Simple Layout for Hillside Foundations

To make quick work of steep-site footings and stemwalls, pull all your measurements from one base line and build the forms as you go

Using rough-sawn 1x6, the author can form anything from high retaining walls to complicated stemwall systems.

Where I live, in the mountains of Southern California, just about every building site is sloped. In 30-odd years of building foundations here, working on hillsides has become second nature to me.

In this climate, the ground never freezes more than a few inches deep, so there's no need for a deep frost footing. On flat sites, all you need is a shallow trench around the perimeter of the building, a simple perimeter form, and you're ready to pour the slab and footing in one shot (see "Monolithic Slabs on Grade," 3/95).

On many sloped sites, we do much the same thing on the side of a hill. We build stemwall forms in a stepped trench that serves as the footing form, then pour the stemwall and footing in a single pour. After that, the carpenters take over, framing stepped "pony walls" to reach the level of the first-floor deck.

Simpler Is Quicker

Transferring even a simple building plan to a hillside is harder than putting it on a flat site, and funny angles

by Jack Fuller

Figure 1. *Using a plumb bob, the author positions his transit over the intersection of his first two strings (left). Then he sights down the second string to establish a 90-degree corner (right). A helper fastens the end of the string in place.*

and pop-outs just add to the fun. But the process doesn't have to take as long or be as complicated as some people make it. Some builders start a job by locating all their corners and setting up strings for all their walls. But you don't have to locate a whole bunch of points and run strings all over the place to lay out a stepped foundation accurately. In fact, it's much quicker if you don't. All those strings just get in the way of the work. Getting them in the right place is a lot easier if you do it later in the process.

When we form up a job, all we need to get started is two sets of batter boards and two strings. We establish one corner and set up strings for two walls at right angles to each other. Then, using the strings as guides, we start right into running forms. As we work, each form we get in place serves as a reference for locating the next. This simplified technique is quick and accurate.

Finding the First Wall

Our first step is always to check the setbacks. The surveyor has usually marked the lot line with plastic tape. We measure from that tape to set the location of our first string. If we're building an addition, we use the existing building for a reference point, but we still check the setbacks just in case.

Since we're using the excavation trench for our footing form, we count on the excavator to dig it in the right place. But we measure again to be sure and to get our walls positioned just right. We take our time, because there's no room for error: If the foundation ends up just a few inches too close to the road or the property line, it can mean trouble.

Turning the Corner

Once we have one string in place showing where that first stemwall will go, the next step is to "turn the ninety": Set up one square angle that we can work from (see Figure 1). It doesn't really matter which corner of the building we use as our starting point; we can work up the hill, down the hill, or whatever. I usually just pick the corner that's most convenient for bringing in materials. While I'm occupied laying out my first two strings, I keep the rest of the crew busy hauling in boards and stakes.

To establish a 90-degree corner, I need a transit and a helper. I set up the transit over the exact point where the outside of two walls will meet. Then I run another string that I'll use to locate the second wall. With a plumb bob hanging from the transit just over the corner point, I sight on the point where the first string is fastened to its board. I turn the scope 90 degrees and pivot it in the vertical plane as necessary to follow the slope. While I sight the second batter board, my helper marks the point where the end of the second string should be set. He drives a nail at that point or cuts a saw kerf to hold the string firmly in place. I then fasten the transit-end of the string to the other set of batter boards, making sure it passes directly under the plumb bob.

Now we have two sets of batter boards holding two strings in place, establishing where two walls will be set — and we have a pile of rough 1x6s ready to go. No more strings for a while; it's time to start running forms.

Just Form It!

My typical foundation is just a footing and short stemwalls, where both the footing and the stemwalls step up or down the hill as needed. For these short walls, we run our boards parallel to the slope. This minimizes the labor of cutting boards. We set all the outside forms before we run steel and set the inside forms.

Using our two strings as a guide, we drive stakes into the ground in the footing trench and fasten the bottom boards of the stemwall forms to the stakes (Figure 2). We nail vertical members to

Figure 2. *Using the strings as a guide, carpenters plumb the stakes to the line (left). After the forms are nailed together (center), they plumb and brace the wall section (right).*

this bottom course of boards, then stack additional courses of boards up as high as we need for the height of the wall we're forming, nailing each board to the vertical pieces and plumbing the wall to the string with a 4-foot level. This is an easy way to form short walls — if you've done it hundreds of times like I have, it's a snap.

In a little while, we have the outside form of our first two walls in place. If there are pop-outs or spots where interior footings will intersect the outer wall, we'll come back and deal with them later.

Locating the Third Wall

With the outside forms for our first two walls in place, we use them to locate the next wall we form. This is when you'll appreciate how much simpler it is to locate the third wall after the first two are up. The plan dimensions of the building are horizontal distances, and we're working up or down a slope. But with the boards in place, we don't have to hold strings out in the air or work complex math problems to convert horizontal and vertical measurements to distances along the grade. We just step off our measurements along the forms.

Starting at our first corner, we mark a level line with an 8-foot level, going until we run out of wood. Assuming we're working down the slope, we measure along that line and pick a point to plumb down. A round number works best, and we go as far as we can before making a mark to plumb down from.

Measure over, plumb down, measure over, plumb down — you keep going until your horizontal measurements add up to the dimension on the plans and you've found your next corner.

This is the time to watch out for bonehead mistakes, though. I usually plumb down and measure over at the same time, by hooking my tape on the level and having my helper hold the measurement on the tape back at my starting point. Two things could go wrong: My helper could hold the wrong number or I could mark on the wrong side of the level. Two inches off (the width of the level) is way too much — that's why I always double-check everything.

Once I've located the corners at the ends of my first two walls, I set up a string for a third wall. Usually the transit isn't needed to set this string — we can just measure with a tape. As long as both ends of the string are the same distance from the opposite wall, the string is parallel to the wall across from it. This is tricky on a hillside, though, and it takes practice: You need to make sure you're measuring on the horizontal. If you measure down the slope instead, you'll be way off. I've seen people make this basic mistake and be off by a foot or more in a 24-foot wall.

Again, I hook my tape on the level and plumb down, with a helper holding the number at the other end. An 8-foot level usually gives enough vertical reach to make the measurement in one shot. If not, we do it in steps. Sometimes we stick a nail in the dirt to mark the intermediate point.

Reasonable Tolerances

We're trying to work to reasonable tolerances here — we don't insist on perfection. On a flat site, my concrete should be right on the money. But for a big house on a steep site, it can be off by as much as an inch. By adjusting their pony walls, the framers can easily make up the difference and give themselves a square first-floor deck. On the other hand, I could spend hours trying to tweak my strings or my forms and not accomplish much. At a certain point, it's more important to get the job done.

After the outside forms of the third wall are in place, a fourth wall is just a matter of connecting the dots. With the level and tape, we mark the corners

Figure 3. *Odd angles and even curves are easy with this forming method. For curves, the boards bend more easily if they're wet.*

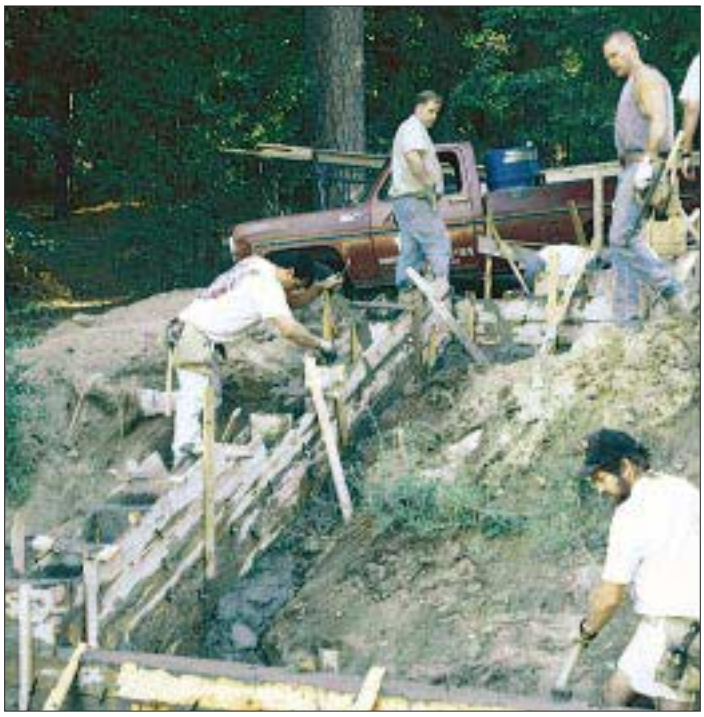

Figure 4. *The author uses strips of 3/4-inch plywood for the bulkheads that form the vertical steps in a stemwall.*

of the two opposite walls, run a string between them, and proceed with running the outside form.

Odd angles and curves. Of course, some houses go beyond the basic rectangular shape. If there are lots of short walls and corners, I set up the longest wall first and use it as a reference point. But if there are odd angles that aren't based on 90 degrees, we'll have to use the transit to set the strings. The only difference from the procedure I described earlier is that I'm reading a different angle on the transit. Forming with boards also allows me to easily form curved stemwalls (Figure 3).

Building Bulkheads

When the whole job is ringed with outside forms, we put in bulkheads and run our steel. For the bulkhead boards, which define the vertical faces of the steps, we use 3/4-inch plywood ripped in 8-inch strips (Figure 4). With the level, we draw a plumb line on the inside of the outer form and nail through the form into the bulkhead from the outside. After the inner forms are up, we nail in from that side, too.

Interior Pads and Footings

Most houses around here used to be built with carrying beams under the floors, sitting on concrete or steel columns. You still see that sometimes, but more often now there are interior pony walls instead of girders. That turns out to be cheaper all around (it uses smaller lumber) and stronger, too. So instead of locating and pouring pads for the columns to sit on, we usually have to run footings and stemwalls all the way across the middle of the building at certain points (photo, page 31).

The footings of all these interior stemwalls have to be continuous with the outer footings, so there's a monolithic grid under the whole building — stronger than a pad here and a pad there. By code, the stemwalls themselves don't have to tie together, but some builders ask for it.

Once the outer walls are all formed up, laying out the interior stemwalls is a piece of cake — we just do our tape-and-level thing to locate the ends of each wall, then connect the dots. When the inner walls are formed up, if the builder wants monolithic connections, we get a saw and whack out the 1x6 where the walls meet.

Pop-Outs

Every house seems to have a pop-out or two on it — for a bay window, a breakfast nook, or whatever. We generally locate these last. The main thing is to get the outside face of these the right distance from the main wall. We set up a string at the distance from the wall that's on the plans and form up the outside of that part first.

You don't need to worry about angles as long as you locate the corners in the right place — the plans should have dimensions that you can use to find those points by squaring off the main wall.

Once the stemwall for the pop-out is formed up, you can cut away the main form where the walls connect, if that's called for.

Double-Check Twice

The guys on my crew laugh at me sometimes because I do so much double-checking. If I've been closely involved in doing the layout myself, and it's not too complicated, sometimes I just go with it. But if it's a complicated job or if someone else has done a lot of the layout, I go back and check everything. I compare all the measurements with the plans, and I check for squareness with diagonal measurements.

I don't mind the laughing — after all, once concrete is poured, it's kind of hard to move. The time to catch mistakes is while the only material that's in the wrong place is wood. ■

Jack Fuller is a foundation contractor in Cedar Glen, Calif. Photos by Peter Rintye.