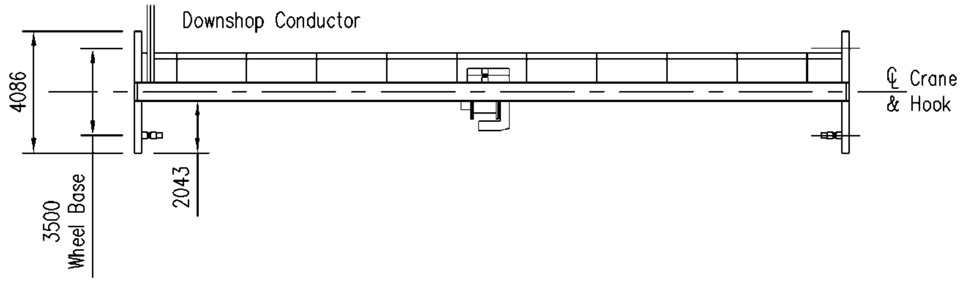
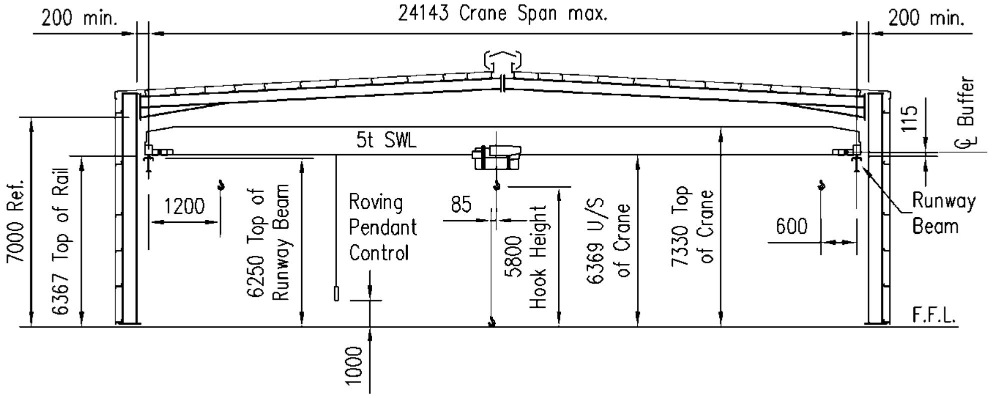
8 Crane Runway Beams

8.1 GENERAL

Overhead travelling cranes or gantry cranes as shown in Figure 8.1 are generally used in workshops and warehouses where lifting capacity is required over a large proportion of the floor area. Monorails are used where the need to lift and move items can be confined to one direction. This chapter is intended to give guidance for the design of crane runway beams and the portal frames required to support overhead travelling cranes while monorails are treated in the following chapter.



Plan



Elevation

Figure 8.1 *Overhead Travelling Crane in Design Example*

The relevant Australian standard for crane runway beam design is AS 1418.18 Part 18-2001: *Crane runways and monorails* [1]. The code is quite comprehensive and deals with forms of construction, loading and both local and global design issues. For fatigue assessment purposes, the code sets numerous structure classifications S1 to S9 which depend on the crane utilisation and the state-of-loading. The utilisation classes are U_0 to U_9 and they depend on the maximum number of operating cycles. The state-of-loading categories are Q1 to Q4 being Light, Moderate, Heavy and Very Heavy. These categories depend on the load spectrum which is essentially a measure of what percentage of the loads lifted are at the capacity of the crane. It should be noted that the words 'light' and 'heavy' in this context mean the state-of-loading and not the magnitude of the Safe Working Load (SWL) of the crane. Fatigue analysis is not required for structure classifications S1, S2 and S3 and so fatigue is not otherwise addressed in the text of this book.

The code [1] makes a further distinction between Light Duty and Heavy Duty runways. This is potentially confusing as the words 'light' and 'heavy' in this context have different meanings from those in the state-of-loading categories. Light Duty runways are defined as those comprising a hot rolled single or multiple sections with structure class up to and including S8 or those comprising a fabricated beam such as WB's or WC's with structure class up to and including S7. Heavy Duty runways are those with structure class S9 for hot rolled single or multiple sections and with structure class S8 or S9 for fabricated sections such as WB's or WC's.

The distinction between Light and Heavy Duty runways allows the code to offer minor design concessions for Light Duty runways. These concessions are as follows:

(a) Lateral loads can be assumed to be applied at the top flange and be resisted by the top flange alone (Clause 5.6.2).

(b) Torsional loading from rail eccentricity and from the action of lateral loads may be neglected (Clause 5.6.2).

(c) Local transverse bending of the top flange need not be checked (Clause 5.7.2.1).

(d) Local torsional effects due to vertical loads acting eccentrically with respect to the girder web centreline may be neglected.

Because the concessions are relatively minor, the checks are still done in the design example despite the crane runway beams being classified as Light Duty runways. Reference [2] considers that portal columns with corbels are suitable to support Light Duty runways whereas lattice, stepped or separate columns are considered suitable for Heavy Duty runways or for cranes which are high above the floor [2]. Adopting separate columns has the design advantage of separating the functions of building and crane support [2].

To proceed with the design, the designer needs to establish the level of the top of the rail, the clearance above the top of the rail and the crane wheel base. These vary with the type of crane, and can be obtained from the manufacturer. The working loads are also best obtained from the crane manufacturer who knows the self-weight of the crane, the wheel centres, the limits of hook travel across the span and the intricacies of the crane code AS 1418.18 Part 18-2001: *Crane runways and monorails* [1]. The manufacturer can usually provide loads factored for dynamic effects and lateral loads calculated in accordance with the code. There can be a significant difference in wheel loads and geometry between single and double girder cranes, so the designer should at least establish, at the preliminary design phase, the type of crane that is to be used. If the designer cannot establish the type of the crane, then a contingency of say 10% could be added to the loads provided by one manufacturer to allow for other makes which might be adopted. Nevertheless, the design should be checked when the actual crane has been chosen.

AS 1418.18 [1] directs designers to AS 4100 [3] for the limit states design of crane runway beams except where specific requirements of AS 1418.18 take precedence. Because monosymmetric beams such as crane runway beams with loads applied above the top flange are not directly covered by AS 4100, methods are proposed in this chapter to deal with such beams. Tables giving member moment capacities of crane runway beams using these methods are presented in Appendix 8.1. It should be noted that AS 1418.18 nominates a load factor of 1.25 for dead loads. Because this has now been superseded by the current dead load factor of 1.20 in AS/NZS 1170.0 [4], the 1.20 factor is used in the design example.

8.2 DESIGN PROCEDURE FOR CRANE RUNWAYS AND SUPPORTING STRUCTURE

Once the crane wheel loads and the overall geometry have been established, the general design procedure is as given below. This procedure is presented from the viewpoint of the *additional* steps needed for the design of a portal frame building with an overhead travelling crane compared with those needed in Chapter 4 for a building without a crane.

1. Obtain the static and dynamically factored vertical and lateral wheel loads from the crane manufacturer or likely manufacturers.
2. Design the crane runway beams for combined vertical and lateral loading using the design capacity tables in Appendix 8.1 for major axis bending capacity or from the first principles given in Section 8.3.
3. Carry out other checks on the crane runway beam such as flange and web thickness checks, deflection checks, shear checks and bearing checks.
4. Check whether fatigue analysis and detailing are required.
5. Determine the maximum crane load reactions on the corbel supporting the crane runway beam, and the coincident minimum crane load reactions on the opposite portal column. (If the corbel is included as a member in the computer model, these vertical loads are applied directly to the corbel. If the corbel is not modelled, the crane load needs to be applied to the column as a vertical load and a coincident moment at the level of the mid-height of the corbel.)
6. Determine the coincident lateral loads on the portal frame due to oblique travel or lateral inertia. (For the purposes of portal frame design, these loads are assumed to be applied to the portal column at the level of the top of the crane runway beam.)
7. Add the crane runway beam dead load to the dead load case in Chapter 4 and *add* the following new crane load cases:
    - Loads with maximum vertical load at left column
    - Loads with maximum vertical load at right column
    - Lateral inertia loads
    - Oblique travel loads with maximum at left column and acting from left to right
    - Oblique travel loads with maximum at right column and acting from left to right
8. Determine the load combinations.

Design of Portal Frame Buildings

including
Crane Runway Beams and Monorails

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