12.5.7 Drilled Piers (Caissons)

Drilled piers, or caissons as they are commonly called now, are somewhat of a cross between spread footings and piles. Some caissons are formed in an open excavation, but the majority are drilled by a special rig. Similar to piles, caissons are best suited for heavily loaded buildings bearing on poor soils. A typical pier has a vertical round shaft, with or without a flared bottom, and works by end bearing, like a massive plain concrete column with a deep footing. Caissons with flared bottoms bear on soil; caissons bearing on ledge are straight and are socketed into the rock.

Caissons can also rely on skin friction, as friction piles do. Such caissons are limited in their load-carrying capacities and are rarely used; a combination of end bearing and some skin friction is more common.

Drilled piers are often preferred to piles not only because of their low cost but also because they are free from such pile disadvantages as noise, vibration, and soil heave—important considerations for urban construction. Another advantage held by caissons over piles is the fact that the bearing stratum can be inspected prior to concrete placement. In contrast, pile driving is conducted blindly. In one humorous case, piles became so distorted during driving that they assumed a semicircular shape and penetrated the ground from below, damaging the cars parked nearby! All the while, the pile drivers were under an impression that everything was fine.

Caissons' substantial size—usually 2 to 6 ft in diameter plus the bell—and large weight make them uplift-resistant. Some additional uplift resistance is provided by soil on top of the bell and by skin friction. When an uplift force exceeds the tension capacity of a plain-concrete shaft, a full-length reinforcement cage can help. Similarly, a partial-length reinforcement cage may be specified to improve the bending capacity of the shaft's upper part.

Caissons resist lateral loads as piles do—by shaft bending and by load transfer to grade beams which engage passive soil resistance (Fig. 12.23). The depth and thickness of the grade beams are determined by analysis.

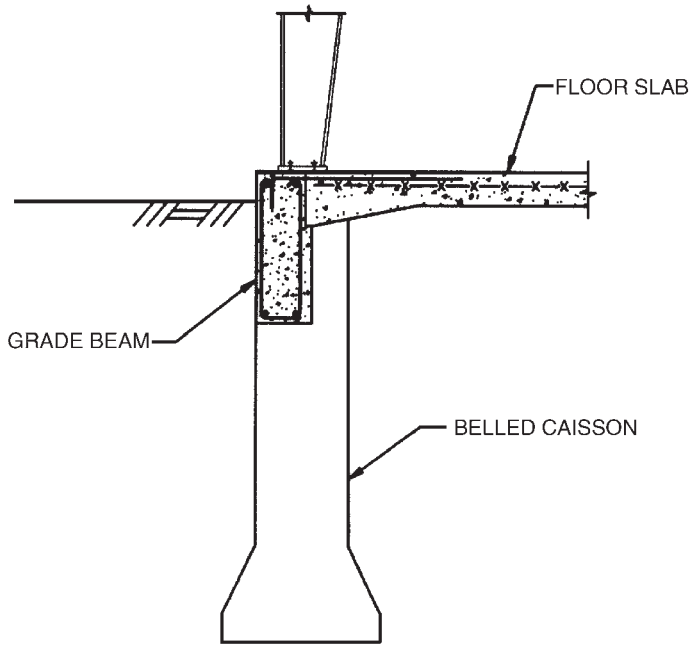

FIGURE 12.23 Belled caisson and grade beam foundation.

12.5.8 Downturned Slabs

The cheapest imaginable foundation—short of simply bearing columns on the ground—consists of slab on grade turned down at the perimeter (Fig. 12.24). This design dispenses with foundation walls and is commonly used by residential builders in warm frost-free climates. The depth of the edge beam used for houses and light temporary structures might be as small as 12 to 18 in.

This version of downturned slab, whether in its basic or "heavy-duty" (slightly widened) version, is usually inappropriate for pre-engineered building foundations, because it provides little dead weight to counteract wind uplift and does not engage enough soil to take advantage of passive pressure. This design assumes some nebulous slab contribution to help resist uplift and lateral loads—with little justification. As a rigorous analysis would indicate, the thin unreinforced, or lightly reinforced with welded wire fabric, slab becomes overstressed at the point of thickness change. As Ref. 3 states, "A crack will almost surely occur in the floor slab at the point where the `grade beam' starts." Once the slab cracks, the thickened portion becomes a separate—and probably inadequate—foundation for the building column.

This type of foundation becomes more effective if the size of the downturned slab is increased. For example, the design commonly used in the southern states for metal building support has the edge beam 24 to 30 in deep and about 24 in wide at the bottom. In some cases, the foundation is further widened at the column locations. At moderate loading levels this size might be adequate, but a better solution from the standpoint of preventing slab cracking is to design the edge beam independent of the slab, as described next. If a combined foundation is desired, a mat can provide the solution.

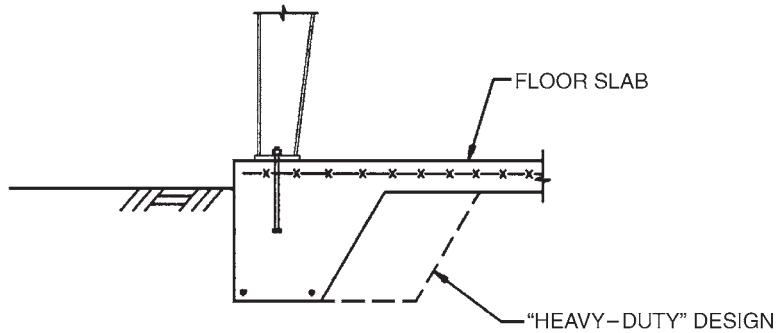

FIGURE 12.24 Downturned slab.

12.5.9 Mass Foundations

There is another alternative to foundations comprised of separately placed column piers and footings—and more substantial than the downturned slab. A mass foundation, also known as formless footing, does not rely on slab-on-grade for stability. In this type of construction both the footing and the wall are placed together in an excavated trench, eliminating the formwork and the reinforcement (Fig. 12.25). Mass foundations are often used in residential and light commercial buildings in areas where cohesive soils can safely support vertical cuts in the soil. The word *safely* is the key, as many accidents have occurred in open-trench excavations. Some sources suggest