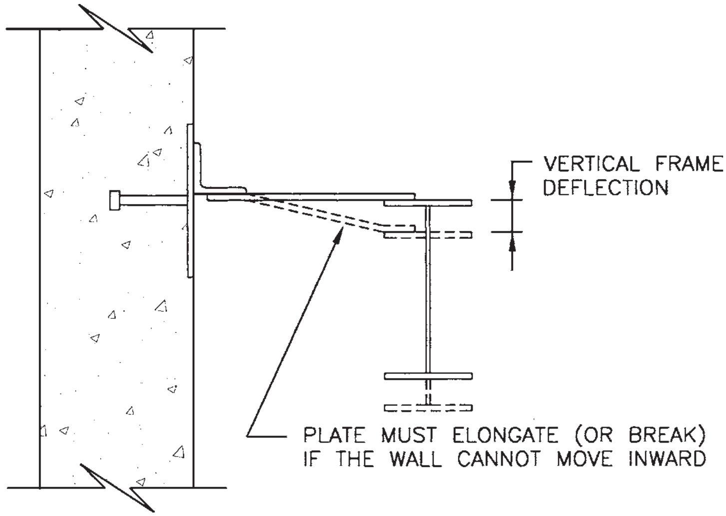

FIGURE 7.19 As the frame deflects downward under gravity load, the length of the connecting plate must increase or the wall must move inward. If the wall cannot move, the plate or its connections can break.

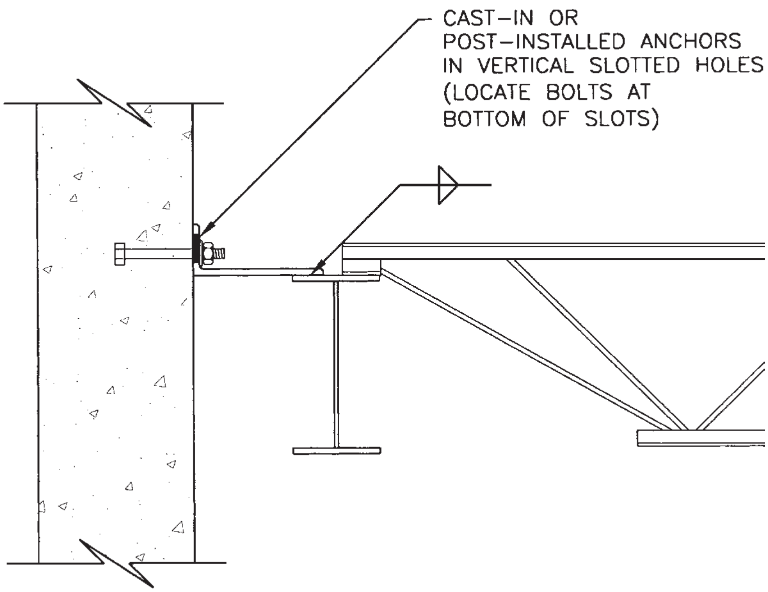

FIGURE 7.20 Connection between endwall frame and shear wall. Using an angle or bent plate with vertical slotted holes allows the frame to deflect without jeopardizing shear transfer to the wall.

7.3.5 Spanning Horizontally or Vertically?

In conventional construction, concrete and CMU walls are usually designed to span vertically from top to bottom. The bottom support is provided by the foundation, the top lateral support by the perimeter roof beams or floor deck. This approach is not well suited for a typical pre-engineered building, where in place of the perimeter roof beams one finds light-gage eave girts.

As discussed in Chap. 5, the channel-like shape of an eave girt allows for its easy connection to both metal roofing and siding. As originally conceived, the eave girt serves as a transition point between those two elements. However, while it works well with flexible metal roof and siding panels, the standard channel-like eave girt usually does not possess enough strength and rigidity to brace brittle hard walls laterally. It is easy to demonstrate that horizontal wall reactions from wind acting perpendicular to the wall will produce forces that require a much more substantial section than that of a typical light-gage eave girt. The magnitude of the forces can be seen in the design examples in Sec. 7.4.

How rigid should the top girt be? Many engineers specify the maximum allowable horizontal deflection of steel members used to brace masonry as the member length L divided by 600 (the $L/600$ criterion). Some use criteria that are even more restrictive. The same the $L/600$ criterion can be used for concrete as well.

Alternatively, concrete and masonry walls can be designed to span horizontally between the metal building columns, with masonry anchors or clip angles transferring the lateral reactions from walls to columns. While relatively straightforward for concrete walls reinforced in two directions, CMU spanning horizontally requires primary structural reinforcement to be placed in the horizontal bond beams spaced at close intervals.

The horizontal-span arrangement works with regular eave girts and seems to be preferred by many manufacturers. However, it presents the obvious problems at the doors and at any wall control joints that do not coincide with the column locations. Furthermore, load-bearing and shear-wall capacities of horizontally spanning CMU walls are not well established. And finally, the system becomes uneconomical with wide column spacing, and even with the common eave heights and bay sizes (see Example 7.3 in the following section).

7.3.6 Design Details for Hard Walls Spanning Vertically

To ensure a high level of rigidity and meet the $L/600$ criterion discussed above, the girts spanning horizontally between the frame columns must be made of structural steel rather than of cold-formed metal. There are two basic choices: to use a structural steel tube at the top of the wall or a wide-flange girt behin the wall. Both solutions have their advantages and disadvantages.

In the first solution, the tube stays hidden within the wall's thickness (Fig. 7.21). Since the wall is connected to the bottom flange of the tube, the tube is subjected not only to flexural, but also to torsional stresses. Fortunately, tubular members have superior resistance to torsion. The main disadvantage of this solution is the fact that the tube's depth is limited by the wall's, and it is economical only in areas of low and moderate wind loads. For example, a hard wall in the building with a 25-ft frame spacing and 24-ft eave height subjected to 20-psf design wind load will probably require an HSS $8 \times 8 \times 5/8$ section to satisfy the $L/600$ criterion—a rather heavy steel member.

The tube can be attached to the top of the wall in a number of ways. Perhaps the simplest is to weld headed shear studs onto the tube's bottom flange and to embed them into the still-plastic concrete or into the CMU grout placed in the top bond beam (Fig. 7.22*a*). This method requires the hard wall to be erected and grouted first, except for the top course of concrete or CMU, which is grouted immediately prior to the tube installation. Obviously, the sequence of construction requires close coordination between the trades.

Taking the opposite tack—erecting the tube before the wall—tends to make construction difficult, particularly for CMU walls. To insert vertical reinforcing bars and to place grout, workers would have to remove some side shells of the blocks and pump grout through those openings. To make their work easier, they might be tempted to simply stop the vertical bars short of the top few block courses, to the detriment of the wall's strength and ductility.