



Fast Forming for Stepped Footings

Careful excavation and simplified forming techniques speed up the construction of stepped footings

The footings in a level excavation are a straightforward affair that most builders can easily handle — knock together some 2x10s, level and square them, then fill them with concrete. But things get trickier on sloped sites, where the footings must be formed in steps, whether to walk up a hill or to drop below a walk-out basement door. Even a level lot may require stepping, as where a garage or crawlspace connects to a full basement. In this article I'll examine each of these conditions and explain the methods I've developed over the years to cope with them.

I learned to build forms the hard way. One of the first step-forms I built — using 1/2-inch plywood and unbraced uprights — blew apart when the first wad of concrete hit it. I overcompensated with forms that would satisfy the specs for a nuclear power plant. But the high cost of better materials and precision cutting blew apart my profits. Now I build forms to middle-of-the-road standards — rugged and accurate enough, but not necessarily pretty. The goal is to form them quickly, using as little material as possible, and in such a way that I can strip the forms easily.

Footings and Frost

The most common reason to step footings is to protect them from frost. If the soil around a footing freezes, it can

expand and push the house around in what's usually called a frost heave. Houses don't perform well when pushed around.

To eliminate frost heaves, building codes require that footings be placed below the frost line. The frost line is the maximum depth that frost will penetrate the soil in a given locality. Three feet is typical for regions with 5,000 heating degree-days (Philadelphia, for example). Your local code enforcement officer can provide you with information about frost depth in your area.

Frost penetration is rarely a concern in full basements, where the footings are placed several feet below the frost line anyway. But this changes when there is a walk-out entrance to the foundation, like a grade-level hinged or garage door, or a step-down bulkhead entrance. All of these are exposed to cold winter air, and will thus be subject to frost penetration. The solution is to step the footing down where it passes beneath the exposed doorway, so that its entire base remains below the frost line.

Remember, too, that frost penetrates in all directions. If a walk-out door is flanked with retaining walls, for example, the dropped footing must extend beyond the face of the retaining walls. I extend it far enough so that the bottom of the footing is always below frost depth.

by Carl Hagstrom

Quick Walk-Out Footing

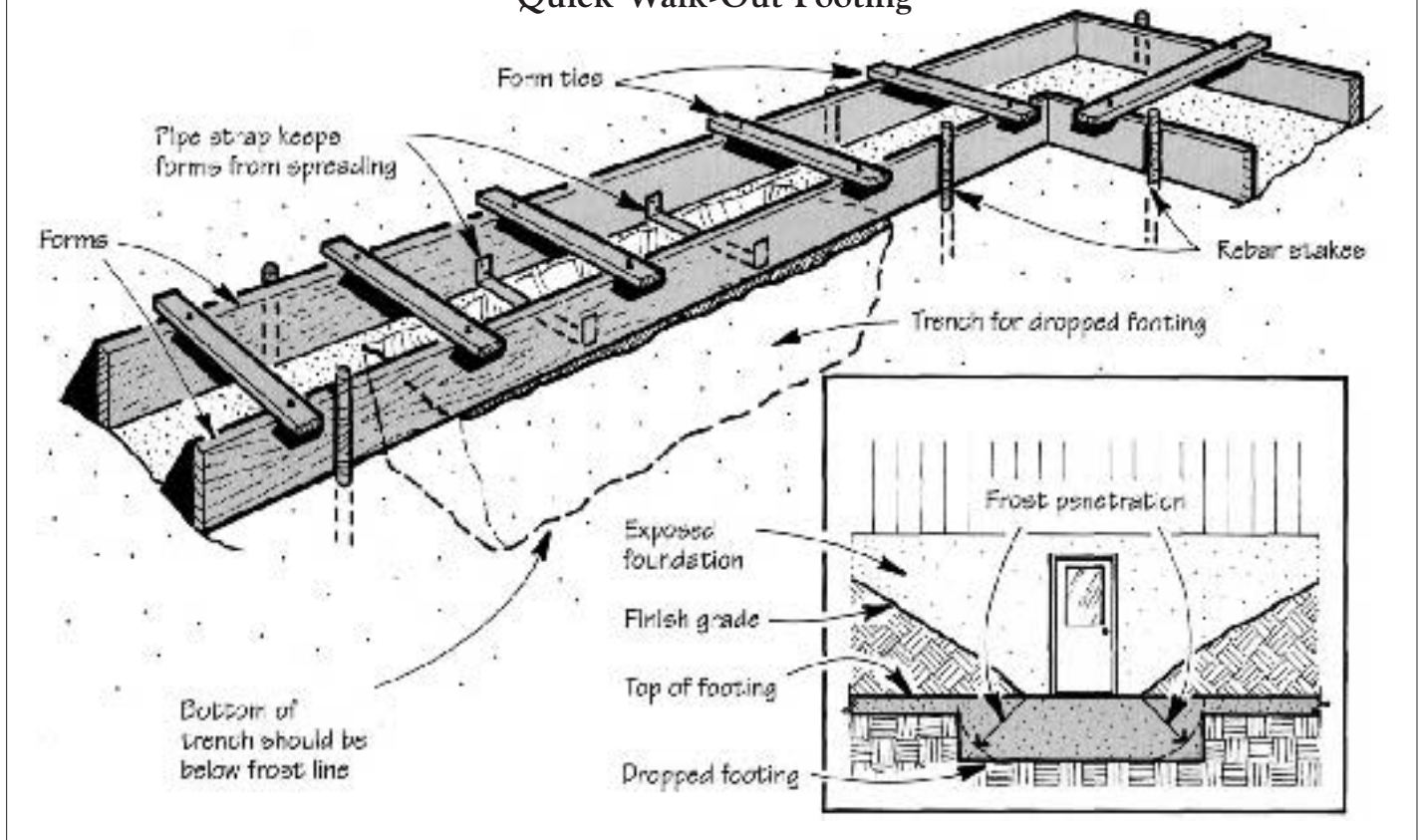


Figure 1. To avoid frost heaves, footings for walk-out entrances must drop below the frost line. To save time, the author prefers to form walk-out footings as a solid trench wall.

Dropped Footings at Walk-Outs

The trench for a dropped footing should be excavated before you start forming the rest of the footings. There are two ways to form this: One is to pour them as steps. The problem with this method is that it requires odd-sized forms for poured walls, or requires that masons lay block in the narrow confines of a trench.

An alternative is to pour the dropped footings as a 3-foot high wall (Figure 1). Layout is critical here. If you get the trench in the wrong spot and the backhoe is gone, you'll quickly establish the order of seniority within the crew, because someone will be faced with a lot of pick-and-shovel work. Have your backhoe operator use a one-foot-wide bucket; this will let him start with a narrow trench, then widen it only as much as necessary. (Most codes require footings to be twice the width of the wall.) When the trench is complete, simply fill it with concrete and top it out at the same level as the rest of the house footings, arranging your form board lengths so that you span the trench with a single board.

If the backhoe operator digs the trench too wide, you may want to fasten some plywood to the sides of the form boards to cut down on the amount of concrete you'll need. Fasten this plywood on the outside of the form with doubleheaded scaffold, or "duplex," nails so that it can be removed easily after the pour. Spray a light coat of oil on the form to prevent the concrete from knitting to it. Also, keep the concrete that goes into the trenches as dry as possible; wet concrete will work its way out from under the form boards at the top of the trench, preventing you from topping them off. When the concrete truck arrives, and before the driver mixes the load, explain that you want to fill the trenches first, and ask him to add only enough water so the mix will flow down the chute. Fill the trenches up to the bottom of the form and stop. Then have the driver add water, and pour the remaining footings as usual.

Don't forget to include the concrete for the trench wall in your estimate. It's easy to forget dropped footings, because they're seldom shown or mentioned on

the prints. On my last house, which had a basement garage and walk-out double door, I missed this item on the material takeoff. Four hundred dollars for seven yards of concrete put a sizable dent in my profit margin.

Stepped Footings

Occasionally you'll encounter footings that need to be stepped. Frost walls for a garage located on a steep slope are a good example. If you pour a level footing 3 feet deep at the lowest grade level, your trench can end up being 6 feet deep, or deeper, at the highest grade level. Not only is this wasteful, but shoring may be required to prevent the deep trenches from caving in. By stepping the footings up the slope, you eliminate deep trenching and excessive wall materials, while still keeping the footings below frost depth.

Many codes don't address stepped footings in detail. But good engineering practice dictates that the difference in height at each step should not exceed half the horizontal distance between steps (Figure 2). If you're laying a block foundation, the height of the step must

be a multiple of 8 inches — the height of a concrete block. In no case, however, should the steps be more than 24 inches high. If the steepness of the slope won't let you form to these guidelines, get some advice from an engineer. I haven't run into this problem myself, but I know that pile and grade beam systems are one alternative.

My forming method relies on a single "dam" at each trench step to hold back the concrete (Figure 3, next page). To build these dams, I first determine where the outside face of each vertical step will be. I then use a transit to establish a benchmark height, which I use to find the tops of the upper and lower footings at each step. The dams consist of $\frac{3}{4}$ -inch plywood cut 2 or 3 inches longer than the difference in height between two levels (an 18- or 19-inch-long piece of plywood for a 16-inch step). I also make them about 2 inches wider than the width of the trench, so that I can wedge them into the trench walls. Because trench walls are almost always wider at the top than at the bottom, the plywood must also conform to this shape.

I then use a hammer to drive the plywood dam into place until its bottom is where the top of the lower footing will be. I then drive three or four lengths of $\frac{5}{8}$ -inch rebar on the outside of the plywood dam, letting the tops of the rebar stick a few inches above it. Midway on the plywood, I drill a small hole on either side of each length of rebar and tie off the plywood with wire.

On the high side of the step, about 3 feet from the plywood dam, I drive three or four more $\frac{5}{8}$ -inch rebar pins at an angle, leaving their tops at finished footing level. The final step is to use form wire to tie these pins to the rebar behind the dam. The wire ties keep the dam from pushing out during the pour.

Pouring Steps

As with the trenched dropped footings, the only way to successfully pour steps is to use a dry concrete mix. Forms that hold wet concrete must function as a dam, holding back *all* the material behind it. Dry concrete puts much less stress on the forms.

Pour the concrete for the steps first. Avoid dumping all the concrete in the stepped form at once, because the shock could blow out the form. Instead, slowly place the concrete in the form,

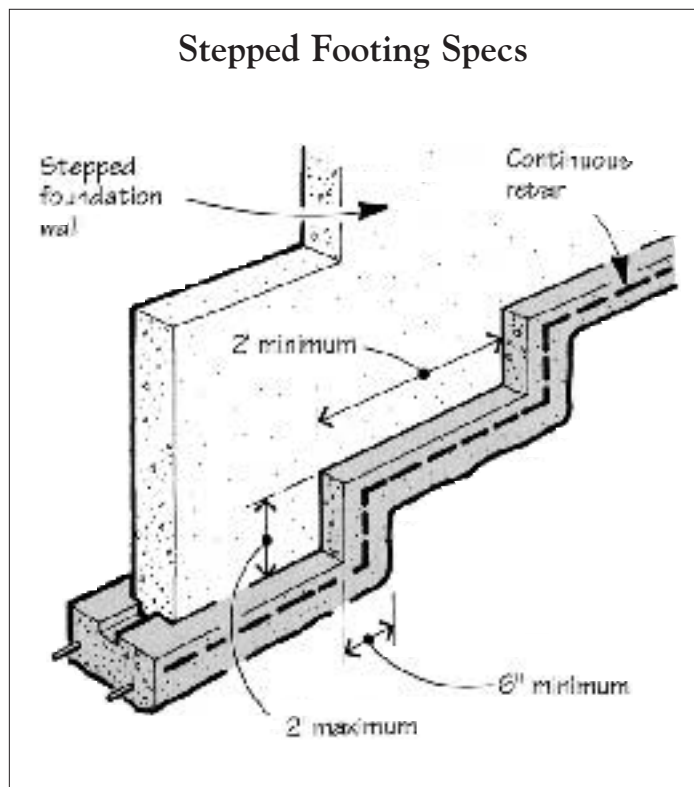


Figure 2. The rise of a stepped footing should not exceed 2 feet. There should be at least 2 horizontal feet between steps.

Guidelines for Successful Footings

Regardless of footing design or site conditions, you'll get a better job if you follow these guidelines:

- Always make sure that the area to be excavated is free of utilities, storage tanks, supply lines, and the like. When I first started out, one of my workers "discovered" an underground electric service cable with a wooden-handle pick; the ensuing spark was the size of a soccer ball. Had he been using a metal digging bar, he could easily have been killed. I've since discovered that my state has a toll-free service that contractors can use to locate utility lines. I make a point of using it.
- If you sub out your excavation and footing work, meet with the subs on site before beginning. Discuss elevations, orientation, and any steps required, and establish what tolerances you expect. Plus or minus a quarter inch is a reasonable tolerance for standard footings when it comes to being level and square, but masons need the 8-inch increments in stepped footings to be right on.
- Make sure that someone is on hand to supervise the excavation.

Otherwise, if the excavator encounters an unusual soil condition, he may decide on his own how to proceed.

- Take your time when forming and pouring — every hour invested in getting the footings right will save two hours down the road.
- Keep a tight schedule. Once the excavation is complete, get your footings poured as quickly as possible. A heavy rain can cave in trench walls, compromise the soil's bearing capacity, and make working conditions a muddy mess.
- When trenching footings, always try to provide an outlet trench for drainage. This trench should extend from the lowest trench footing to a downhill exit point so that any ground water or rain water that accumulates before the footings are poured will drain.
- Familiarize yourself with shoring requirements for your soils. Depending on soil type, OSHA guidelines require trenches to be shored when they exceed 5 feet in depth.

— C.H.

Quick Stepped Footing Form

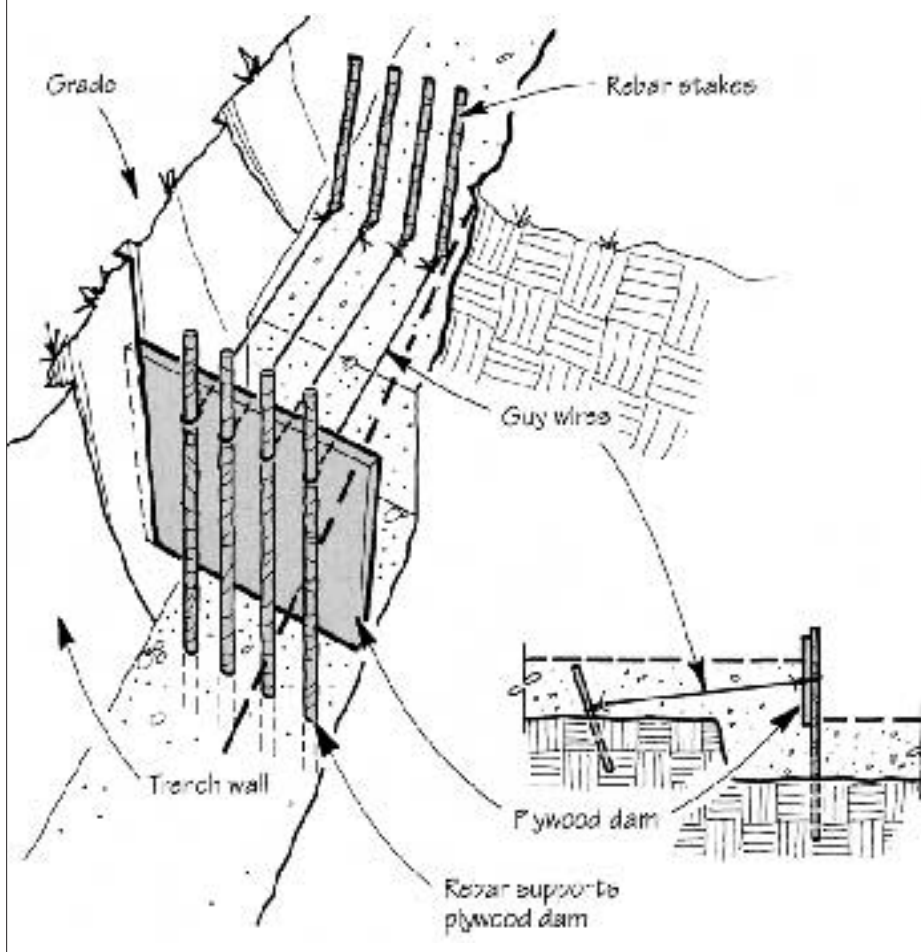


Figure 3. When pouring stepped footings, the author uses the trench walls and a plywood dam at each step to form the concrete. This technique requires careful excavation to avoid wasting concrete, but is much faster than building conventional stepped forms from two-by-stock.

Tying In a Footing

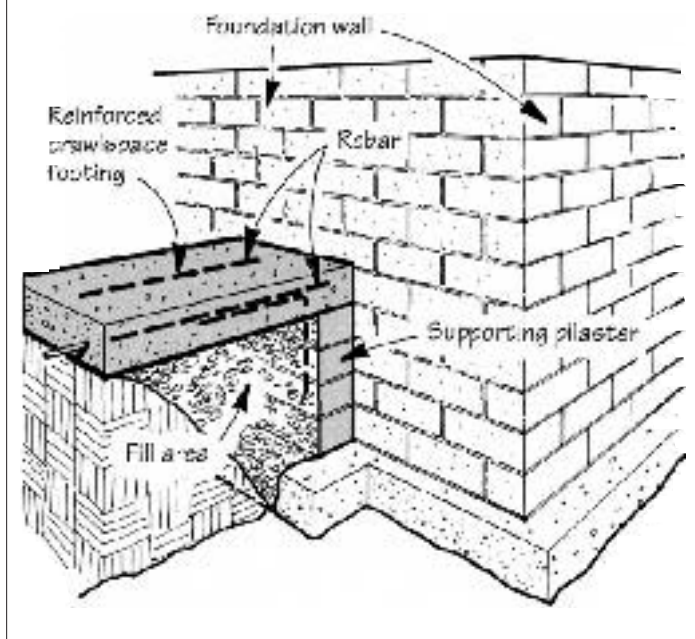


Figure 4. Where a garage or crawlspace footing meets a full-basement wall, the author increases the basement footing width and builds a block pilaster to support the edge of the concrete. Otherwise, the portion above the excavated trench is likely to settle.

using shallow lifts to fill it to the top. Careful placement with a shovel works best. After the steps are done, wet the mix to your liking and pour the remaining footings. Stripping my stepped forms is about as easy as it gets. Clip the tie wires, flex the rebar back, and remove the plywood.

Tying In With Stepped Footings

Stepped footings are also needed where one part of the house sits over a full basement while another rests on a crawlspace or a slab (an attached garage, for instance). In such cases, you'll need to complete the full-height walls before pouring the shallow footings for the crawlspace or slab. Because foundation holes are always dug oversized, there is usually a void that the shallow footing must span where it ties into the full basement.

How you handle this detail depends on the expected load on the footing. For minimal loading — like a gable wall that supports no roof loads — compacting the backfill below the tie-in point in 6-inch lifts may suffice. Be sure the foundation is up to the task, however; compacting fill with a mechanical tamper next to a freshly laid block wall can push the wall in. Concrete could give as well, though not as readily. It's better to let the wall cure for a week, to use temporary bracing on the inside, or to wait until you've framed the first floor deck.

You can provide a bearing shoulder for the shallow footing by placing a block or concrete pilaster directly beneath it at the tie-in point (Figure 4). The pilaster can be poured along with the concrete walls or bonded in with the blockwork as it goes up. You may also want to add steel reinforcement to the footing. This will create a beam that spans the filled area (the fill should still be compacted). The one place you may run into trouble is with concentrated loads: A two-story garage with a 16-foot-long door header that bears on a footing over fill material can get you into trouble. If you're new at this, or just aren't sure of the loadings involved, talk to an engineer before you begin. ■

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