One-Step Stem Wall Foundations

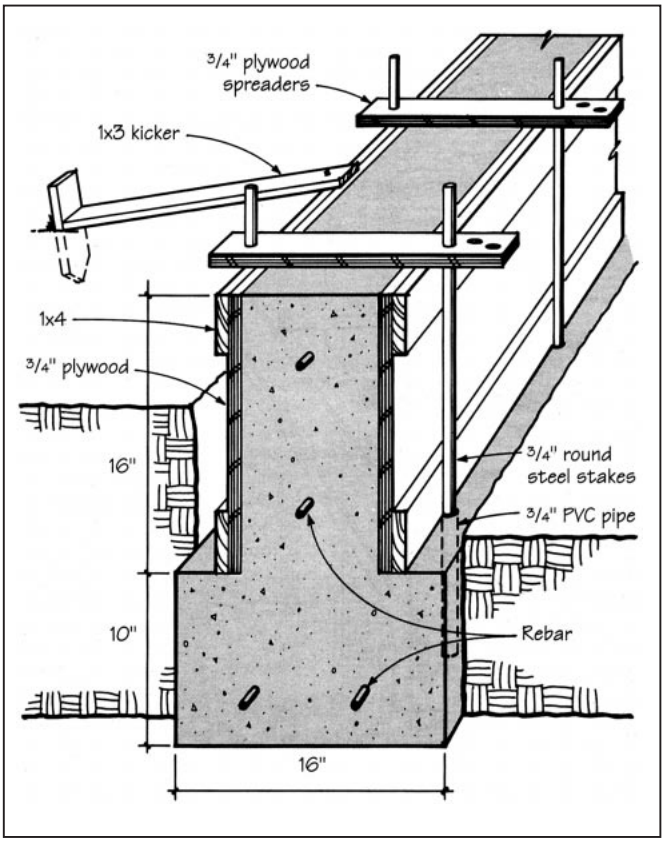
by Jim Hart and Art Prindle

Remodelers can pour the footing and stem wall at once with this simple form setup

Nine out of ten additions we put in have 16-inch spread footings and 8-inch poured concrete foundation walls. We don't hire a concrete subcontractor for this work. Instead we pour the foundations ourselves. After several years of these concrete pours, we have devised an efficient forming system that produces a straight, level, and economical foundation, which we don't dread building on. Our method works best for additions on fairly level lots. However, we have adapted the system to form slabs, stepped foundations, and low retaining walls.

The primary advantage of our system is that we can pour the footing and stem wall at once, forming a monolithic foundation wall that saves considerable time and expense. To accomplish this, we hang the form boards on steel stakes about 10 inches off the trench floor. This lets the concrete spread out under the form to the full width of the trench to create the footing. The steel stakes pass through PVC sleeves, which prevent the concrete from hardening around the base of the stakes, so we can retrieve them for reuse (see illustration at right).

The system has other small advantages. We can lift the spreaders during the pour, so the top of the stem wall can be easily finished. Ordinarily, the spreaders would be nailed onto the form work, making voids beneath them likely. Also, the stakes are easy to inventory. We store them in bundles bound by 12-inch-long pieces of 3-inch ABS pipe, which makes transporting and counting easy.



To speed up the forming process for short stem walls, the author uses steel stakes to support plywood form boards. The resulting monolithic foundation is accurate and sturdy.

Form Boards and Stakes

We build form boards from 3/4-inch CDX plywood, reinforced along the top and bottom edges with 1x4s. The 1x4 is nailed to the plywood with 1 1/2-inch ringshank nails every 12 inches, or with 8d nails with the tips bent over, which we think is even stronger. Typically we rip the plywood slightly less than 16 inches wide to get three lengths out of a 4x8 sheet of plywood. With a 10-inch-high footing, this gives us a 26-inch-deep foundation, and an 18-inch-minimum crawlspace beneath our floor joists, as required by code in this area. For deeper foundations we keep an inventory of 24-inch-wide forms. On these wider forms, we run an additional length of 1x4 reinforcement along the midsection for extra support. In some cases, we've added a 2x6 underneath the plywood, to give us additional form height. If you go much higher than this, you need to use form ties to keep the walls from bulging in the middle.

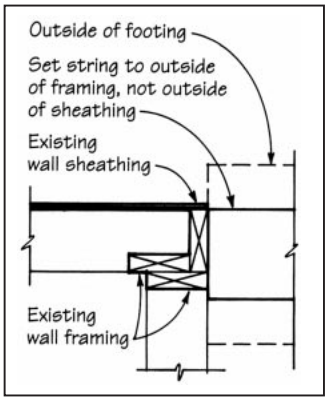


Figure 1. *Strings set on batter boards mark the building lines, defined as the outside edge of the foundation and frame wall.*

We use 3/4-inch steel stakes that have holes for duplex nails. In most cases we use 48-inch stakes because you can drive them in the ground at least 6 inches, which is deep in sun-parched California earth. This leaves plenty of stake above the form to lift the spreader up for finishing without lifting it off. Four-foot metal stakes run about $3.50 apiece (see "Sources of Supply", at end of article).

Layout and Excavation

We do our foundation work after the demolition so we can accurately locate the subfloor elevation, and we refer to this benchmark as we are setting the forms.

First layout. After studying the plans, we lay out batter boards and strings along the building lines (see Figure 1). The building lines define the outside edge of the framed wall (not including sheathing), and also the outside of the concrete stem wall. At this stage, we don't worry too much about the precise placement of the strings, because the backhoe operator will more than likely run over the batter boards.

Setting Anchor Bolts And Mudsills

Putting a little extra thought into the placement of anchor bolts can save work later when framing the floor.

While it seems natural to center the anchor bolts on the mudsill (2 3/4 inches in from the building line for a typical 2x6 sill), in every case where I've done this the blocking ends up conflicting with the anchor bolts. As a result, I end up with a creative notching project when nailing in end blocking. (We always use end blocking in addition to a rim joist to resist joist rotation and give greater bearing for the walls.) To avoid this problem, I set the anchor bolts an extra inch inside of the building line (3 3/4 inches).

Here in seismic country, we usually space anchor bolts every 4 feet on-center, at least 12 inches from the end of each sill, and with a minimum of two bolts per sill run. Check the joist spacing to make sure a bolt doesn't land where a joist should go.

To hold the bolts in place, I use predrilled blocks that suspend the anchor bolt at an exact depth and location above the form. The blocks are 11 inches long, so I can quickly line them up on the outside edges of the form during the pour. I don't nail the blocks to the form, however, because I might end up with a void under the block.

Once the concrete has cured and I'm ready to frame, I reset the strings that were previously used for setting the forms. Going back to this reference, I can correct any bulges in the foundation with the mudsill.

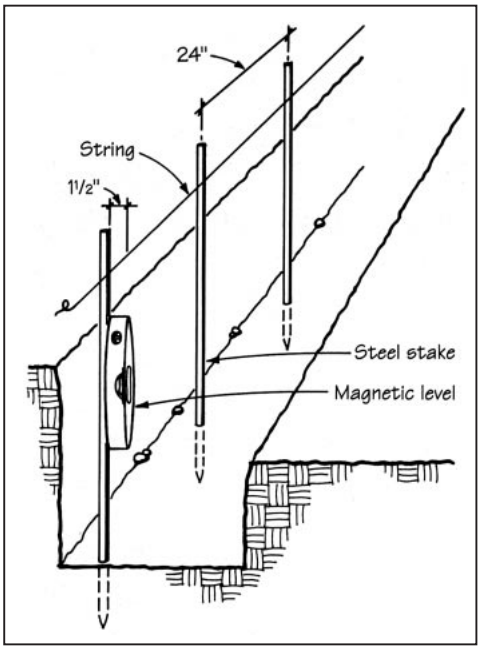
I measure from the string toward the inside of the foundation the width of the mudsill (5 1/2 inches for a 2x6 sill), and snap a chalk line parallel to the string line. This line marks the inside edge of the mudsill on the foundation.

Next, I place a length of pressure-treated sill stock on the stem wall, butting it against the outside of the anchor bolts. (With the bolts placed 3 3/4 inches in, the 2x6 will rest on the wall without falling off.) Then, using a speed square on the inside edge of the sill, I can mark off the location of each bolt, measuring in the distance from the chalk line to the center of the anchor bolt.

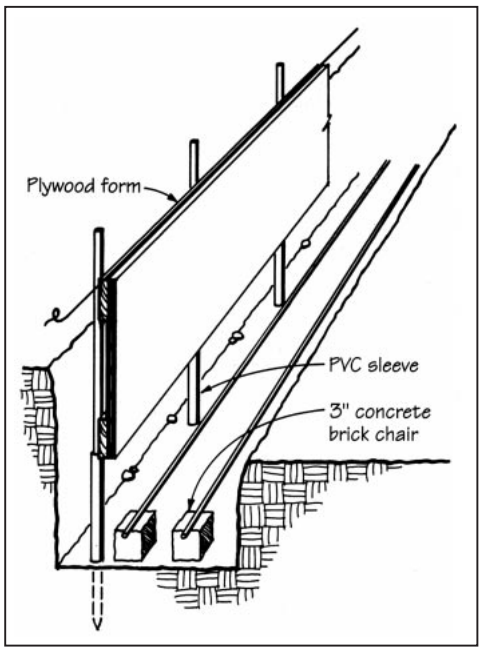
I oversize the bolt hole by 1/8 inch so I can adjust the alignment of the sill as needed. It also saves time if you cut the sill sections to length after you have bolted them in place. Cut to the chalk line on inside corners, and 5 1/2 inches (the width of the mudsill) beyond the chalk line for an outside corner.

— J.H.

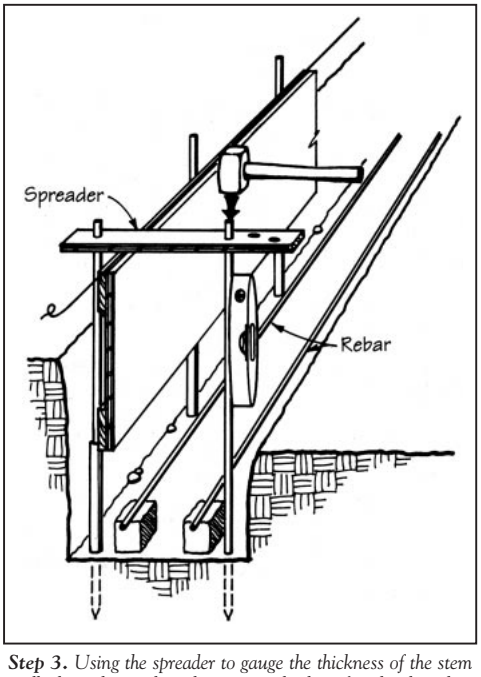
Hanging The Forms



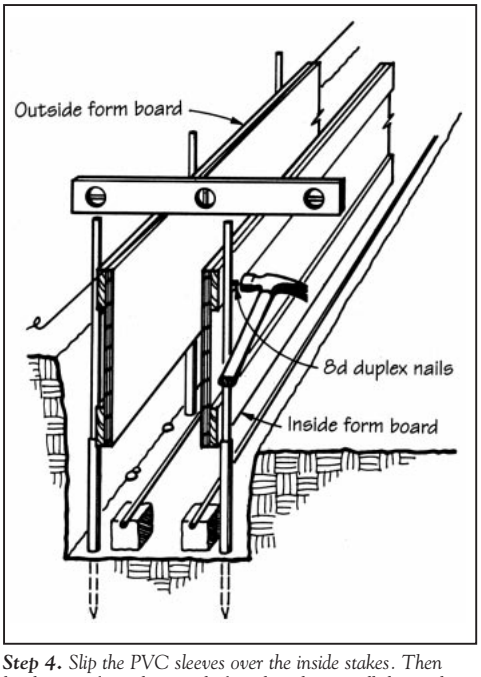
Step 1. *Using a magnetic torpedo level to check for plumb, drive the stakes 1 1/2-inches outside the string lines.*



Step 2. *Slip the PVC sleeves over the stakes and nail the outside form board to the stake an inch below the string line. Install the footing rebar before hanging inside form boards.*



Step 3. *Using the spreader to gauge the thickness of the stem wall, drive the inside stakes, again checking for plumb with a magnetic level.*



Step 4. *Slip the PVC sleeves over the inside stakes. Then level across from the outside form board to install the inside form boards.*

We do make sure the strings are square (by measuring diagonals), and at the approximate elevation (by siting through a builders level), so we know how deep we have to dig.

Before taking down the strings, we lay down a line of sifted lime for the backhoe operator to dig by. If the structural design allows for an 8-inch-wide stem wall, we lay our line 4 inches beyond the building line. This marks the outside edge of a 16-inch-wide footing trench, with an 8-inch stem wall centered over it. We prefer an 8-inch wall because it will accommodate a girder hanger that laps over the stemwall beneath the mudsill. Using this type of hanger is much easier than forming in a beam pocket. The hangers cost only about $12 apiece.

Final layout. After most of the digging is completed, we reset our strings and drag out the builders level to check the existing floor elevation at periodic points where our new floor will tie in. If the existing floor is within 1/2 inch of level, we usually pour our new foundation level, and make up the difference in the framing at the transition.

Some cases are more extreme, and we are forced to compromise the level of our foundation to match the existing conditions. On a recent addition, for example, we had to slope our new foundation 2 inches over 20 feet so that, where the new floor met the old, both

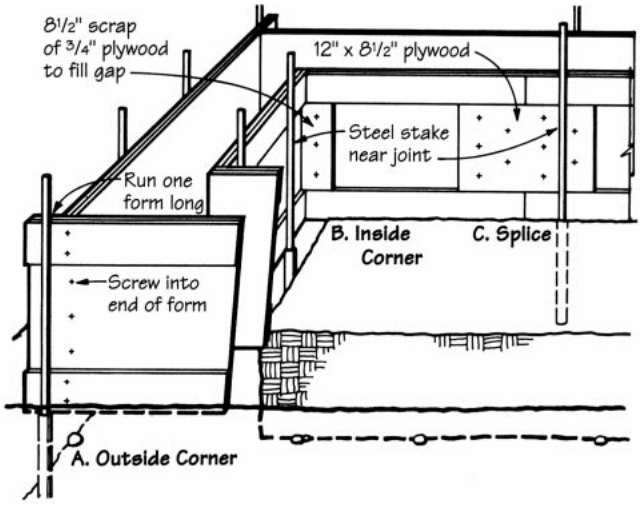


Figure 2. *To form an outside corner, the author runs one board long and screws into the end of the other (A). At inside corners, he fills the gap with scrap plywood (B). To join two form boards, the author splices the connection with plywood, making sure a stake is placed within 3 inches of the joint (C).*

floors were roughly in the same plane. With the addition's open floor plan, if we had poured the new foundation level, we would have had to build an unsightly wave in the hardwood floor.

I almost always calculate a finish concrete elevation for the new foundation, rather than match the existing foundation height. The existing floor framing material is often irregularly dimensioned, and compensating for this in the foundation is easier than trying to correct the floor framing. Using the builders level and a tape measure (with the hook end pointing down), we find the elevation of the finished concrete by adding the thickness of the new floor framing, including the new subfloor and mudsill, to the top of the existing subfloor elevation. For example, if the existing subfloor elevation is 47 9/16 inches, we add ¾ inch for plywood subfloor, 7½ inches for a 2x8 floor joist, and 1½ inches for the 2x6 mudsill. This gives us a finished concrete elevation of 57 5/16 inches. It's a good idea to have the floor framing material on site to check for actual dimensions.

We set the strings one inch higher than the expected concrete height, and then I send a laborer around with a tape measure, digging bar, and shovel to fine tune the walls and bottom of the trench.

Setting The Stakes

We drive stakes every 2 feet around the perimeter of the foundation. This spacing gives enough support to keep the forms from bulging. However, when using 2-foot-high forms, I'll space the stakes 20 inches apart. (To support the half span between each metal stake, we later put in 1x3 kickers.) I place the stakes 1½ inches outside the building line to account for the 1½-inch-thick form board. A magnetic torpedo level will stay on the stake as you drive it. I use a torpedo that is a convenient 1½-inches wide, which spaces the stake precisely. If the stake doesn't drive in perfectly straight, that isn't a problem. The kickers installed later will straighten out the top edge of the form where accuracy is most important.

Before nailing on the form board, we slip the PVC sleeves on the stakes. We use a ¾-inch Schedule 125 PVC pipe, which is cheap (about 6¢ a foot) and easy to cut with sharp gardening shears or a circular saw. The length of the pipe isn't critical — an inch high or low doesn't cause a problem with pulling the stakes out later. If I forget to place a sleeve on a stake before the forms are nailed on, I've found that a utility knife will slice the side of the pipe, and the sleeve can be wrapped around the stake.

Hanging Outside Form Boards

After all the outside perimeter stakes and sleeves are in place, I lay out all the form boards and spray them with a good amount of form oil. I leave plenty of time before I handle them to allow the oil to penetrate into the wood. Spraying the form boards when they are in place is risky, because the oil might get on the rebar. This will prohibit a good bond between the rebar and concrete. Also at this time, I tighten all the strings, since they will determine the placement of the form boards. If the string is stretched over a 30-foot span, I check it at the midspan with the builders level to make sure it doesn't sag.

When I put in my first form board, which is usually an 8-foot section, I nail it to the stakes at each end with 8d duplex nails. I set it approximately ½ inch below the string. Then I tap down the stakes until my form board is exactly 1 inch below the string. When I'm happy with it, I nail off the rest of the stakes.

To place the next form board, I splice it to the first with scrap ¾-inch plywood and several 1½-inch drywall screws. (I use a cordless drill so I don't have to drag around a power cord, which can mess up the string.) If there isn't already a metal stake near the splice, I place one within 3 inches to strengthen the seam. At outside corners you can run long with one form. The fewer form boards you cut, the more useful they will be on future pours (see Figure 2).

When all the outside form boards are in place, I straighten the top edge with kickers. Ideally, kickers should be placed at a 30- to 45-degree angle. Having the string an inch above the form board works out well, as the kickers won't conflict with the string. I drive wooden stakes to hold the foot of the kicker. When I have the form where I want it, I pin it with a 1½-inch drywall screw. If you nail the kickers in place with duplex nails, you run the risk of knocking the form elevation down.

Before finishing the form, I set the footing rebar on "dobies" (3-inch concrete block chairs). We do a good trench cleaning at this point, too, since it will be much more difficult after the inside form is installed.

Hanging the Inside Form

To position the inside-perimeter stakes, I gauge the width of the stem wall with the spreaders. I use pre-made spreaders with holes for an 8-, 9-, or 10-inch-wide foundation. The holes allow for some play, so the inside stakes don't need to be directly opposite the outside stakes. Once all the inside stakes are in the ground, I put the sleeves on.

Hanging the inside form board is very much like hanging the outside one, except that I use a 2-foot level, resting on the outside form, to position the inside boards. Again, when I nail the form board on, I set it so the bubble shows "high" and then tap it home. I usually don't put kickers on the inside form; the spreaders seem to do the job of keeping the footing a consistent width. After the inside form is complete, I hang rebar for the stem wall off the metal stakes with string. Finally, we plug the inside corners with ¾-inch plywood.

I keep the strings in place until the moment of the concrete pour just in case someone knocks something out of alignment and doesn't tell me. The spreaders are only ¾ inch thick so they sit below the string.

As a final precaution, I cap each of the metal stakes with a plastic protector, so that in the hectic pace of the concrete pour, no one will impale himself on a stake. The protector caps are made for rebar, but a model sized for #3 to #10 rebar works for a ¾-inch metal stake. The caps cost about 50¢ each, and are a worthwhile investment when you consider the danger involved.

On Pour Day

After pumping the concrete to the top of the form, the spreaders can be gently lifted 8 inches or so to finish the concrete with a trowel, and to make room for the anchor bolts. I set the anchor bolts into 2x4 blocks that rest on top of the forms to gauge both the depth and location of the bolt (see "Setting Anchor Bolts and Mudsills," previous page).

There is no need to remove the stakes until after the concrete has had time to cure. A metal stake puller, which costs between $50 and $75, eases the job of lifting the stakes out. In the past several pours, we've ruined only three metal stakes. If any of the sleeves stick up too high, they can be splintered off with the blow of a hammer. The forms can be saved after they have been peeled off the stem wall, and the concrete scraped off. We save all form lengths longer than a foot because they can be used for damming the concrete where a crawlspace access is needed. Surprisingly, we find the "form attrition rate" to be slow. We typically use the boards for eight to ten concrete pours before they show any significant signs of damage. ■

Jim Hart is a carpenter in Palo Alto, Calif. The methods described in this article were devised by Palo Alto contractor Art Prindle.

Sources of Supply

Steel stakes and stake puller:
Rap-I-Form
P.O. Box 60430
Phoenix, AZ 85082
602/437-3177

Protective caps:
Dayton Superior Corp.
9415 Sorensen Ave.
Santa Fe Springs, CA 90670
213/946-5504

Girder hangers:
Kant-Sag
703 Rogers Dr.
Montgomery, MN 56069
800/328-5934

Simpson Strong-Tie
1450 Doolittle Dr.
San Leandro, CA 94577
800/338-1881