Crane Rail Mountings

Jeff Brook[1]

[1]Aspec Engineering Pty Ltd, Brisbane, Australia; jbrook@aspec.com.au

Abstract

Crane rail sections are used in a variety of applications in heavy industrial, materials handling, mining and port industries. Large rail mounted machines such as shiploaders, stackers, reclaimers, ship-unloaders and container cranes require reliable rail systems in order to operate effectively. The runway rails carry the load of the whole machine which may be many hundreds of tonnes. Other rail systems are used for secondary motions such as shuttling and traversing. Factories and workshops use gantry cranes for operations and maintenance and many of the same issues apply.

This article provides guidance on the design consideration for the selection of rails and rail restraint systems.

1. Crane Rails and Wheels

Some of the crane rail sections used in Australia for stackers, reclaimers and shiploaders are shown in Table 1 below. Design aspects of crane rail selection are covered in Australian Standard AS1418. The FEM Rules which are commonly used internationally adopt a similar methodology.

Table 1: Crane Rail Sections

Designation	Weight (km/m)	Head Width B (mm)	Head Width H (mm)	Base Width P (mm)
BSC164	166	150	140	230
A150	150.3	150	150	220
CR100	100.2	120	150	155
CR73	73.3	100	135	140
MRS87A	86.8	102	152	153
MRS86	85.53	102	102	165
MRS73	73.63	70	157	146

Specifications for the supply of rails are typically in accordance with their country of origin (European rails to DIN, PN 79/H, and BS11 standards, American rails to ASTM standards, and Australian rails to AS 1085 Part 1). Rails are manufactured in a range of tensile strength grades from 690MPa to 1080 MPa.

Rails for bulk materials handling machines are normally continuously welded. Common methods of splicing include aluminothermic “thermit” welding or puddle arc welding. Thermit welding relies on a reaction to produce molten steel which solidifies to produce a butt weld. A mould is used to contain the molten metal during the thermit welding process. Arc welding needs to be carefully planned in terms of selecting the type of welding consumables, preheating and welding procedure to suit the rail steel type. In Australia, welded rail splices typically use the “thermit” welding process. For light duty applications, rails can be spliced with bolts and “fish” plates. The designer needs to check that the fish plates and bolts do not interfere with the machine bogies and wheels.

Wheels and rails need to be considered together in the design process. Generally wheels with a wider tread have a larger load capacity than wheels with a narrow tread. Increasing the diameter of the wheel also increases the load capacity. Thus if large loads are required on a small wheel diameter, it is advisable to choose a crane rail with a wide head. Wheel failure often manifests itself as excessive wear and spalling of the surface of the wheels rather than a catastrophic fracture. Commonly used standards such as AS1418 and the FEM rules base the selection of the wheel material on material strength with no account for the effects of heat treatment and surface hardening which is commonly used on such wheels. For wheels with hardened surfaces AS1418 and the FEM rules may be over conservative. The American Iron and Steel Engineers Technical Report No 6 allows for surface hardening and this maybe more applicable when specifying and selecting wheels of this type. Typically the wheel will be specified with a hardness greater than the rail, and this can improve the overall wear resistance of both the wheel and rail.

2. Crane Rail Mountings

Crane rail mounting systems are selected to suit the rail, rail loading, and the support structure that the rail is mounted on. The mounting system is selected to enable the rail to be aligned to the design tolerances, which is typically the requirements of AS1418.1.

For heavy loads the rail is generally continuously supported, whereas a discontinuous support can be more economical when the wheel loads are lower. For long rails on concrete beams a continuous

support is generally not practical and a discontinuous support system is typically used (eg stacker reclaimer machines on reinforced concrete rail beams – Figure 1).

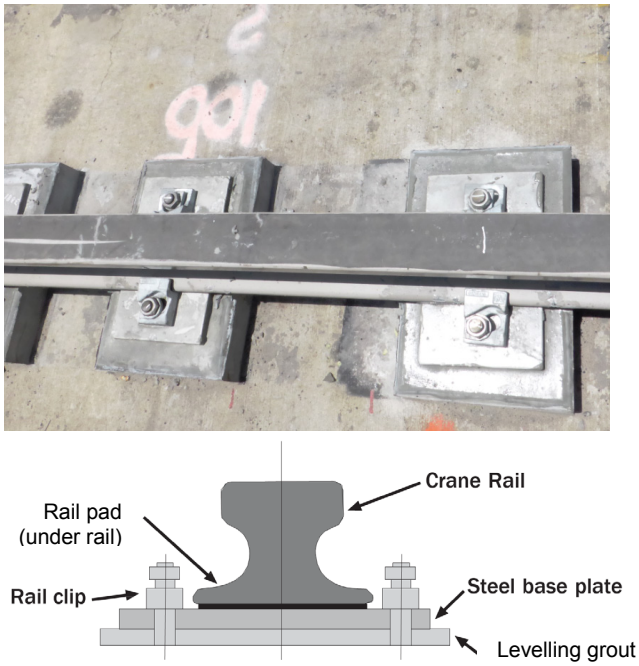

Figure 1: Crane Rail Mounting Details

Rail system supports consist of the following components:

- Crane rail
- Steel base plate
- Rail Clips - Generally rail clips are a proprietary supplied component. Clips have lateral adjustment for rail alignment, and can either have a bolted or weldable base. The selection of the base type depends on the application, but typically the welded bases have a higher lateral load capacity. For improved corrosion protection, the welded base can be welded to the steel base pate, and the component galvanised prior to installation. Clips spacing is selected to suit the lateral wheel loads and the strength of the rail to distribute the lateral load. Rail clips can be supplied with a rubber nosing which applies a controlled downward force to the foot of the rail which can assist with controlling movement of the rail while allowing the rail to expand and contract longitudinally. For load cases where there is a high lateral load and a small or zero downward vertical wheel load (eg, shiploader tied down during a cyclone wind event) the rail clip can be subject to high uplift forces caused by prying action as shown in Figure 2. Proprietary rail clips have a limited uplift capacity and often additional or special clips are required in the storm park area to transfer this prying force.

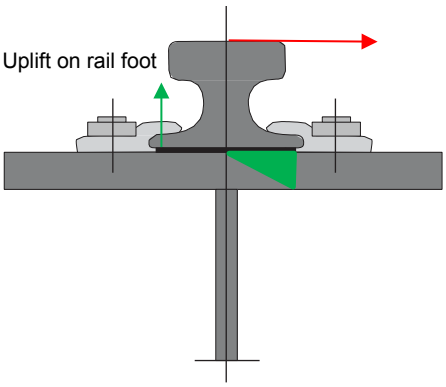

Figure 2 – Prying Forces on a Rail Clip

- Hold down bolts – Hold down bolts are selected to suit the application. For reinforced concrete foundations these can be cast insitu or post installed chemical anchors. For steel beams supporting the rail, the hold down bolts can be welded studs or through bolts.
- Levelling grout – Discontinuous or continuous base plates on reinforced concrete foundations are levelled with a high strength grout. The grout is generally selected for the imposed loads and can either be an epoxy or cementation material. The installation of the grout needs to be carefully planned to avoid air pockets and to ensure that the grout flows completely under the base plate. For cementitious grout, the installation needs to be in accordance with the supplier's instructions, particularly for pre-soaking the concrete substrate and curing, to reduce the likelihood of shrinkage cracks.
- Rail pad – Rail pads are designed to allow some movement of the rail which can reduce the dynamic compressive forces at the wheel / rail head interface, and reduce wear rates. For discontinuous sole plates, rail pads need to be carefully installed in accordance with the suppliers recommendations or the pads can move from their installed position (rail pad walking). Rail pad walking can be caused by several factors including poor fit of the rail pad restraining lips on the ends of the base plate, base plates that are not level, insufficient confinement provided by the rail clip for lateral moment of the rail pad (more common for longer sole plates relative to the length of the clip), and friction between the pad / rail base and pad / base plate.

- Longitudinal restraint - Longitudinal restraint is typically provided to the rail for the transfer of longitudinal loads and to restrict the rail from ‘walking’ for rails that are able to freely expand and contract due to thermal loads. For this type of system, a slot is machined out of the rail foot and a shear block restrains the rail at a designated location (Figure 3).

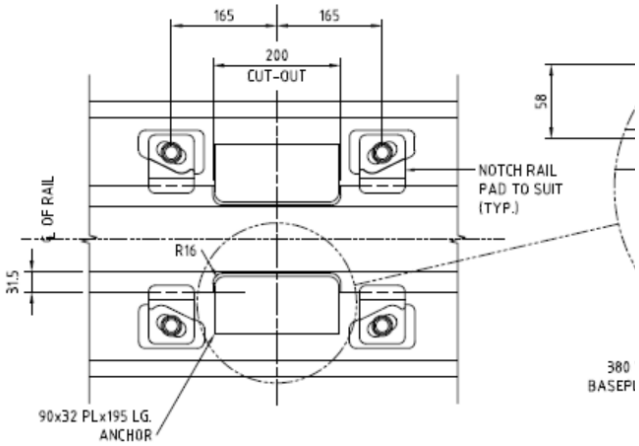

Figure 3: Example of a longitudinal restraint

The appropriate selection of rails, rail joints and rail restraints is important for the efficient and safe operation of the machine or crane.