Better Deck Piers

Part 2: Best practices for forming and pouring concrete deck footings and piers

by Mike Guertin

[Editor's note: The first part of this two-part series described how to design properly-sized deck footings. Here the author discusses excavating pitfalls and how to form and pour the concrete piers.]

Footing holes can be a pain to dig. After a couple of hours of blister-raising, back-breaking work have already been spent trying to dig down to frost depth through hard-packed and dense soils, rocks, tree roots, and groundwater, is it any wonder when successive footing holes become shallower and narrower, and start to worm around obstructions?

You probably have wondered if a deck will really fail if the footings aren't quite up to par, especially if you're the one doing the digging. But do you want to risk your company's reputation on a faulty footing installation?

If you're looking for guidance, you won't find much in the IRC, which addresses only frost depth, soil suitabil-

Figure 1. Before digging footing holes, call 811, your local utility locator. It will find and mark utility lines, but dig carefully; this service doesn't typically locate sprinkler lines, and here it missed a telecom cable conduit, too.

Figure 2. You're always disturbing the soil at the bottom of the hole as you dig and it's hard to scrape it out, especially from deep holes. One trick for removing the loosened soil is to vacuum it out.

Figure 3. Alternatively, loose soil can be compacted with a tamper, a framing offcut, or with a section of a 4x4 or 6x6 post.

ity and bearing capacity, and concrete standards. By code, the bottom of a footing must be at least 12 inches deep and below the local frostline—whichever is deeper—and bear on stable, undisturbed soil that is free of organic matter. And the code requires a minimum compressive strength of 2,500 psi for the concrete. But the code doesn't address many of the finer points that can impact how well a footing provides stable support for the deck.

Excavation

Even if I don't suspect there are any nearby utilities, such as gas, sewer, or water lines, or power or telecom cables, I have the deck area marked out by utility reps or an independent service locator prior to digging. In fact, in most areas, state law requires a quick call to a utility-funded service locator; in my area, this service is called DigSafe (digsafe.com), which I reach by dialing 811.

But even utility marking services can make mistakes. On a recent project, for example, all the major utilities ran through an area near where I was to dig a couple of holes. Even though the marking by DigSafe showed that the nearest utility was 4 feet away from my holes, I still carefully dug them by hand, rather than by machine. Good thing, too: I uncovered a sprinkler line (which usually is not something that locating services identify) and a telecom conduit (**Figure 1**).

When I'm comfortable digging the holes by machine, I use either a backhoe or a post-hole auger, depending on soil conditions and the quantity and size of the footings. Mechanized equipment is fast but unforgiving—a utility strike due to one too-deep scoop or auger spin can result in a safety problem, lost time, additional costs, and an upset client.

Sometimes it's necessary to dig deeper than frost depth to reach stable, undisturbed earth. Where organic and highly compressible soil extends beyond the frost depth, it must be removed. Footings within 5 feet of a house foundation should be at least as deep as the foundation itself, since the soil was likely disturbed by excavation and filling operations when the house was built.

I always make sure that the bottom of the hole is flat—rounded or pointed bottoms won't support as much weight. And because loose soil can compress over time and lead to settling, I tamp or physically remove loose soil from the bottom of the hole (**Figures 2, 3**).

When I'm pouring concrete piers without using footing forms, I make sure that the hole sides are parallel and not tapering inward toward the bottom (tapering outward is OK). Otherwise, frost can grab the sides of the pier and heave it out of the ground. The holes should also be plumb, rather than angled, since slanted footings don't transfer gravity loads to the bottom. Offset loads can cause the footing's side to sink, while frost can heave the sloped edge.

Anything—rocks, roots, utility conduits—that impinges on the side of the hole should also be removed. While it would be easier to dig around obstructions and then just pour around them, impingements weaken the concrete and create ledges that frost can grab onto, heaving the pier.

Footing Forms

Whether cardboard, steel, plastic, or site-built out of wood, footing forms prevent some of the problems associated with piers poured directly into holes. First, the form isolates the surrounding earth from the concrete as it's poured, so there's less chance of contamination. The form keeps the sides parallel and smooth, so frost won't have a ledge to grab hold of; and it contains the above-grade portion of the footing, preventing mushrooming.

Rather than cutting footing forms to height before dropping them into the holes, I let them run high and then set the height for the pour. When the existing grade is fairly level, I use a laser level and mark the footing forms at a uniform height. When the grade is sloped I mark the pour height 4 to 6 inches off the grade level at each footing. The easiest way to level off the concrete at the top is to trim the form off level at the desired height before placing the concrete. A visible laser strikes a line halfway around a cylindrical form, making for easy marking and precise cuts.

Cardboard tubes are standard for most deck builders, but when the soil is wet or rain is expected there's a risk of even the good coated forms dampening and collapsing under the weight of the backfilled soil before the pour. When the weather forecast is iffy, I use round light-gauge sheet-metal duct in place of cardboard forms (**Figure 4**). Removing the above-grade metal takes a bit longer

Figure 4. You can form piers using metal duct, which costs 30% to 40% more (about $4 more per footing) than cardboard tubes, but is more durable in wet conditions. To reduce costs, the author recycles his HVAC sub's offcuts, as well as old ductwork removed from remodeling jobs.

Figure 5. To increase a pier's bearing area without adding a lot to the total volume—and weight—of concrete needed to build it, many deck builders add a wide-base form to their standard cardboard-tube footing forms.

than peeling off a cardboard spiral—about 10 minutes to score the metal with a 4-inch angle grinder at ground level and pop the piece.

A round tube form can be used without a widened footing base, but the footing diameter is then limited to the tube diameter. The easiest way to form footings with larger bases that can bear greater loads is to use a wide-base footing form (**Figure 5**). Forms are made in many styles from cardboard or plastic, and they can have either round or square bottoms, with tapering tops that mate up to cardboard form tubes, which bridge the distance between the top of the wide-base form up to grade (see Big Form, Small Hole, at right).

Most deck builders don't place steel reinforcing rebar in footings, but in areas with expansive or other unstable soils rebar is usually required. Otherwise, the only time I use rebar is when the concrete pier needs to be poured more than 12 inches above grade and when I'm building on severe slopes that may be subject to erosion.

Pouring Concrete

The "just right" Goldilocks concrete mix—not too dry, not too wet—is wet, but stiff. A squeezed fistful should hold its shape and neither crumble (too dry) nor squeeze through your fingers (too wet). When the mix is too dry, the cement in concrete won't hydrate properly and bind the aggregate, resulting in a footing that cracks and crumbles. A wet mix reduces the compressive strength of the concrete. If you're unsure, check the packaging of your bagged concrete mix for the proper water-to-mix ratio.

Don't add aggregate to the mix. If you're working in bony soil, the temptation may be to toss those extra rocks that you've dug out of the hole back into the footing as the concrete is poured. But concrete may not bond to rocks that have even a small amount of residual dirt, which will weaken the footing. Rocks

Big Form, Small Hole

Wide-base forms work great, but require jumbo-sized holes. One trick to reduce the amount of digging for a wide-based form is to dig a narrower shaft and just widen out the bottom of the hole. Before placing the form in the hole, make a cut in the side of the form (A) and fold it onto itself (B). Then tape the folded form to hold the narrower dimension and drop it in the hole. When the tape is cut, the form will spring open to its full diameter (C). When a form has been cut like this, however, you won't be able to pack the backfill in the hole before the form has been filled with concrete, or it may crush at the joint. So just lightly backfill and wait until the concrete has set up before backfilling the hole completely and compacting.

can also create air pockets in the footing.

To avoid cold joints, make a continuous pour. Cold joints—or seams between layers of concrete—can occur with a mix that's too dry, or when there's a delay between the pouring of successive batches of concrete into a form. I always rod or vibrate the concrete in successive batches to make sure they mix well where they meet.

Also, keep the pour clean. This can be tricky when footings are poured directly into holes without a form, since dirt from the sides can fall into the concrete. The contamination will reduce the concrete strength and can leave a fracture line, much like a cold joint.

It's possible you'll hit the water table when digging a hole, or rainwater may fill the bottom if the weather turns inclement. But don't pour concrete into a wet hole, because standing water will mix with the concrete and weaken it. Instead, pump the water out, or isolate the concrete from groundwater until it cures, to prevent contamination. One technique I use with a partially water-filled hole is to place a garbage bag in the hole or—if I'm using a footing form—around the base of the form before setting it in place. As the bag fills with concrete, the water will be displaced (**Figure 6**).

Figure 6. Garbage-bag footing bases are useful in wet conditions, as well as when your footings will be wider than concrete tubes but smaller than prefabricated wide-base forms. The author digs a 12-inch-diameter footing hole about two-thirds of the footing depth, then widens the last third of the hole to the calculated size. After duct-taping a heavy-duty garbage bag to a footing tube cut 6 inches longer than two-thirds of the depth, he pokes rebar horizontally through the form 6 inches from the top to suspend the form in the hole. Finally, he pours concrete in the bottom third—the bag—then backfills the space between the hole and the form before filling the form to the top with concrete.

Piers should extend 4 inches or more above grade, because footings that are recessed below grade put the post-base connector at risk of being covered by backfill (**Figure 7**), and deck hardware is generally not rated for below-grade use. But unless you're using a form, it's difficult to prevent concrete from spreading out at grade and forming a mushroom cap, which frost can seize and heave up. In general, the portion of the pier that is above grade should be the same size as the footing below grade.

Figure 7. A pier should extend a few inches above grade so that the hardware used to connect the PT post to the pier won't get covered with soil.

Anchoring Posts to Piers

A post base is needed to anchor the bottom of a bearing post to its supporting pier. A properly installed post base resists uplift forces while acting as a capillary break to reduce the amount of water wicked into the post's end grain (even lumber treated for ground contact can decay over time) (**Figure 8**).

The trick to installing post bases is locating them precisely on the piers so they're directly beneath the beam. In one approach, I locate and install the anchor bolts for the post bases at the time the concrete is poured; in the other, I locate and install them after the concrete has cured. In either case, I use a string line to orient the post bases. The string aligns to the edge of the post position.

Wet installation. Galvanized ½-inch-diameter J-bolts can be set right after the footings have been poured, but before the concrete firms too much. I use a minimum 8-inch-tall bolt and embed it 7 inches into the concrete.

I use a post base as a guide to position the anchor bolt, aligning it with my string line and then lowering the bolt into the concrete (**Figure 9**). Jiggling the bolt helps displace the concrete aggregate so it will settle into the footing. Once the bolt is embedded into the concrete, I turn it 180 degrees; this ensures that the bottom of the "J" hooks under aggregate. If the bolt isn't turned, then the "J" portion only has sand and cement over it.

Dry installation. To secure post bases to the piers after the concrete is cured, I use ½-inch-diameter galvanized wedge anchors. I wait a minimum of seven days for the concrete to cure before drilling and installing anchors; any less and the concrete may strip out or crack as the wedge anchor is tightened. I place the post base in position on the footing and hammer-drill a hole into the concrete. A quick blast of air from a compressor before bolting the post base to the pier clears out the dust on the sides of the hole that could reduce the wedge friction. ❖

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Figure 8. Most post bases have an elevated plate that prevents the bottom of the 4x4 or 6x6 post from coming in direct contact with the concrete. Even though PT posts are treated for ground-contact, end grain will wick up moisture and is particularly vulnerable to rot (inset).

Figure 9. After the author pours concrete into the form, he makes sure the top of the pier is flat, rather than angled or crowned. Sloped tops make it hard to set a post base properly.