTM Specifications, AISI Steel Product Manuals and Producer's Catalogs. In addition to these Standards, the following should be applied to crane runways.

a. Sweep: not to exceed ¼ in. in a 50-ft. beam length.

b. Camber: not to vary from the camber given on the drawing by plus or minus ¼ in. in a 50-ft. beam length.

c. Squareness: within 18 in. of each girder end the flange shall be free of curvature and normal to the girder web.

Columns, base plates and foundations should adhere to the following tolerances.

a. Column anchor bolts shall not deviate from their theoretical location by 0.4 times the difference between bolt diameter and hole diameter through which the bolt passes.

b. Column base plates: Individual column base plates shall be within ± 1/16 in. of theoretical elevation and be level within ± 0.01 in. across the plate length or width. Paired base plates serving as a base for double columns shall be at the same level and not vary in height from one to another by 1/16 in.

Crane runway girders and crane rails shall be fabricated and erected for the following tolerances.

a. Crane rails shall be centered on the centerline of the runway girders. The maximum eccentricity of center of rail to centerline of girder shall be three-quarters of the girder web thickness.

b. Crane rails and runway girders shall be installed to maintain the following tolerances.

1. The horizontal distance between crane rails shall not exceed the theoretical dimension by ± ¼ in. measured at 68 °F.

2. The longitudinal horizontal misalignment from straight of rails shall not exceed ± ¼ inch in 50 ft with a maximum of ± ½ in. total deviation in the length of the runway.

3. The vertical longitudinal misalignment of crane rails from straight shall not exceed ± ¼ in. in 50 measured at the column centerlines with a maximum of ± ½ in. total deviation in the length of the runway.

The foregoing tolerances are from the AISE *Technical Report No. 13*. The Table shown in Figure 19.1 is taken from MBMA's *Low Rise Building Systems Manual* and gives alternate tolerances.

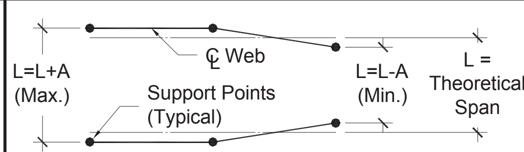
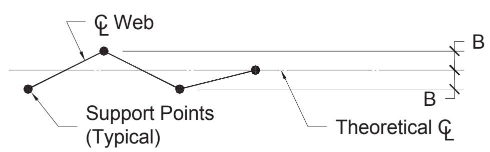
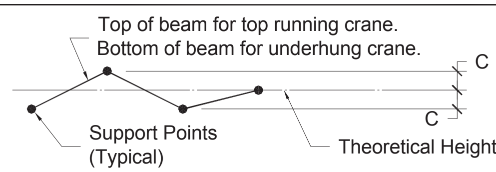
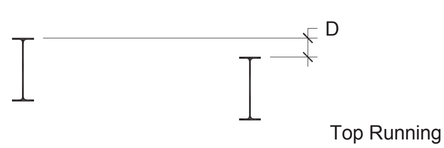
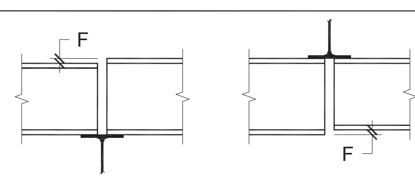
Item		Tolerance	Maximum Rate of Change
Span		A = 3/8"	1/4" / 20'
Straightness		B = 3/8"	1/4" / 20'
Elevation		C = 3/8"	1/4" / 20'
Beam to Beam Top Running		D = 3/8"	1/4" / 20'
Beam to Beam Underhung		E = 3/8"	1/4" / 20'
Adjacent Beams		F = 1/8"	N/A

Fig. 19.1 Summary of Crane Runway Tolerances