by Robert Hatch

SONOTUBE TIPS

How to excavate, lay out, and pour concrete pier foundations

I've built lots of masonry pier foundations. I used to either stack cinder blocks or pour concrete into site-made wooden forms. Then, a few decades ago, the job got a lot easier with the invention of the Sonotube pier form, which is now an industry standard. In this article, I'll give some basic tips for working with tubes, along with some unusual ways of using them that I've learned over the years.

Some Rules of Thumb

Before laying out a run of piers, I determine the required diameter, the size and depth of the footing, and the spacing between the piers. After fixing several sagging decks, I've developed a few rules of thumb, based on an old piece of Yankee logic — when in doubt, bigger is better.

Pier diameter. My rule of thumb for pier diameter is "one inch per foot of span." Thus a deck that spans 8 feet will stand comfortably on 8-inch-diameter piers, while a deck that spans 10 feet requires 10-inch-diameter piers. For spans longer than 12 feet, I always add a second row of piers and a second girder at the center of the joist span. (I use No. 2 or No. 3 grade pressure-treated lumber, so I don't trust it for spans over 12 feet.) Reducing the span also cuts material costs by letting me use 2x8 joists rather than 2x12s.

Footings. A lot of builders install piers without footings. But I've found that footings help keep the structure from settling; to leave them out risks having a railing or rim joist that looks like a roller coaster. For most decks, a pier footing should be as thick as the pier's diameter, with sides that measure twice that much. So an 8-inch pier should rest on a footing that's 8 inches thick and 16 inches square, while a 12-inch pier should rest on a footing that's 12 inches thick and 24 inches square.

The key factor in determining how deep to place the footing is the local frostline. Here in the White Mountains of New Hampshire, we typically set the top of the footing 4 feet deep. For critical applications, though, we go down to 8 feet. These

Figure 1. *Saturating the pier hole with a garden hose helps compact the soil at the base to keep it from settling.*

Figure 2. *The author makes pier footing forms from scrap lumber and plywood and lowers them into the hole with a hoe.*

Figure 3. *When mixing concrete by hand, a tube ripped in half with a circular saw makes a convenient chute.*

include structures that will support a lot of weight, and piers that are close to a plowed driveway (where the lack of an insulating blanket of snow means a deeper frostline). To ensure that you're on undisturbed soil, it's also wise to go deep when setting piers for a room addition to an existing building. The backfill of an existing building might just contain a 6x6 wood scrap that's below your footing depth. When the 6x6 later decomposes, the resulting void will collapse under the weight of the tube.

Spacing. How closely we space our piers depends on the load they will carry, and the number and size of the girders. On a simple deck with a built-up triple-2x8 girder, an 8-foot spacing is fine. This spacing also works for most single-story additions. If the piers will have to support a two-story addition or a cantilevered deck with a hot tub, the spacing will have to be closer. When in doubt, it's best to call an engineer.

Digging the Holes

I hear that power augers can make quick work of soft soil. However, I know too many guys who hit a rock with a power auger, then went flying across the yard. We avoid power augers, opting instead for either a backhoe or a pick and shovel, depending on the number of tubes and the access to the work site. We dig by hand when there's only a few tubes to set, or at well-landscaped homes, where we don't want a backhoe tearing up the yard. When working on existing homes, we spread the excavated dirt over the inside perimeter of the deck or addition. We also set aside all the sod and some of the topsoil so that we can use it to dress up the perimeter when we're done. This is more work than just digging holes, but it makes for a cleaner job and puts a feather in our cap with the owners.

Regardless of the digging method, the footings should rest on good, undisturbed soil. Every good foundation specification requires the soil under foundation footings to be compacted, and pier footings are no different. You can't get a compactor down into the hole, but running a garden hose into it for three or four minutes will help the earth settle (Figure 1).

Setting the Forms

We make square footing forms from scrap one-bys, then cap them with a plywood lid (Figure 2). The lid has a hole cut into it that's $^{1}/_{2}$ inch smaller in diameter than the tube. We lower this form into the hole with a hoe, then plumb up to the dry line to center it. We don't add rebar to the footings unless it's specified by an architect.

The most accurate way to align a row of tubes is to stretch a line across where their outside edge will be, rather than across their centers (photo). This is also easier than centering the string — you just set the tubes against the string, rather than having to measure from their centers. On level lots, we set the line a couple of inches above grade, then cut the tubes off just below the line. This is just a personal preference, as I don't like to see a lot of concrete sticking out of the ground. (On a slope, where the grade falls away from the line, we place a level against the outside of each form and level up to the reference line.)

If the piers must protrude above grade to directly support a rim joist, we install the tubes high, then cut them all at once. There are two easy ways to do this. One is to use a story pole and a transit to mark the elevation on each tube; another is to level out from the house to the two end tubes, then snap a chalk line from these two points across the remaining tubes. There is no need to cut the tubes at exactly this elevation. Once they're marked, we cut off the tubes a little high, poke a nail through the side at the reference mark, then pour concrete to the nail.

We tie our reference lines to stakes or batter boards driven outside the perimeter of the layout. We temporarily remove these lines while digging, and reset them after the holes have been roughed in. We then carefully backfill around the

Figure 4. *Rebar goes in when the tube is partially full of concrete. The bend at the end of the rebar ties the pier to the footing.*

footing form by hand, and tamp it to keep it in place. One person then centers the tube on the hole in the footing while another backfills with a shovel.

Pouring the Concrete

Redi-mix isn't cost-effective for small jobs, so when setting less than a dozen piers, we mix the concrete by hand. If we have to haul the concrete any distance from the mixer to the forms, we use a wheelbarrow, then shovel the concrete into the tubes. On steep grades, we make a handy cement chute by using a circular saw to slice a tube lengthwise into a pair of half-cylinders (Figure 3).

To eliminate voids and make sure the concrete fills the entire footing, we place the concrete slowly, then tamp it vigorously with a stick or a paddle as we go. When the tube is half-full of concrete, we insert a length or two of rebar into the center, making sure the bend in the rebar extends well into the footing (Figure 4). We then continue pouring and tamping until the concrete reaches the reference nail we use to mark the finished elevation (Figure 5). Before the concrete sets up, we install whatever strap ties, anchor bolts, or stirrups the job requires. A dry line stretched across the row of tubes makes a good centering reference for the anchors.

Working in Winter

Setting Sonotubes in midwinter is difficult at best. When the frost is set hard in the ground, it's tempting to load the truck with a pick ax, a crowbar, a flame thrower, and some dynamite. Luckily, there's an easier way.

We remove any snow from the excavation area, and put an empty gallon-sized metal paint can everywhere there will be a pier. We start a good kindling fire in each can, and keep these fires going throughout the day. Every couple of hours we lift the cans, scrape away any willing soil from the excavation, and reset the cans into the holes. We use the excavated dirt to build a berm around the cans, which helps hold in the heat.

This goes slow at first — it can take five or six hours to get the cans set to their rims, but after that, the process gets easier. Before we leave for the day, we put a good bed of coals and a perforated lid on each can. We also place a rock or a brick on top of each one; the heat tends to draw water out of the frost, so unweighted cans are apt to float up in the hole. We keep the rim of the can above grade so that any melted snow or ice will drain away rather than submerging the can and putting out the coals.

We can drive 3 feet of frost out of the ground overnight with this method. A paint can will typically melt a 12-inch-diameter cylinder of soil, which is easily dug out by hand. And though we can't get a box footing into the frozen ground, we take a spade and "bell" the bottom of the hole to act as a footing. Even stony hardpan is easier to dig after using this method. *— R.H.*

Figuring Concrete for Tubes

You can quickly figure the amount of concrete needed to fill a tube by multiplying the following factors by the height of the tube in feet:

- 8-inch pier: *.013 cu. yd.* (0.6 80-pound bags of concrete mix per lin. ft.)
- 10-inch pier: *.02 cu. yd.* (0.9 bags per lin. ft.)
- 12-inch pier: *.029 cu. yd.* (1.3 bags per lin. ft.)

For rectangular footings, use these amounts per footing:

- 8x16x16-inch footing: *.044 cu. yd.* (2 bags each)
- 10x20x20-inch footing: *.086 cu. yd.* (3.8 bags each)
- 12x24x24-inch footing: *.15 cu. yd.* (6.75 bags each)

As an example, say you have four tubes and that they're 8 inches in diameter and 4 feet deep. With a total lineal footage of 16 feet, the tubes will require 9.6 bags of concrete mix (0.6 bags per foot). The four 8x16x16 footings will require a total of 8 bags (2 bags per footing). So you'll need 18 bags to complete the job.

— R.H.

Figure 5. *Tamping throughout the pour gets rid of voids in the pier. The nail in the side of the tube marks the finish concrete elevation.*

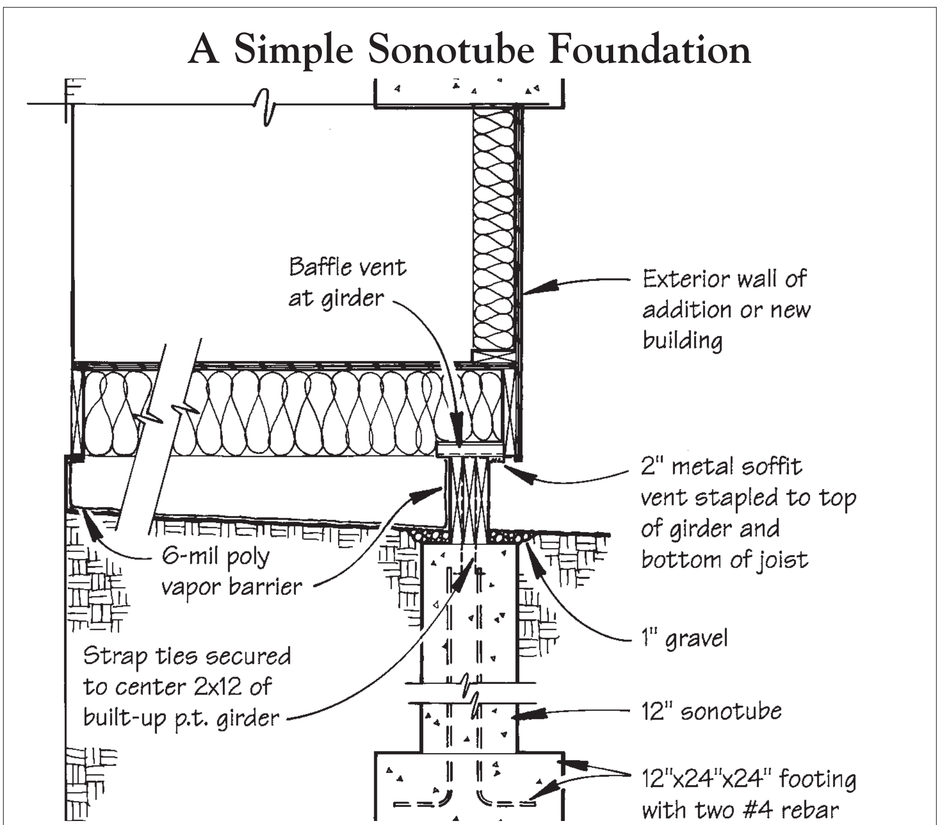

Figure 6. *Pier foundations work well for garages, pole barns, and even small home additions. This foundation detail provides good insulation and ventilation, and doesn't disturb existing utility lines.*

About three years ago, I designed a simple pier foundation system for level lots. It consists of piers whose tops terminate in a shallow trench about an inch below grade (Figure 6). The piers carry a pressure-treated girder that's partially backfilled with one-inch-diameter gravel. Although I mainly use this system for garages, pole barns, and utility buildings, I've also had good luck using it for one- and two-story additions. Some clients want additions built where a stemwall foundation would interfere with septic, water, or utility lines. Others just want to save money. I can build a 14x28-foot poured-concrete frost wall and footing, including the excavation and backfill, for about $2,000; a pier foundation for the same building costs around $1,100.

We anchor the piers to a triple 2-by girder with strap ties. The ties wrap around the center stick in the built-up girder and lap over the top. (The girder looks better if the ties aren't exposed on its face.) A poly vapor barrier is then laid over the ground beneath the joists and run up and stapled to the inside of the girder. The joists are cantilevered 2 inches beyond the rim of the girder, and a 2-inch-wide standard metal soffit vent is fastened to their undersides. This prevents water vapor from building up in the shallow space beneath the joists. We suspend fiberglass insulation in the joist bays before installing the subfloor, and lay short pieces of attic ventilation chutes across the top of the girder to keep the space ventilated. Here in New Hampshire, the vent closes for the winter once the snow cover gets above 6 inches, then reopens in the spring after the snow melts.

It's important that the finished grade pitch well away from this type of pier foundation — I shoot for a slope of 4 inches in 10 feet. This foundation will also be closer to grade than the foundation on the rest of the house, so chances are that you'll have to take two steps down from the main house to the addition. But given the cost savings, most clients are happy to take the few extra steps. ■

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