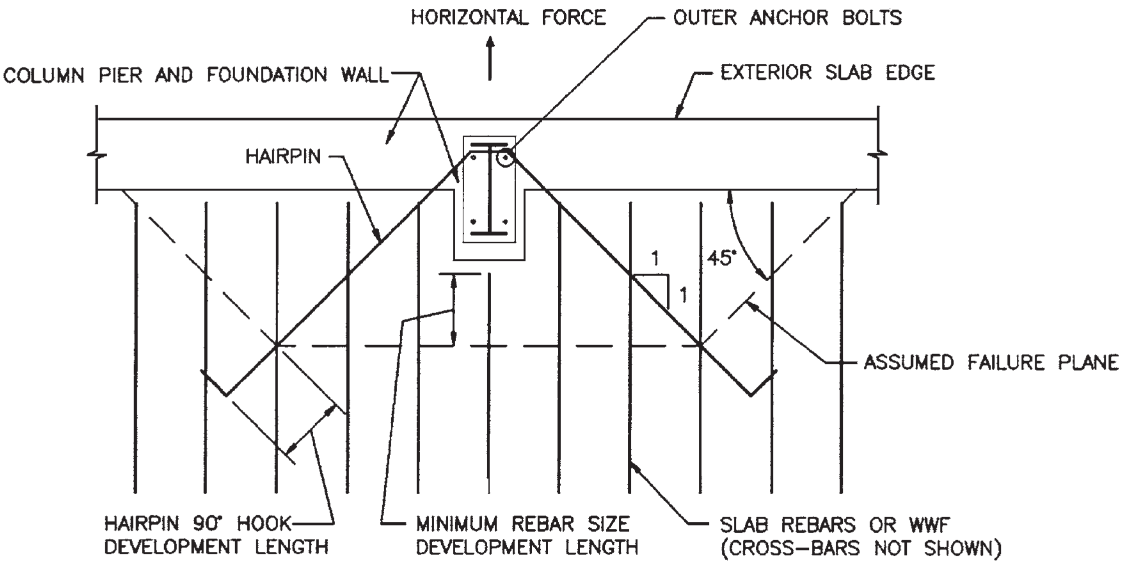

FIGURE 12.10 Hairpin rebars.

fabric, which tends to receive less attention in terms of placement and splicing practices than deformed bars. Third, slabs-on-grade usually have construction and control joints where all or most of its reinforcement is interrupted—along with tension transfer. (A conscientious engineer who is determined to preserve the load path and chooses to continue the welded wire fabric through the joints may pay dearly by having a cracked floor—hardly a good alternative.) Even if the slab contains no joints at all, as is possible with shrinkage-compensating cement, there is a fourth, and the biggest, problem—a possibility of the slab's being cut in the future to replace an underground cable or pipe. The building's lateral load-resisting system could be destroyed in one cut—without anybody realizing it! Such debacle is much less likely to happen to a structural slab. Additionally, a caveat about floor pits and trenches that was mentioned for tie rods applies equally well to hairpins.

Some engineers contend that a slab-on-grade need not be continuous between opposite ends of the building, because lateral loads can be transferred directly into soil by underslab friction; others respond that common use of polyethylene vapor barriers would severely reduce any friction potential. In any case, a sole reliance on friction to transfer lateral loads is unsettling. Still another unanswered question is: How does the slab, being weakened by joints, perform *in compression* against horizontal inward loads? Will the slab hold or will it buckle as a sheet of ice near a bridge pier?

As the author has recommended in the past,[6] it is better not to rely solely on hairpin rebars for tension transfer in slabs-on-grade. This suggestion goes against the persistent recommendations of many in the metal building industry, who see the inexpensive hairpins as an easy solution for a complex issue. Still, until some realistic tests of this system are made under various conditions, it is better to limit the use of hairpin bars to the slabs with continuously spliced deformed bar reinforcement.

12.5.3 Moment-Resisting Foundations

Column foundations can be designed to resist vertical and lateral loads in a cantilevered retaining-wall fashion, completely independent of any floor ties. The design methodology is well developed and widely available; one good source is the *CRSI Design Handbook*.[7] Unlike retaining walls, however, moment-resisting foundations have sizable vertical loads applied to them, and it is often advantageous to proportion their footings with a longer toe than heel, instead of the other way around. In this configuration, the downward column reaction helps counteract the outward horizontal load (Fig. 12.11).

This solution offers many advantages: It allows for future cutting or even a total removal of the slab-on-grade without jeopardizing foundation integrity; it can accommodate any number of floor pits, trenches, and slab depressions; it can resist both inward and outward lateral loads. This method, however, normally results in foundations that are larger than those designed by any of the previous two methods, although some extra weight could be needed in any case for a wind uplift prevention. Design of moment-resisting foundations is rather time-consuming.

Horizontal column reactions can fail a moment-resisting foundation by overturning, sliding, or both. A minimum factor of safety against both overturning and sliding caused by transient loads should be at least 1.5; it should be increased to 2.0 if the loading is caused by gravity.

While column uplift is counteracted by the usual means such as adequate "ballast," resistance to lateral loads is achieved by a combination of soil friction and passive soil pressure. Sliding resistance can be developed by soil friction and, if needed, by a concrete shear key that protrudes below the bottom of the footing into undisturbed soil (Fig. 12.11).

Moment-resisting foundations depend on some degree of wall rotation under load to mobilize active and passive soil pressures, as most cantilevered retaining walls do. The tilt occurs because soil pressure under the footing is not uniform (Fig. 12.12). This rotational movement may endanger brittle exterior wall materials. Such rotation can be prevented by a floor slab, as discussed below, but in that case a much higher "at-rest" soil pressure coefficient must be used instead of active pressure. Basement walls, for example, are commonly designed for at-rest pressures.

How much rotation has to occur to allow the use of active and passive soil pressures instead of at-rest pressures? Common practice allows the use of active pressure coefficients for movements of walls or piers as small as one-tenth of 1 percent of their height.[8]

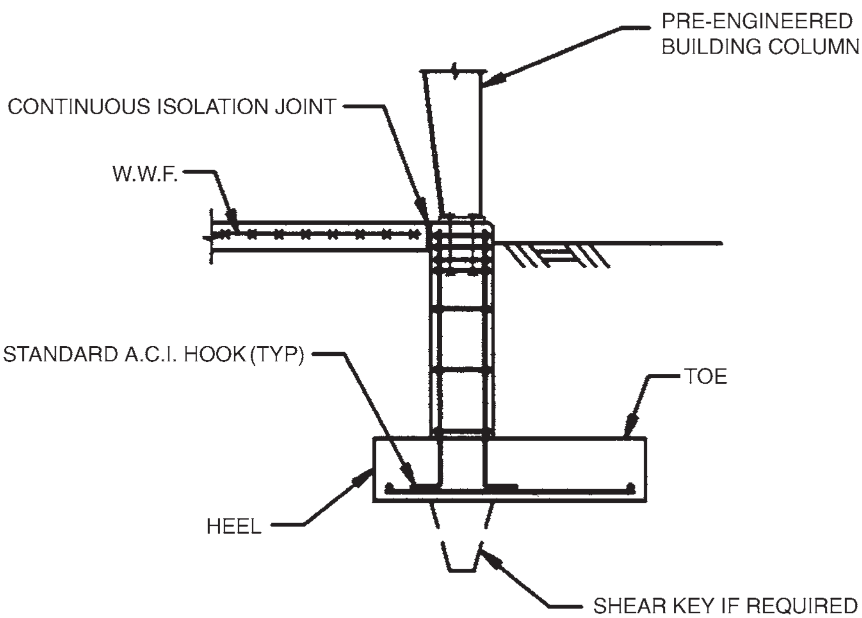

FIGURE 12.11 Moment-resisting foundation.