KEEP IT SIMPLE: FOUNDATIONS FOR ADDITIONS

by Stephen Coyle

Connect new to old — without forms, footings, or frost walls in some cases

One of the most difficult and expensive parts of building an addition is the foundation. Yet the foundation is often the least "designed" element of the structure when adding a sunroom, garage, or two-story addition.

Foundations, however, should be carefully designed—taking into account both the soil-bearing capacity (see chart) and the building loads. While most builders, with a little extra effort, can calculate these values and design a basic foundation, it's wise to consult with a structural engineer—even if only for a half-hour plan review. Professional design is particularly wise if the project involves poor soil conditions, complex load patterns, or sloped sites.

If the design is simple and straightforward, however, and you have the confidence and experience to go it alone, by all means proceed!

The primary foundation question is: Basement or no basement? If no basement, the next hard question to ask is "Do I really need foundation walls, or will piers suffice?" We will examine both basement and crawl-space foundations, individual pier construction, and an alternative matt-type foundation.

Consider Piers

Perimeter crawl-space foundations require excavation below frost depth, as well as footings, vents, drainage, connection to existing foundations, and backfilling. This means considerable time and money, and the added difficulty of working in the wet and cold conditions of a crawl space. After contemplating this, you might decide to make the crawl space into a basement, as the bonus square footage is usually well worth the extra excavation, waterproofing, and slab.

However, if no basement is needed, consider substituting individual pier-footings for foundation walls and span the piers with above-grade framing (see Figure 1). You might add dry-laid stone or lattice to the opening between grade and framing, and trim out the posts. In any case, follow the simple procedure outlined below.

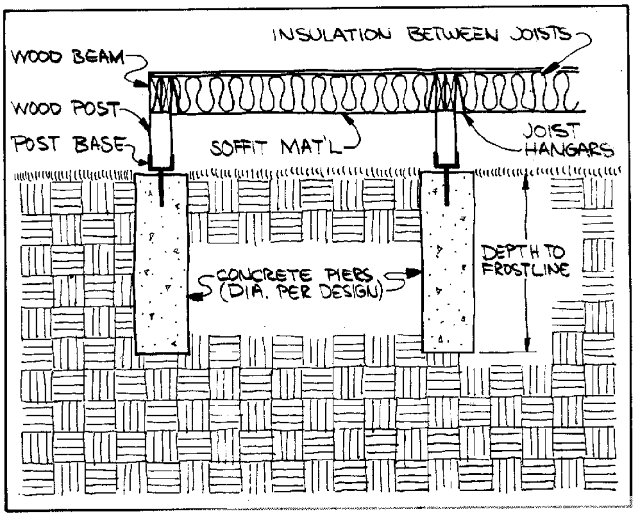

*Figure 1. **Pier foundation.** This simple alternative requires no forming, no waterpoofing, and minimal engineering. Above-grade posts can be wood or masonry, and the openings between piers can be infilled with lattice work or solid material.*

*** Soil Bearing Values**

Material	Allowable bearing (tons/sq.ft.)
Massive crystalline bed rocks, (granite, gneiss, trap rock, etc.) in sound condition	100
Foliated rocks (bedded limestones; schist, slate) sound condition	40
Sedimentary rocks (hard shales, siltstones, sandstones, soft limestones), sound condition	15
Hard pan; gravel, sands, exceptionally compacted	10
Gravel, sand-gravel mixtures; compact	6
Gravel, loose; coarse sand, compact	4
Coarse sand, loose; sand-gravel mixtures, loose; fine sand, compact; coarse sand, wet, confined	3
Fine sand, loose; fine sand, wet, confined	2
Stiff clay	4
Medium stiff clay	2
Soft clay	1

*Values are for general reference only. Consult engineers and local codes for allowable values

To design a foundation, you must first determine the soil's bearing capacity at the footing level. When underlying soils have been previously disturbed, contain expanding clays, or are filled with organic debris such as stumps and peats you must excavate down to undisturbed or firm soil. Deep excavations may be partially filled with compacted stone or gravel. Whichever fill materials are used, compact in 6- to 9-inch layers.

Figure the structure's point loads, increase the values by 1/4 as an additional safety margin, and divide by the soil value to get the required footing area. For instance, a 4,000-pound point load becomes a 5,000 pound design load. A 2,500 pound-per-square-foot (psf) soil capacity gives us 2-square-feet minimum bearing area or a 20-inch-diameter footing. This type of footing can usually be dug by hand or power-augered, but must be dug below the local frost depth.

You can make a quick-and-dirty pier by filling the hole with dry 4,000-pound pre-mixed concrete and wetting it completely (slump is not important since the concrete is contained by the soil). Or you can pour in a minimum 2,500 psi low/no slump concrete. Reinforcing may be required, especially in deep piers. Screed off level at grade and set a galvanized post base in the top if wood posts are used. If you plan to build masonry columns, key them to the concrete pier with cast-in-place reinforcing bars.

Spacing the piers 8- to 12-feet on-center generally makes both the foundation and framing economical. As the spacing increases to over 12 feet, the footing area and lumber sections may become overly large and unwieldy.

You can install insulation between the floor joists, and box it in with treated plywood under the joists. If you want to close in the perimeter, one option is to use fiberglass-reinforced cement board, buried several inches into the earth. Or for an open system, you can install treated-wood or pvc lattice work between posts and framing.

Perimeter Walls

Perimeter foundation walls require more careful design solutions than piers. You must also design connections to the existing foundation to provide watertight and structurally compatible joints. For instance, walls may have to resist soil and hydraulic pressures and slabs may have to resist differential settlement or other adverse conditions.

Footings should be sized for the total building loads, including the weight of the foundation, applied continuously per linear foot of wall. For instance, a total building load of 2,000 pounds per foot in fine sandy soil will require a minimum 12-inch-wide footing. Also, footings should be at least 2 inches wider on each side than the foundation walls. This allows some tolerance in positioning the walls on the footing.

The footing should be at least 12 inches thick to bridge high areas and soft spots, but may need to be thicker depending on the specific load and soil conditions. Also, where backfill soil pressures are high, secure the wall to the footing with some type of keyway, such as a pull-out 2x2 along the center of the footing. Where the water table is high, or drainage a problem, you may need to use continuous waterstops in place of keyways, especially when slabs are poured at or close to footing levels. Waterstops should always be mechanically braced during the pour to prevent their collapse.

Whether to use block or poured concrete depends on existing conditions, local trade practices, and cost. Concrete block can always be reinforced, although solid concrete will always be stronger and inherently more moisture resistant. Many state codes require structural reinforcement of both masonry and concrete. But as a rule of thumb, any masonry foundation deeper than typical crawl-space depth should be vertically reinforced at least enough to resist horizontal soil pressures.

Finally, if you opt for a full foundation, you'll need to pour a slab. Too often, though, basement slabs are poured without giving any forethought to the underlying soil conditions. The result is often slab settlement, water penetration, or slab uplift. Where you can't prevent slab settlement by compaction or fills, you can use "floating" slab construction to prevent damage to the concrete. In this technique, the slab edges are separated from the foundation walls and columns by filler materials such as asphalt board or neoprene, which allow the slab to slide up and down against the walls. If water penetration is also expected to be a problem, you should seal the perimeter joints with a pour-type or gun-applied masonry sealant—typically polyurethane or silicone-based.

When building on extremely weak soils such as soft clays, silts, or cinders, or where hydrostatic pressures could cause slab uplift, you may need to design a structural slab. A true, self-supporting slab will require professional consultation, period.

Connecting New to Old

Connecting new to existing foundations presents three problems: The first is how to maintain structural compatibility—in other words, how to prevent the new from settling down or away from the old. The second is how to maintain a watertight joint between the foundations. And the third is how to design for different footing elevations.

The best way to prevent differential settlement between the new and old walls is to apply all the standard rules of good foundation design to the new walls. As an additional precaution, new foundation walls should be dowelled to the existing wall, but only when the old wall has enough integrity to secure the dowels. Dowels usually consist of lengths of horizontal reinforcing bars spaced along the vertical wall.

In masonry walls, a #3 bar can be placed at each or alternate horizontal joints. Secure the bars into new or old block by bending each bar into the first full core and grouting it solid (see Figure 2a). Concrete or other monolithic walls should be drilled at least 6 inches deep with a large enough diameter to allow non-shrink grout to be packed in around the dowel (Figure 2b). Dowels typically are placed about 12 inches apart. Use galvanized bars where you anticipate water penetration.

On sites with water-problems, also use some form of waterstop where new meets old. But true waterstops are usually practical only for concrete walls, and difficult to apply to existing walls, since they must be cut in. A practical alternative is the compression-type seal, which is a self-adhesive foam gasket that sticks to the existing wall and is compressed by the weight of the fresh concrete when it is poured into the new form. (Two such products are: Gusset Tape, W.R. Meadows, 130 Toryork Dr., Weston, Ontario M96-1X6; and Will-Seal, Illbruck/USA, 3800 Washington Ave. N., Minneapolis, Minn. 55412.)

If you can't use a waterstop, use an exterior-applied sealant such as a silicone or polyurethane. With these sealants, you must use a non-bonding backing material to limit the joint depth. The depth-to-width ratio should be about 1:2 for 1/4 - to 3/4 -inch-wide joints. For example, a 1/2 inch wide joint needs a sealant depth of only 1/4 inch. Sealant is often applied too deep and fails when the joint opens. Also, merely smearing quantities of sealant along the

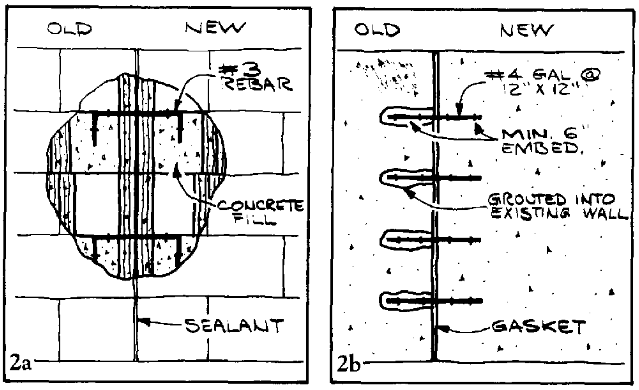

Figure 2. Tying in. *Bent #3 bar should be grouted in place in alternate courses to join new to old block. For concrete walls, drill into the old wall, dowel, and compact with a non-shrink grout. Seal the joint with urethane or silicone (for masonry) or a compressible gasket (for concrete).*

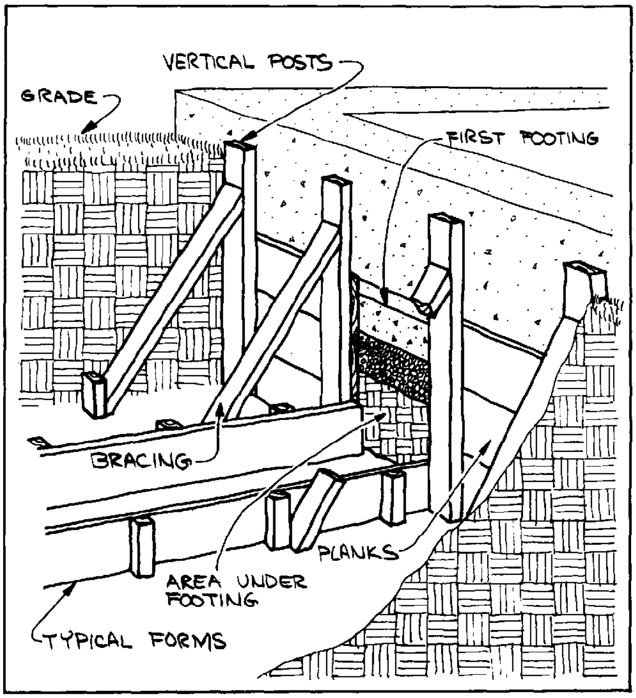

Figure 3. Stepped footings. *Where the new footing lies below the level of the old, simple shoring should be used to prevent undermining of the existing foundation.*

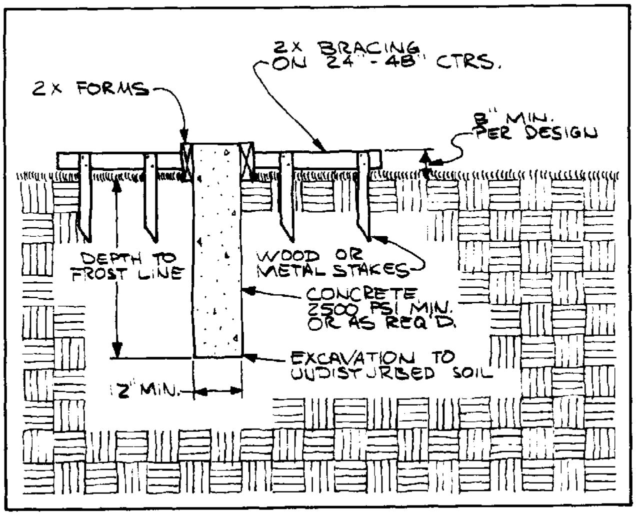

Figure 4. Combined wall/footing. *No footing is needed in a crawl space if the soil can support the structure on a 12- to 24-inch wide base. Formwork can be simplified, as shown, if the soil can hold a vertical cut. Or formwork can be eliminated altogether by pouring only to grade and finishing with block.*

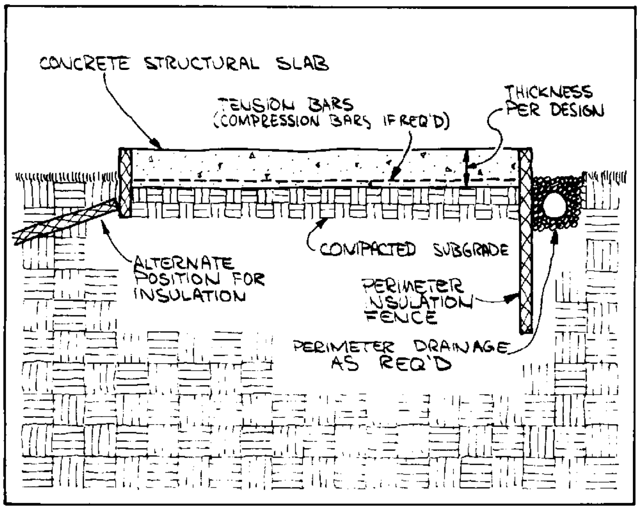

Figure 5. Matt foundation. *This is ideal for sites with high water tables, but well-draining soil. It's also well suited for sites that are difficult to excavate due to ledge. The perimeter "fence" of insulation, installed after the slab is complete, insures against frost heave.*

joint will only increase the likelihood of adhesion failure as the inevitable creep, settlement, and shrinkage of the foundation occurs.

Stepped footings and walls are always a problem when the new foundation is deeper than the existing one. Undermining the old footing can be limited by, the simplest of shoring techniques. Drive old fence posts, 4x4s, or steel angles along the old wall at each side of the new wall connection, bracing horizontal rough-sawn planks or plywood as shoring (Figure 3). If undermining does occur, you'll need to thoroughly compact the area and add layers of structural fill until the area is secure.

Combined Wall and Footing

When soil and loading conditions permit, crawl-space foundations can be simplified by combining wall and footing into one pour (see Figure 4). To do this, soils must be firm enough to hold vertical wall excavations, and the soil must be able to support the weight of the building on a 12- to 24-inch-wide footing. (This system should not be confused with grade beams, which function as beams spanning between piers.)

If you cannot keep the trenching for combination footing/walls straight and true, then set low forms along grade lines to create a neat and even foundation line. You can also use forms to bring the foundation wall up above grade. More typically, however, the wall is poured just to grade and a couple of courses of block are added on top. This "slot-trench" type of foundation may require reinforcement, depending on loads, wall widths, and depths.

This foundation type is easy to insulate. Just set extruded polystyrene insulation boards around the outside perimeter of the trench, and pour to the insulation. It will bond solidly. All in all, the entire foundation operation can be completed in a day or two: Trench, insulate, pour, and screed.

Matt Foundations

Finally, a foundation unfamiliar in the Northeast may be of interest—especially in areas that are difficult to excavate due to ledge or wet ground that cannot be readily dewatered. This is the matt foundation, or monolithic structural slab/footing—a variation of the slab-on-grade techniques popular in warm climates. The primary advantage of the matt foundation is that no excavation is needed. The matt foundation also has the advantage of bridging soft or settled areas, such as pockets of silt.

To make a matt foundation, the slab area is moderately leveled, compacted, formed, and poured (see Figure 5). As with any structural slab, professional design is required, hut the reinforcement usually consists of simple tension bars.

While matt foundations work well on sites with high water tables, they should only be used in areas with well-draining soils, since the natural subsurface drainage will discourage frost heaving. With all matt foundations, however, you should add an insulation "fence" around the perimeter as further insurance against frost heave and to moderate slab temperatures.

To install the insulation, dig a perimeter trench by hand or with a "ditch witch" or similar rentable trenching machine—after the slab is poured. Use a non-hygroscopic and non-water-permeable insulation such as extruded polystyrene (Styrofoam), and carry it up to the top edge of the structural slab so it connects with the wall insulation. (The ditch can also serve as a surface perimeter drain if needed.) In extremely difficult soils, you can angle the insulation away from the foundation, or even run it parallel to grade.

With the insulation, the underlying soils will be protected from freezing when the building shell is enclosed and heated. Even during cold periods when the heating system is inoperative, the ground below the foundation will retain moderate temperatures.

By taking a little extra time to investigate the ground that will support your building, and to properly design the foundation, you can gain confidence and satisfaction at a relatively small cost. Quality work is the foundation of any successful business and the mark of a craftsman. ■

Stephen Coyle is a registered architect with Ondras Associates in Somerville, Mass. He worked as a contractor before apprenticing in an architect's office. A Vietnam Veteran who did not attend college, he became registered after working twelve years in the profession and taking the architectural licensing exam.