SLAB-ON-GRADE FOUNDATIONS

by Will Prull

Accurate excavation and careful formwork are the keys to this simple technique for pouring monolithic slabs

In a slab-on-grade foundation, also known as monolithic slab construction, the floor slab and footings are poured simultaneously to form an integral unit. The concrete slab is placed directly on the ground, with plumbing pipes, electrical work, and ductwork running underneath. Slab-on-grade works well with the passive solar designs and radiant heat floors popular in Santa Fe, where I build custom homes. And compared with a stem wall with footings, slab-on-grade foundations can save money, especially for simple buildings with few jogs or ells. The footing excavation for a slab-on-grade is shallower, the forms are simpler, and there's no floor system to frame. If a building site is level, and the soil is easy to excavate but will hold its shape when trenched,

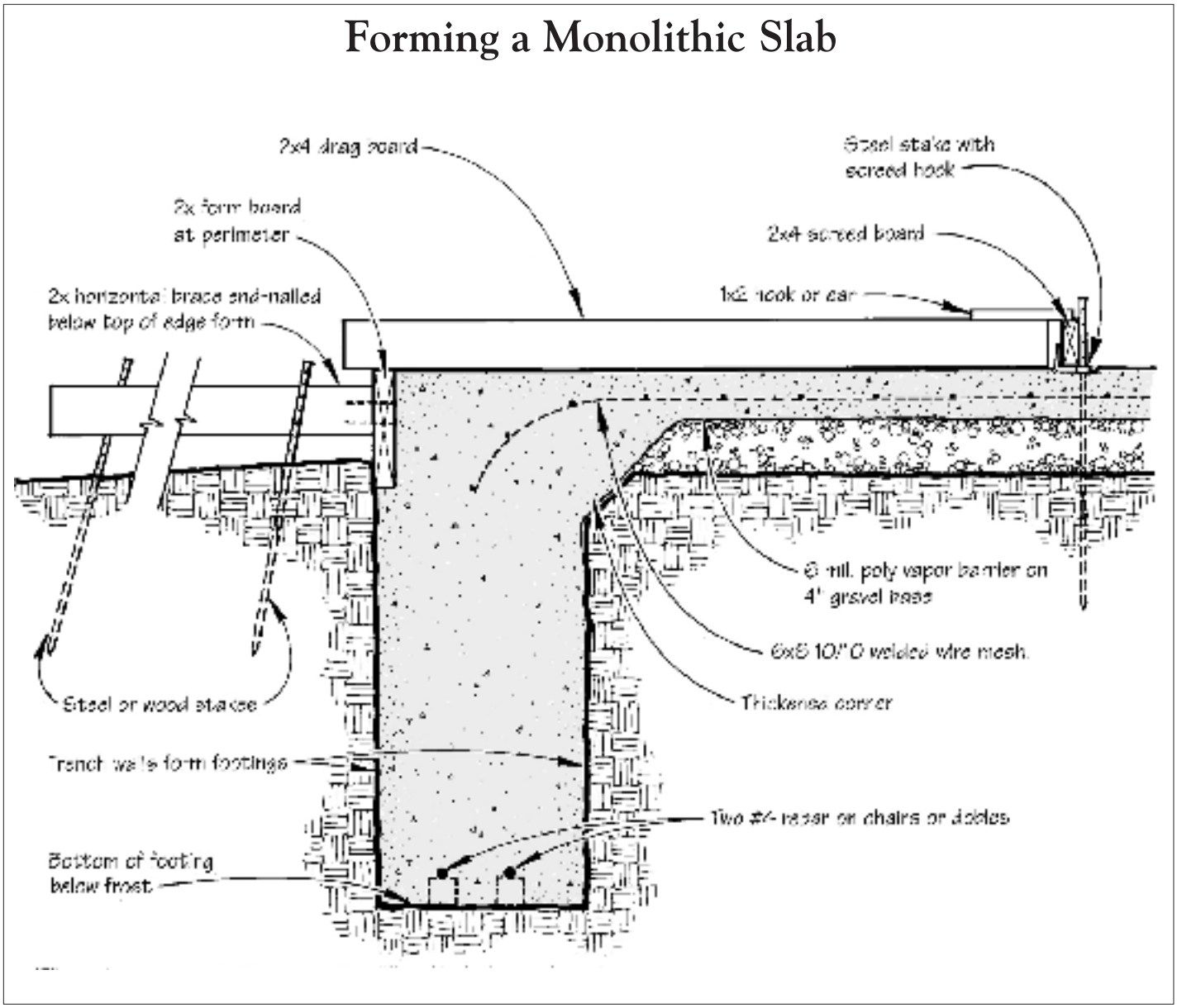

Figure 1. *In slab-on-grade construction, accurate excavation is important because the trench walls act as footings forms. Use a poly vapor barrier, and in damp locations add a 4-inch compacted gravel base.*

slab-on-grade can save from 1% to 4% of the overall cost of the project.

Site Preparation

Proper site preparation is essential. We begin by grubbing the building pad to remove all vegetation, then set a bench mark to establish an elevation for the finished concrete floor. In our area, the top of the finished slab is usually 6 inches above final grade (see Figure 1, above).

Establish the subgrade. If no fill is to be added, the subgrade is usually 4 inches below the top of the finished slab. In damp areas, however, the subgrade is 4 inches lower and we spread a 4-inch layer of gravel to isolate the slab from ground moisture. We use a flat plate vibrator to compact any fill material. Where radon is a concern, we install vent pipes in the gravel base. If mechanicals are going in, the gravel base is usually laid down later as part of the slab preparation.

Layout. To lay out the building's perimeter, I build two batter boards at each corner. Using a transit, I set the tops of all the batters at the same level so that measurements pulled from the strings will be accurate. Where possible, we set the batter stakes at least 30 feet back from the building perimeter to make room for form bracing and to allow concrete trucks to maneuver.

We pull string lines between the batter boards to establish the exterior line of the building. We transfer the string lines to the ground by carefully pouring a lime strip on the ground directly under the strings. After the exterior is laid out, use lime to mark out any interior footings, piers, or pads that will support interior loadbearing walls, structural posts, and fireplaces.

Excavation. We use a backhoe to excavate, starting with interior footings and pads, and finishing with perimeter footings. The width of the footing is usually the same as a typical spread footing for a stem wall. In Santa Fe, that's 16 inches.

Explain to your excavator how important it is to dig the trench right to the lime line. Since we use the side of the trench as part of the form, overexcavation means wasted con-

crete. If the trench is cut too much outside this line, concrete will "boil out" under the forms. If it is cut inside this line, you may have to carve off portions of the trench sidewall by hand. When trenching, most of the excavated footing material should be piled to the outside of the building line.

Rough-in. Once the footings are excavated, the plumbing, mechanical, and electrical subcontractors can rough in any work that is going under the slab. I provide them with a bench mark for the finished concrete floor and reset strings from the batter boards so that they can pull dimensions. Mechanicals stubbed outside the building perimeter either run under the footing or they pass through a schedule 80 PVC sleeve placed in the footing trench.

Slab preparation. The last step before forming includes fine grading, compaction, installation of a vapor barrier, and setting reinforcing steel. We cover the subslab with a 4- or 6-mil vapor barrier, working as neatly as possible around plumbing pipes and other penetrations. Seams are overlapped by at least 6 inches.

With the vapor barrier down, we place horizontal steel in the interior and exterior footings and piers. Rebar should be held off the gravel with steel chairs or masonry "dobies." Vertical rebar that needs to be tied to horizontal rebar is set next. Finally, we roll out 6x6 10/10 welded wire mesh over the entire slab area, overlapping the edges by 6 inches and tying them with reinforcing wire. At the building perimeter, the mesh extends slightly into the footing trenches. Although we tell all our customers that there will be some cracking of the slab, we've never had cracks large enough to worry about. But if you are concerned about slab cracks showing through the finished flooring, consider using fiber mesh or control joints (see "Pouring Successful Slabs," 7/92).

Forming the Perimeter

Perimeter formwork for slab-on-grade consists of an edge band of 2-by form material (usually 2x10) set with its top edge at the finished concrete slab height. The bottom edge of the form board sits at grade, or preferably, hangs slightly down into the footing trench. The outside edge of the form should touch or be very close to the trench wall to prevent concrete from oozing out.

Figure 2. *Because the trench walls are often too unstable to hold stakes, the author hangs the slab form boards over the trench with horizontal 2-by braces spaced 4 feet apart. To keep the braces out of the way during the pour, position them flush or below the top of the form board.*

Bracing. There are several ways to brace the forms for the perimeter edge band. In good soils, and where codes permit, it's possible to pound stakes tight to the wall of the footing trench and nail the form directly to the stakes. You can then align the form using diagonal stakes outside the building line.

In our area the soil isn't stable enough for that method, so we suspend the form over the outside edge of the footing trench (Figure 2) and support the form with 3-foot-long horizontal 2-by braces. The braces are spaced 4 feet apart so that the edge of the form will not bulge from the weight of the concrete. Since the top edge of the form also acts as a screed board, the braces must be nailed flush or below the top edge.

We face-nail the perimeter form board into the ends of the horizontal bracing, then set the form assembly on the ground in its approximate location. We drive two stakes next to each horizontal brace — one about 6 inches from the form board (farther away if necessary to keep the trench from caving in), and one near the tail end of the brace. If the batter boards are set at finish slab height, we can position the inside corner of the form along the string line. Otherwise, we plumb down from the line to the inside corner of the form board.

We first attach the brace to the tail-end stake with a nail or screw, then lift the form to the proper height and drive a screw through the brace into the front stake. Drywall screws and a cordless drill make this work easy and accurate, and don't jar the stakes. We use steel construction stakes manufactured by Dayton Superior (721 Richard St., Miamisburg, OH 45342; 800/745-3700). The stakes come in a variety of lengths and are predrilled every 3 inches or so to accept up to a 16d nail

Figure 3. *Steel stakes eliminate the need to cut wooden stakes for every job. These stakes are predrilled every 3 inches to accept fasteners and come with an optional screed hook.*

Figure 4. *With the bottom of the interior 2x4 screed set to finish slab height, a 1x2 "hook" attached to a 2x4 drag board will ride on top of the screed. The bottom of the other end of the drag board rides on the perimeter form.*

(Figure 3). The optional screed hook is handy when it comes time to place the concrete, and the stakes are durable enough to use over and over.

We start attaching braces to stakes at one end of the form board and work to the other. After the first form piece is in place, we simply butt the next piece up to it, screw a splice board to the outer face, and continue.

Form material. Form boards should be high-grade material and as long as possible. Boards with excessive crowns or twists will yield wavy concrete, and any money you save on inferior materials will be lost in the extra time it takes to wrestle with them. Form release oil sprayed on the interior of the forms makes them easier to strip, but isn't necessary because the surface area of the edge form is so small. After stripping, we clean up the forms and use them again for forming or framing.

We always form and pour porches and patios at the same time as the main slab. Set a standard step form at the doorway location and then form the patio as a slab-on-grade at a lower level. Likewise, form garage floors that need to be at a lower elevation by cutting the grade lower and setting a step form to separate the house slab from the garage slab.

Once the formwork is completed, the subcontractors return to anchor any fittings that will be cast directly in the slab. Everyone working around the forms should be careful not to walk on or disturb them. Since this is hard to avoid completely, thoroughly check the forms before any concrete is poured. Confirm all dimensions both for the formwork and the locations of mechanicals — a toilet flange placed too close to a wall cannot be fixed easily. We pull 3-4-5 triangles off the tops of the form boards to check for square, and inspect the top edge for level and proper elevation. We make sure that all the bracing and splices in the formwork can handle their loads. I also mark forms for the locations of anchor bolts and any vertical steel to be placed in the wet concrete.

Interior screeds. In final preparation before pouring concrete, we set the interior screed boards. We use 2x4 wooden screed boards set on adjustable metal screed hooks attached to steel stakes. But even if you use wooden stakes, the tops of the screed boards should be set 3 1/2 inches above the finish slab elevation. This makes it easy to screed the concrete with a 2x4 drag board with a 1x2 "hook" or "ear" cantilevered and screwed flat to the top edge at one end (Figure 4). The hook hangs on the 2x4 screed board while the other end of the drag board rides on top of the perimeter form. During the tamping phase, we lift out the 2x4 screed boards and remove the screed hooks and stakes as we go.

Concrete

We use fortified 3,000-psi concrete mix for monolithic pours. To get extra strength, we order six sacks of cement to the yard (rather than five) and specify 3/4-inch screened gravel (instead of crushed gravel). The order of the pour should be interior footing trenches, exterior footing trenches, then the slab. This sequence allows the concrete in the footings to set up slightly, and keeps the wet concrete from putting too much pressure on the forms.

When filling the trenches, we go slowly enough to avoid displacing sleeves and rebar, and guide the concrete trucks carefully to avoid running over form bracing. We're careful also, in the rush of the pour, not to step into footing areas and wind up knee-deep in concrete.

After the concrete is placed and floated, we set the necessary anchor bolts and vertical steel, then finish the slab as usual. Depending on temperature and humidity, the forms can usually be stripped in a few days. Forms are stripped and cleaned in reverse order of how they were installed. ■

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