will undoubtedly increase in the future. Still, to paraphrase the famous Calvin Coolidge saying, the business of metal building manufacturers is metal. The industry has accumulated substantial know-how in the design and construction of metal-clad structures, but the same level of expertise might not be necessarily found in its dealing with masonry or concrete, let alone with GFRC or EIFS.

To ensure a successful project, the owner's design team would be wise to provide as much detailing of the hard wall exterior as it would for a conventionally framed structure. An interaction between exterior walls and pre-engineered frames is a common source of problems. Chap. 7 has already mentioned and Chap. 11 will address further an inherent conflict between the hard wall materials and flexible metal framing.

For example, as explained in Chap. 7, a quite substantial eave member is needed for lateral support of vertically spanning masonry and concrete walls or for gravity support of heavy parapet and fascia panels. And yet pre-engineered buildings do not normally have a large perimeter roof beam found in conventionally framed steel structures. Instead, the usual feature is a light-gage eave strut that works well with metal roofing and siding but is nearly useless for hard walls. Most major manufacturers are quite capable of modifying their standard framing for hard-wall conditions, but some others might not be so knowledgeable. If the wall design requires a hot-rolled steel section at the eaves or elsewhere, it is better to design it in-house and show it on the contract drawings. To delineate responsibility, such members designed by the owner's team could be excluded from the design scope of the manufacturer if need be.

Similarly, the architect-engineer team has to decide how to support any partial-height hard walls. The preferred method recommended in Chap. 7 is to "fix" these walls at the bottom and forgo any lateral support from flexible metal structure. If not shown this solution, manufacturers would probably think in terms of Z girts as they would for a metal siding.

CMU and concrete walls are often expected to act as load-bearing or shear-resisting elements. While this use is certainly rational and cost-effective, it introduces another set of problems. Similarly to the building foundations, the walls have to be designed by the architect-engineer team, but for which loads? In theory, the manufacturer could supply the horizontal and vertical loads on the wall upon completion of the framing design. In practice, wall design needs to be completed in advance, based on the specifier's own analysis and later compared with the manufacturer's numbers. The manufacturer might even expect the architect-engineer team to design connections between the wall and metal framing.

A point often forgotten: The manufacturer's standard wall accessories are designed for metal siding and are not necessarily adaptable to nonmetal walls. Items like doors, windows, and louvers, which could otherwise be available from the manufacturer, might need to be purchased outside. As we have already suggested in the previous chapter, it might be a good idea in any case.

10.2 FIXED-BASE VERSUS PINNED-BASE COLUMNS

Most experienced structural engineers will agree that it is rather difficult to achieve a full column-base fixity in metal building systems; some of the reasons are mentioned in Chap. 4, and more in Chap. 12. Accordingly, the "outside" designers routinely assume the column bases to be pinned, that is, not transmitting any bending moments to the foundations. Unfortunately, not everybody remembers to put this assumption in writing—in the contract documents.

Without being "nailed down," the pin-base assumption exists only in the minds of the specifying engineers. Manufacturers may feel free to propose a flagpole-type system with fixed-base design, which is a less expensive solution—for them. Since manufacturers do not see the added foundation costs, they may sincerely believe that the fixed-base solution saves money.

In a public bidding situation, however, by the time the manufacturer's design becomes available, the foundations may have already been designed with the pin-base assumption in mind and could even be constructed by, or at least awarded to, a concrete contractor. Since the fixed-base column design results in an unanticipated bending moment applied to the foundations, a redesign is almost always required.

At this point, the owner's choice is between accepting a large change order from the foundation contractor or a protracted battle with the metal building manufacturer. Both could have been easily avoided with one sentence inserted in the contract drawings and specifications: "The pre-engineered building columns shall have pinned bases and shall transfer no moments to the foundations."

10.3 ANCHOR BOLTS

Anchor bolts, or as the AISC prefers to call them, anchor rods (Fig. 10.3), intersect a demarcation line between the design responsibilities of the metal building manufacturer and the structural engineer of record, who is responsible for the whole project. An inexperienced specifier often assumes that anchor bolts are provided by the manufacturer, who, after all, submits the shop drawings that include an anchor bolt plan, with the bolt sizes and locations clearly indicated. Moreover, shop drawings of column base plates also include the bolt sizes; the submitted calculations spell out how many and what kind of bolts are needed.

In reality, the manufacturer does not normally supply the bolts. This fact is clearly stated in MBMA *Common Industry Practices.* The manufacturer does not even determine the bolt length, which depends more on foundation construction than on parameters of the metal building.

As explained in Chap. 12, holding strength of anchor bolts is controlled by one of the two factors: tensile capacity of the steel section and strength of concrete. The manufacturer determines the former, the design professional the latter. A case in point: anchor bolts embedded in an isolated pier are likely to be longer than those in a large thick footing. The reason: tension capacity of the pier concrete may be less than that of the bolts, a fact that may require an increased bolt length to engage the pier's reinforcing bars.

Since many column anchor bolts are indeed placed in narrow concrete piers, the structural engineer of record may want to specify the minimum bolt embedment length and the minimum edge distance. The engineer should then check the anchor bolt sizes and layout submitted by the manufacturer for consistency with the specified minimum edge distance. Quite often, the manufacturer's standard base plate details will show the anchor bolts placed too close to the edge of concrete to provide the values required by the specifier. To avoid arguments, the structural engineer of record

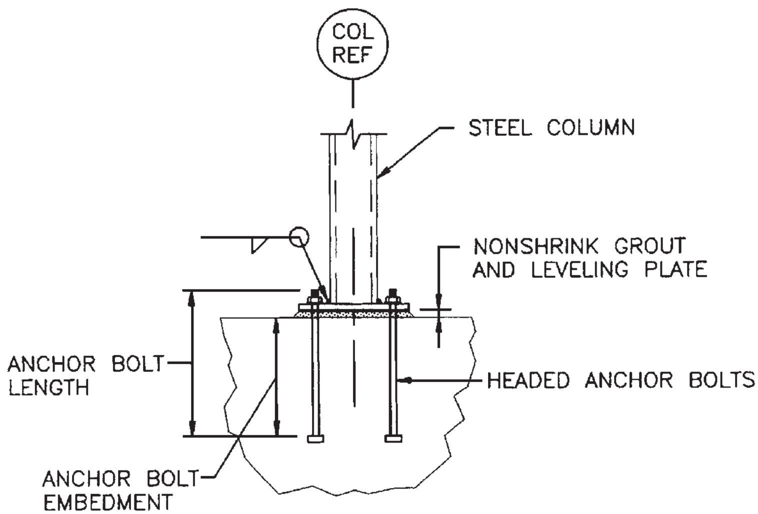

FIGURE 10.3 Anchor bolts.