2. Runway & Crane System

The crane runway girders, crane, columns and building frames can all be regarded as components of the overall crane installation. The individual components cannot be designed in isolation from the whole, as is sometimes the case. Of particular importance is strength, fatigue resistance, limits of deflection and construction tolerances. Proper attention to these design aspects can avoid later problems in the mechanical operation of cranes such as severe oblique travelling forces, high wear in the rail and wheels and severe vibrations. Runway girders can in turn be adversely affected by fractures, excessive twisting, excessive deformations, vibration and fatigue cracking. Thus the runway/crane system is a highly interactive one.

A well-designed runway girder system should have:

- adequate strength in global sense to resist the least favourable load combinations
- adequate strength in local/detail sense to resist eccentric load application and torsion
- adequate rigidity in both vertical and lateral senses
- freedom from brittle fracture or lamellar tearing
- adequate endurance against fatigue cracking
- a sufficiently wide top flange to permit rail clamp fixing and lateral rail adjustment
- good access for later inspection and maintenance.

Ideally, the structural designer and the crane manufacturer should communicate so as to obtain the best overall solution. In practice this seldom occurs because the crane runways are often designed ahead of the owner's selection of the crane manufacturer and the type of crane. It is therefore necessary for the runway designer to acquire some knowledge of the characteristics of the various crane types, to be conversant with the crane operation at least in the areas where there is strong interface between the crane and the structure. The most important interface occurs at the crane rail and the top flange where several actions occur in service:

- variable, moving vertical wheel loads are applied to the rail and distributed into the girder web
- the lateral wheel loads caused by the inertial effects and oblique travelling (meandering) of the crane are applied at the top of the rail
- braking and accelerating forces are transferred along the rail and the girder to a bracing bay.
- dynamic loading and wear being absorbed by the rail to protect the top flange against excessive wear and localised stressing.
- the building frame and the runways work interactively.

2.1. Crane types

Cranes travelling on rails are broadly divided into overhead travelling cranes, portal and semi-portal cranes. Overhead travelling cranes have an important advantage in that the space under the crane rails can be utilised for storage or workshop space. In this text the emphasis is on overhead runways. Self-standing runways for portal and semi-portal cranes could be designed by the same guidelines.

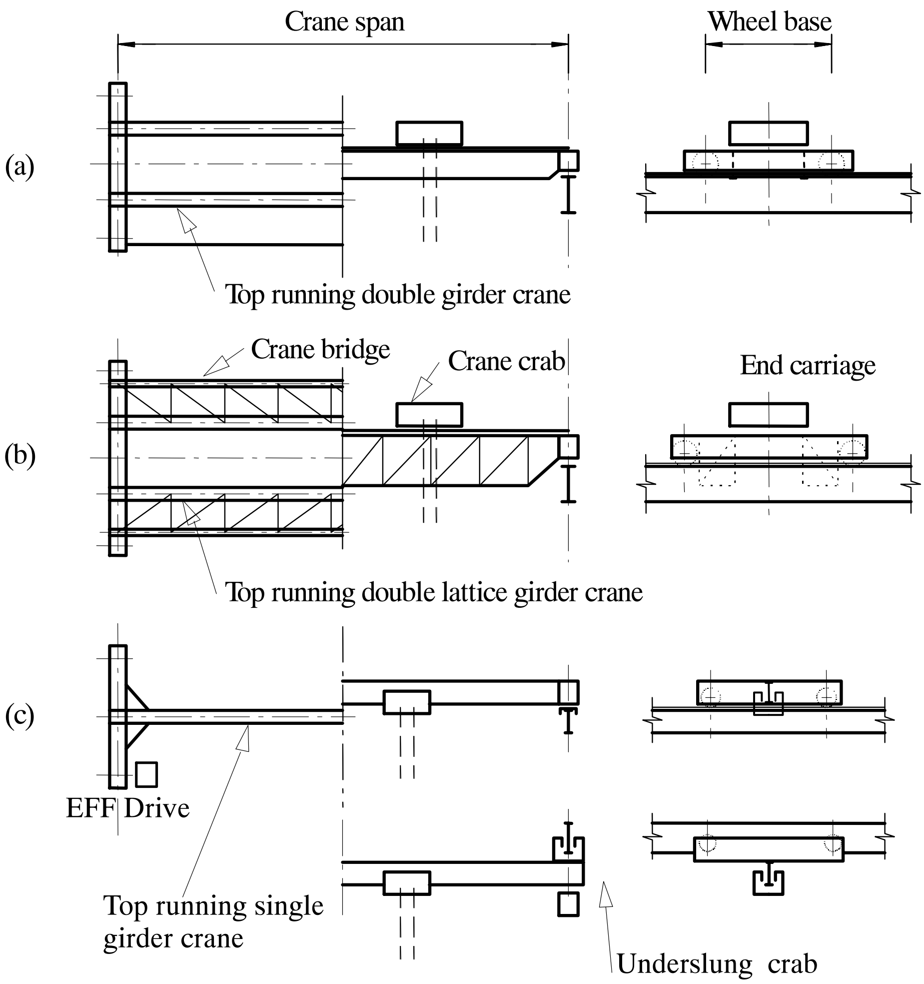

Fig 1. Types of overhead running cranes

Overhead travelling cranes are usually top running, that is, travelling on rails fixed to the top flange of the runway girders. An alternative construction is to have the crane bridge girder underslung (suspended), with the crane wheels running directly on the runway bottom flange, as in monorail beams. The latter type is not suitable for heavy-duty operation and high load capacities because the relatively small diametre wheels and the bottom flanges have a limited carrying capacity.

The typical components of the crane structure are:

- crane bridge girders, single or double girders may be used
- outrigger girders may be incorporated for support to the walkway and central drive if used
- crane trolley(s) with the hoist unit(s) travelling along the crane beam/s
- end carriages, used to transfer the loads to the crane wheels

- crane wheels and side rollers (if fitted)
- anti derailment and anti-drop devices
- drive units, wheels, bogies and bumpers
- crane driver's cabin if fitted

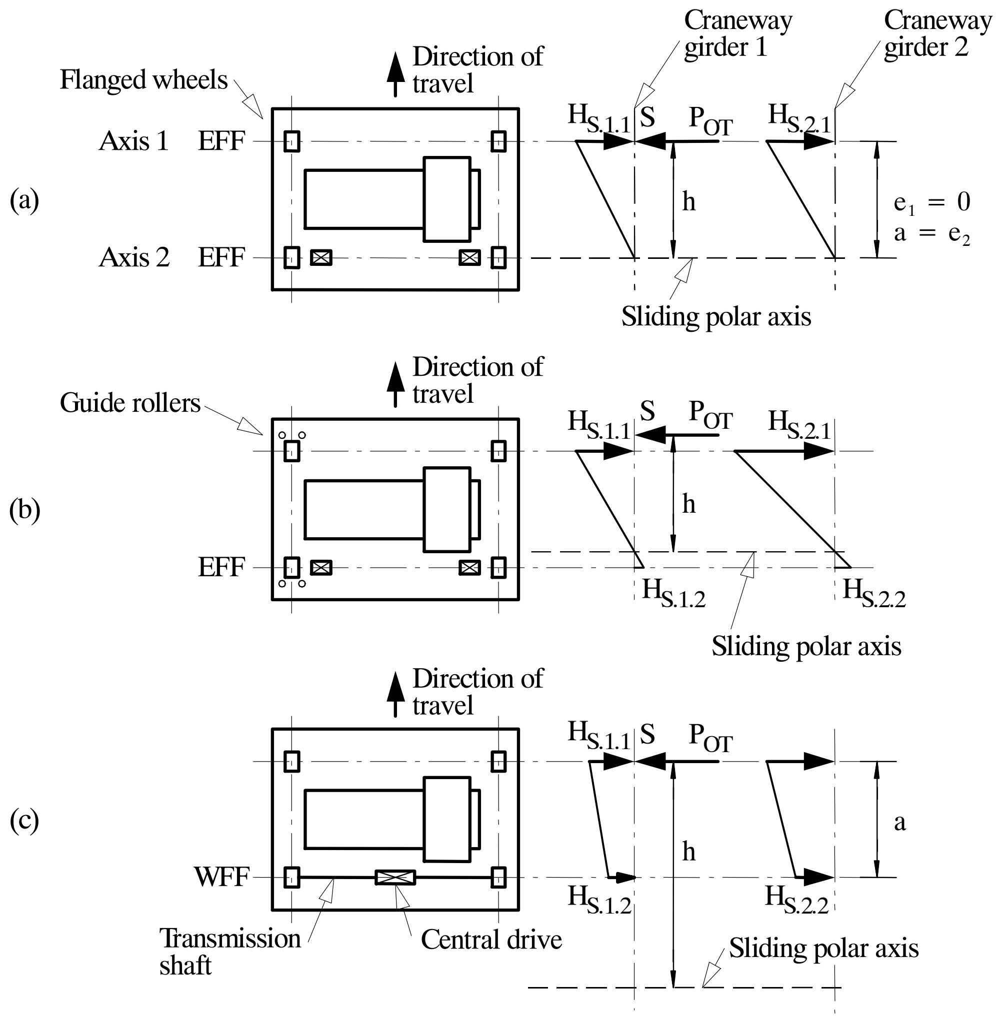

Fig 2. Types of crane drives

The arrangement of the electric drive units is important for the determination of forces applied laterally to the crane rails (oblique travelling forces). The two drive systems are EFF and WFF after the German Crane Code DIN 14018 . The prefix E signifies that the drives are independently driven, and the prefix W stands for coupled left and right drives where coupling is by means of a rigid shaft or by an electronic alignment control. The suffix FF stands for wheels that are both laterally fixed against sliding, while FL would mean that on one side the wheels are laterally fixed, while on the other side they are free to slide laterally. Cranes equipped with independently driven wheels, type EFF, are now prevalent because they have less tendency for meandering and thus produce smaller oblique travelling forces. The drive systems, known as type WFF cause the left and the right driven wheels to turn at the same rotation rate. The problem with the drives of type WFF, is that significantly larger oblique travelling forces are produced then with the EFF drive types unless active electronic anti-skew devices are employed. Figure 2 shows the common types of crane drive.

The selection of a crane is usually a province of the materials handling specialists/owner's project engineer, based on the consideration of -

- magnitude of the lifted loads
- overall sizes and nature of lifted loads
- head room clearance
- height of lift and the closest hook approach distance
- hoisting speed/s and long travel speed/s
- number of hoisting operations per day or year
- drive system and the type of crane control: (pendant or cabin)
- first cost and life cycle cost

The structural designer needs to be aware of these points in order to provide meaningful interchange during the selection process.

2.2. Crane runway girders

Crane runway girders are usually constructed in steel, although occasionally reinforced or prestressed concrete has been used without much success. The reason for popularity of steel runways lies in their versatility, rapid construction, ready provision of reliable and adjustable rail fixings, ease of erection, dimensional stability, and ability to be re-aligned in service.

The main subdivision of runways with respect to the relation to the running surface is as follows:

- runways for top running cranes are the most common type for rail mounted overhead travelling cranes
- runways for underslung cranes, termed monorail beams where crane wheels travel directly on the bottom flange (suitable for moderate wheel loads only).

Runway girders can be constructed as single spans or continuous spans (see Figure 3). Single span runways have been predominantly used for several reasons:

- smaller sensitivity to vertical settlement of columns, within reason
- simple erection without the need for on-site welding or heavy bolting
- ease of design.

Crane Runway Girders

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