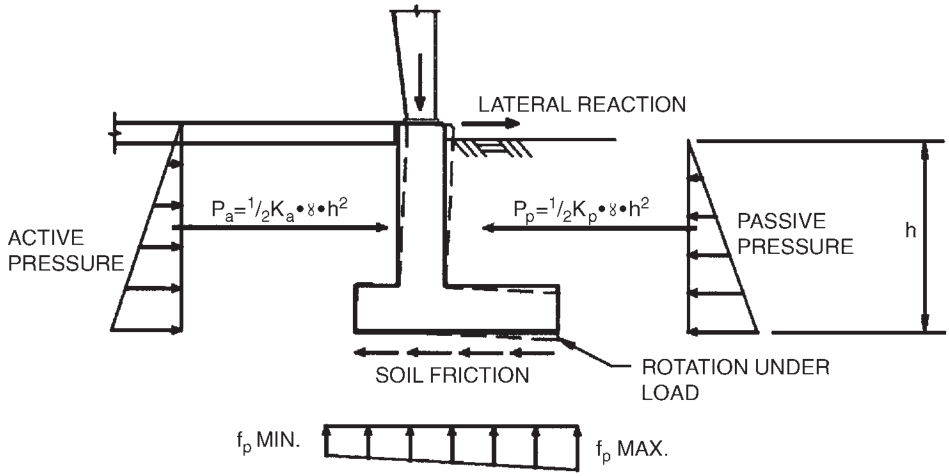

FIGURE 12.12 Load transfer in moment-resisting foundation.

12.5.4 A Combination of Methods

Some methods of resisting lateral loads can be combined to produce an economical and practical foundation design. One common system involves floor slab dowels in combination with a moment-resisting foundation or with a tie rod. This system is often provided unintentionally by the engineers who routinely specify dowels extending from foundation walls into slabs (Fig. 12.13). The design function of the dowels, and of the foundation seat, is to support the slab, allowing it to span over poorly compacted areas near the walls; an unintended function is to restrain the movement of the wall and of the column pier under horizontal loads. In effect, the dowels act as well-distributed hairpins—at no additional cost.

The main advantage of this "belt-and-suspenders" system is its redundancy: The moment-resisting foundations or the tie rods serve as primary means of resisting horizontal reactions at extreme levels of loading; the slab helps by acting as a limited horizontal diaphragm and by bracing the tops of the foundations at all other times. Were the slab continuity to be violated at some point, the foundation would not lose all of its lateral load-resisting capacity; at worst, the structure might suffer some minor serviceability problems, but not a complete breakdown in the load path.

Similarly, a tie-rod building foundation could rely on slab dowels to transfer into the slab the *inward* forces, against which tie rods are ineffective (unless encased in grade beams). In fact, design of tie-rod and moment-resisting foundations against horizontal forces acting inward and accompanied by uplift (Fig. 12.6*b*) would be quite difficult without any reliance on the slab. While the objections raised in Sec. 12.5.2 still stand, it seems easier to justify the slab contribution when it is placed in compression rather than in tension.

Example 12.1 Design a typical moment-resisting foundation for a building with single-span, pinned-end rigid frames spanning 84 ft and spaced 25 ft o.c. The frames have a roof slope of 4:12 and an eave height of 16 ft (Fig. 12.14). The frost-depth distance is 3.5 ft, and the bottom of column is 6 in above the adjacent soil. The following load combinations have been found to yield the worst-case frame reactions:

1. Dead + collateral + snow load: vertical, 37 kip (downward); horizontal, 30 kip (outward).
2. Dead + wind load from right (for the right-side foundation): vertical, −14 kip (uplift); horizontal, −11 kip (inward).

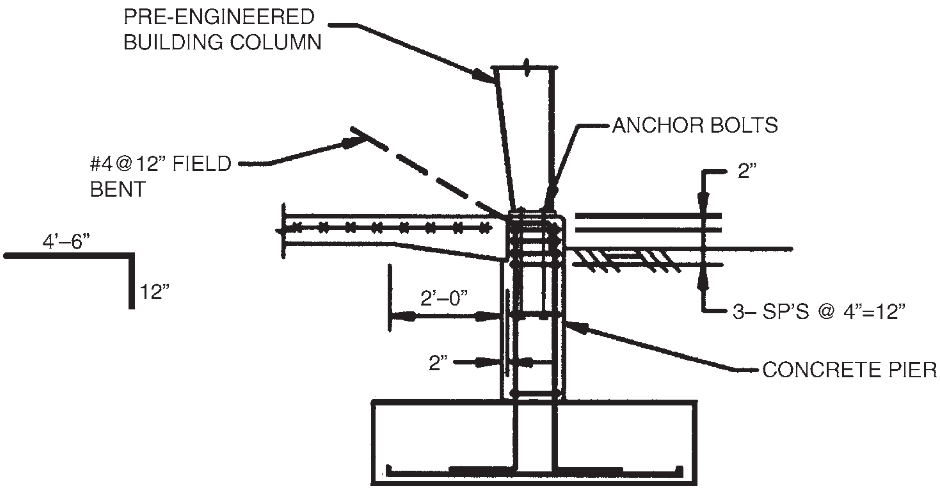

FIGURE 12.13 Moment-resisting foundation combined with slab dowels.

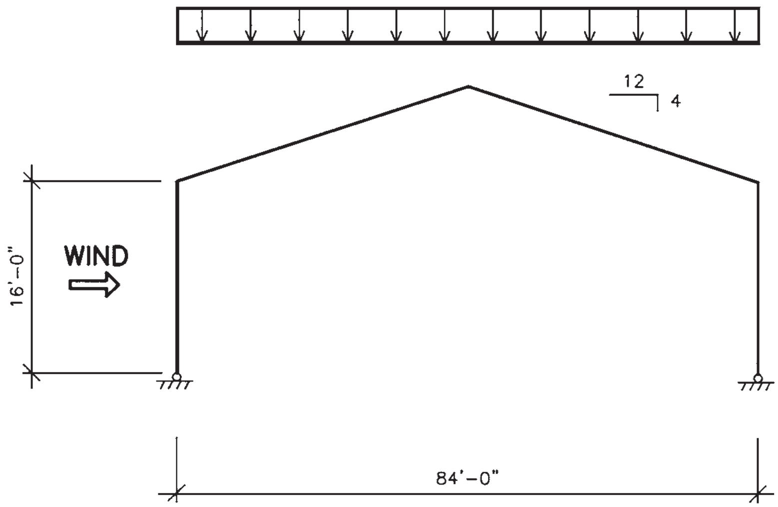

FIGURE 12.14 Rigid frame model used in Example 12.1.

The direction of column reactions on foundations caused by gravity loads is shown in Fig. 12.15*a* and by wind loads in Fig. 12.15*b*. Assume that the column vertical load is applied 6 in away from the right edge of the pier, the soil weight of 120 lb/ft^3, and concrete unit weight of 150 lb/ft^3. The slab-on-grade covers the interior part of the foundation. The allowable bearing pressure of soil is 3 ksf. The desired factors of safety against overturning and sliding are 1.5, and against uplift 1.1. Use $f_c' = 4000$ psi.

Establish overall foundation resistance to overturning, sliding, and uplift

Case 1: Dead + collateral + snow load. The foundation sizes are determined by trial and error. Try a footing 9 ft long, 4 ft wide, and 2 ft thick with a 2 ft × 2 ft column pier. The weights and restoring moments are as follows (Fig. 12.16):