Next, a trial section is selected which keeps both the deflection criteria and the combined stresses within the limits established before. Beam tables of AISC *Manual,*[18] *AISC Design Guide* 7, or Ref. 19 can be useful for this task.

The last step usually involves checking the selected section for sidesway web buckling in accordance with Sec. K1.5 of the AISC Specification.

*AISC Design Guide* 7 points out that there is yet another step that is commonly overlooked: a calculation of the local longitudinal bending stress in the top flange of the runway girder caused by moving wheels of the crane. This additional contributor to the total bending stress in the top flange can increase it by 1 to 4 kips/in$^2$.

In most cases, the design procedure outlined above results in a selection of the wide-flange beam–capping channel combination. For the heaviest cranes or for long runway spans, built-up steel girders with built-up cap channels, or even with top-flange horizontal trusses, could be required. For light cranes and relatively small bay sizes, it might be possible to select a single heavy wide-flange beam without a top channel. The increased beam weight might be more than offset by savings in labor required to weld the channel. A rule of thumb is that to be economical, a wide-flange–channel combination has to be at least 20 lb/ft lighter than a single wide-flange beam. If a single beam is used, its flange should be wide enough to allow for rail fastening hardware.

One problem with capping channels involves tolerances: since neither the channel nor the wide-flange beam are perfectly straight, there are likely to be small gaps between the two. As the crane wheels pass over the gaps, some distress in the connecting welds or in the channel itself may occur. For this reason, capping channels or capping plates should be avoided in girders used for crane classifications E and F.[15]

Crane runway beams can be of simple-span or continuous design. Continuous beams will deflect less under load and require lighter, and therefore less-expensive, sections. Continuous members, however, are susceptible to damage from unequal settlement of the supports and to buildup of thermal stresses. Simple-span runways not only are virtually unaffected by such problems but are also easier to design, erect, and replace if needed. We recommend that all runway beams be designed as simple-span members.

### 15.6.4 Supports for Runway Beams

The easiest, and perhaps the most common, method of supporting runway beams for top-running cranes is by brackets shop welded to rigid-frame columns (Fig. 15.13). The bracket supports are

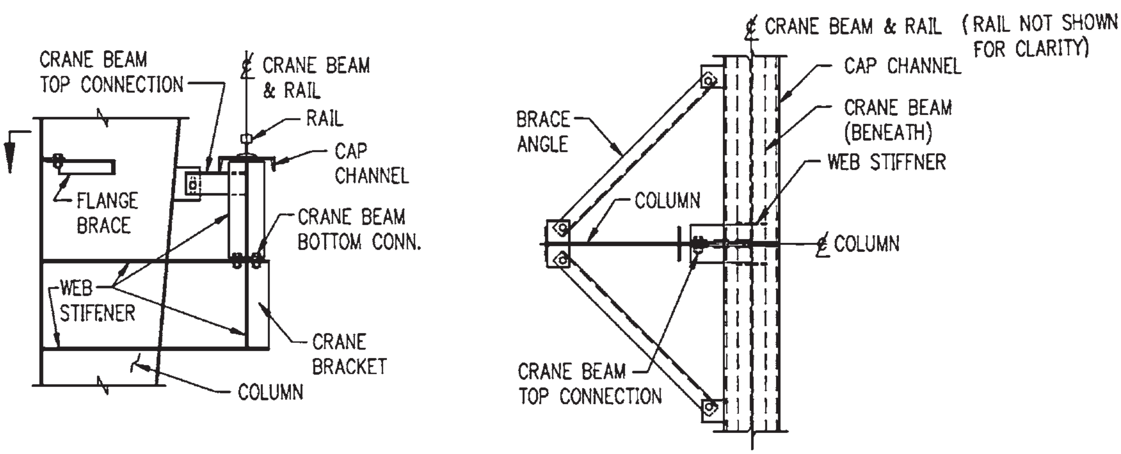


**FIGURE 15.13** Bracket-supported runway beam for top-running crane. (*Metallic Building Systems.*)

most appropriate for relatively light cranes, up to a 20-ton capacity; for heavier cranes, the eccentrically loaded building columns become uneconomical. Also, every slight impact on the runway is transmitted into the metal building structure, possibly causing vibrations and annoying the occupants.

In this system, building columns are typically reinforced with web stiffeners at the points of bracket attachment. In addition, continuous double-side welding of frame web to flanges—or using mill shapes—is recommended to improve fatigue behavior of the frame. The bottom flange of the runway beam is attached to the bracket with high-strength bolts.

The top flange of the runway beam is laterally braced back to the building frame. As discussed further in the following section, this difficult connection must allow for an in-plane movement of the runway beam's ends in two directions—horizontal and vertical, while ensuring load transfer normal to the plane of the beam. Figure 15.14 illustrates schematically how the girder ends move and curl under load.

A second method of runway support utilizes stepped building columns (Fig. 15.15), a solution that was common in old mill buildings. Stepped columns are appropriate for heavy-duty cranes and for the buildings with large eave heights that can benefit from a substantial stiffness of such columns. With this design, as with the previous one, crane vibrations are likely to be transferred to the rest of the building and be felt by the occupants.

Runways of top-running cranes with capacities exceeding 20 tons can be economically supported by a third method—separate crane columns. The separate columns are positioned directly under the runway beams and receive only vertical loading, while the building frame resists only lateral loading from the crane. A separate set of small columns may be cost-effective even for crane capacities less than 20 tons but with spans exceeding 50 ft.[3] Lateral reactions are transferred to the building frame by bracing between the two sets of columns, which also acts as a lateral support for the top flange of the runway beam (Fig. 15.16). The runway-supporting columns are normally oriented with their webs perpendicular to those of main frames. Some engineers prefer to design these columns with fixed bases to decrease the column drift, although, as discussed in Chap. 12, column fixity may be difficult to achieve in real-life construction.

### 15.6.5 Bracing against Lateral and Longitudinal Runway Forces

Of the three forces that act on a runway girder shown in Fig. 15.12, the vertical reaction $V$ is taken by the supporting bracket or column. The side thrust $S$ is resisted by a cap channel or the girder's top

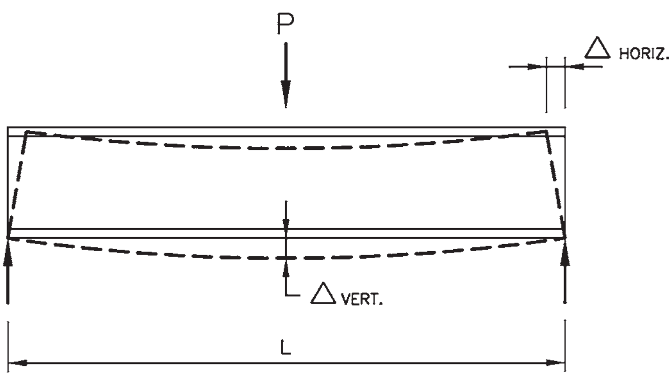


**FIGURE 15.14** Movement and curling of crane girder under load.