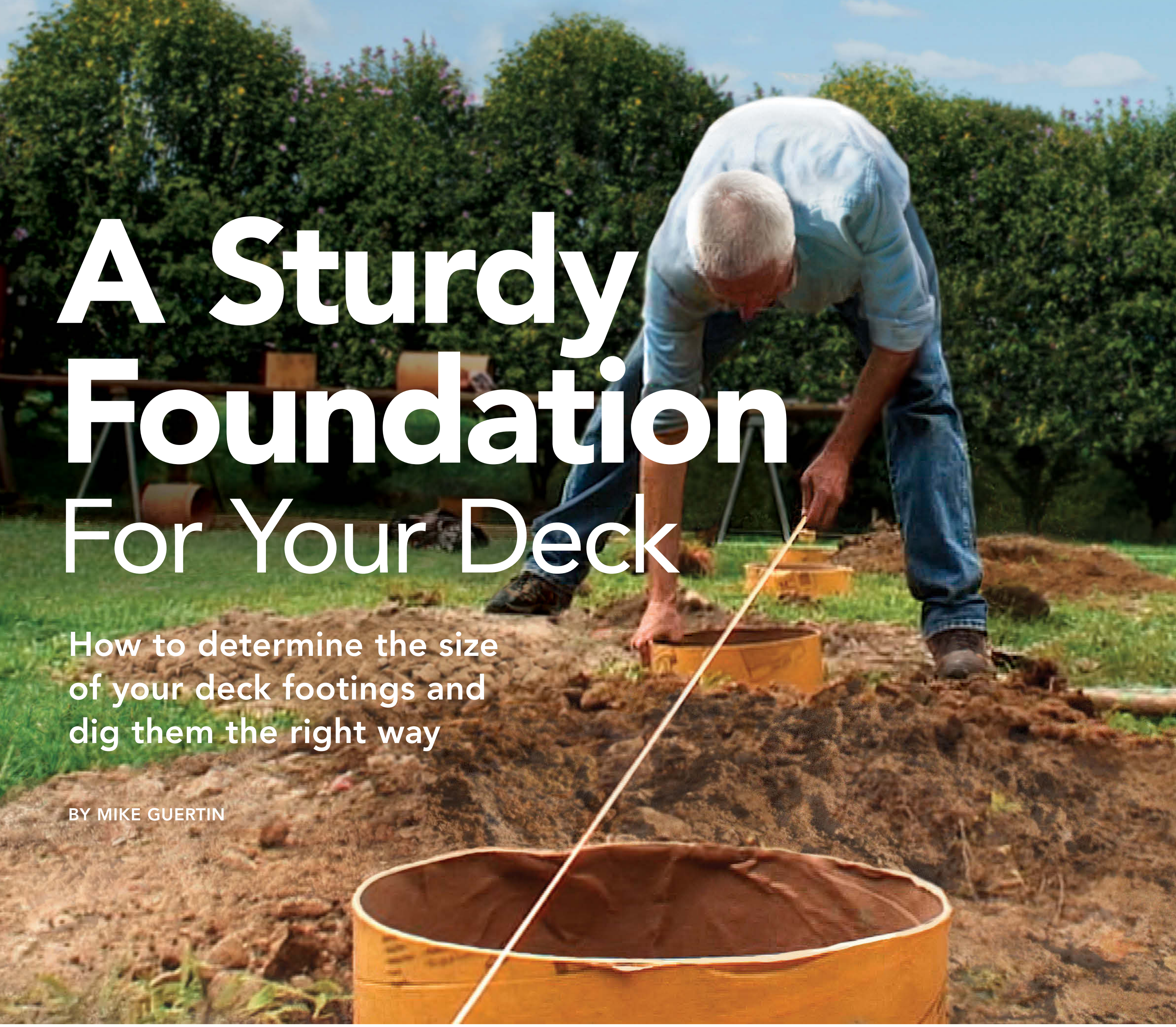


A Sturdy Foundation For Your Deck

How to determine the size of your deck footings and dig them the right way

BY MIKE GUERTIN

Deck footings transfer the weight of a deck and its occupants to the ground, forming a solid foundation to support the deck and its live and dead loads. How many footings you need and how big to make them is specific to each deck. Doing the calculations takes only a few minutes, ensures that I'm following best building practices, and keeps me from digging more than necessary.

The size and the spacing of footings tie directly to the maximum spacing between posts of the beam they support. A larger beam can span a greater distance, requiring fewer but larger footings. The 2018 International Residential Code (IRC) contains a table for sizing deck beams, which allows me to determine how many posts I need. Once I know how much of the deck will bear on each post, the code also includes a table to aid in sizing deck footings that go beneath them. The table includes footing solutions for regions with live and snow loads up to 70 lb. per sq. ft. (psf) and for various soil conditions. While the 2018 IRC is enforced in many jurisdictions, some areas rely on earlier versions of the code that only have tables for 40-psf live load, and aren't as useful for building decks in areas with snow loads that exceed that amount.

Knowing the size of the deck, and the number of footings, I can do some simple math and refer to the code table to determine footing sizes based on the soil's bearing capacity. □

Editorial adviser Mike Guertin is a builder in East Greenwich, R.I. Photos by Dan Thornton, except where noted.

Photo this page: John Ross. Drawings: Christopher MIlls.

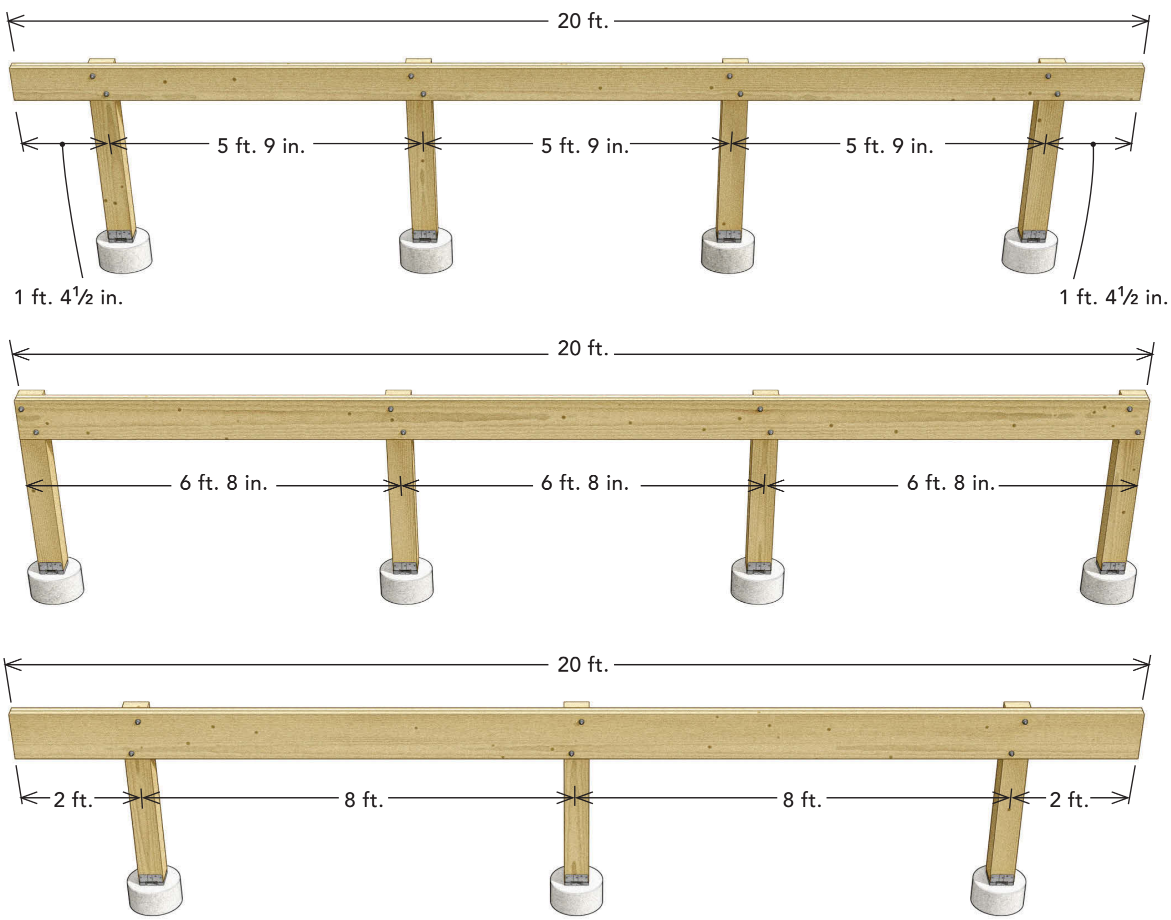
CHOOSE A BEAM

Several factors determine which beam setup to use. Should it overhang the end posts or end flush with them? Is there a backhoe at hand so that digging a few large footings makes sense? Or is this deck on a house with established landscaping that calls for a greater number of smaller-diameter footings that can be dug by hand around obstructions? What is the joist span?

After answering those questions, I choose a beam configuration, such as a double 2x8, from the IRC's Table R507.5 (Deck Beam Span Lengths) and determine the number of footings needed based on the size of the deck. I prefer a double 2x beam because it can rest on notched 6x6 posts. The 2½-in.-thick leg on the back of the notch bolts to the beam. Triple 2x beams can make sense, but require a structural connector to join to the post.

The IRC table allows joist overhangs (cantilevers) past the beam of up to one-quarter of the span between the beam and the ledger. The beams themselves can overhang the end posts by one-quarter of the post spacing. By cantilevering the end of the beam, you often can eliminate one footing.

Three beam options for a 14-ft. by 20-ft. deck



A double 2x8 beam offers a maximum span of 5 ft. 9 in. and a maximum overhang of 1 ft. 5¼ in., resulting in four posts spaced 5 ft. 9 in. apart and overhangs of 1 ft. 4½ in. at the ends.

A double 2x10 beam with a maximum span of 6 ft. 9 in. results in four posts spaced 6 ft. 8 in. apart.

A double 2x12 beam with a maximum span of 8 ft. and a maximum overhang of 2 ft. results in three posts spaced 8 ft. apart and overhangs of 2 ft. at the ends.

Post spacing for southern-pine beams

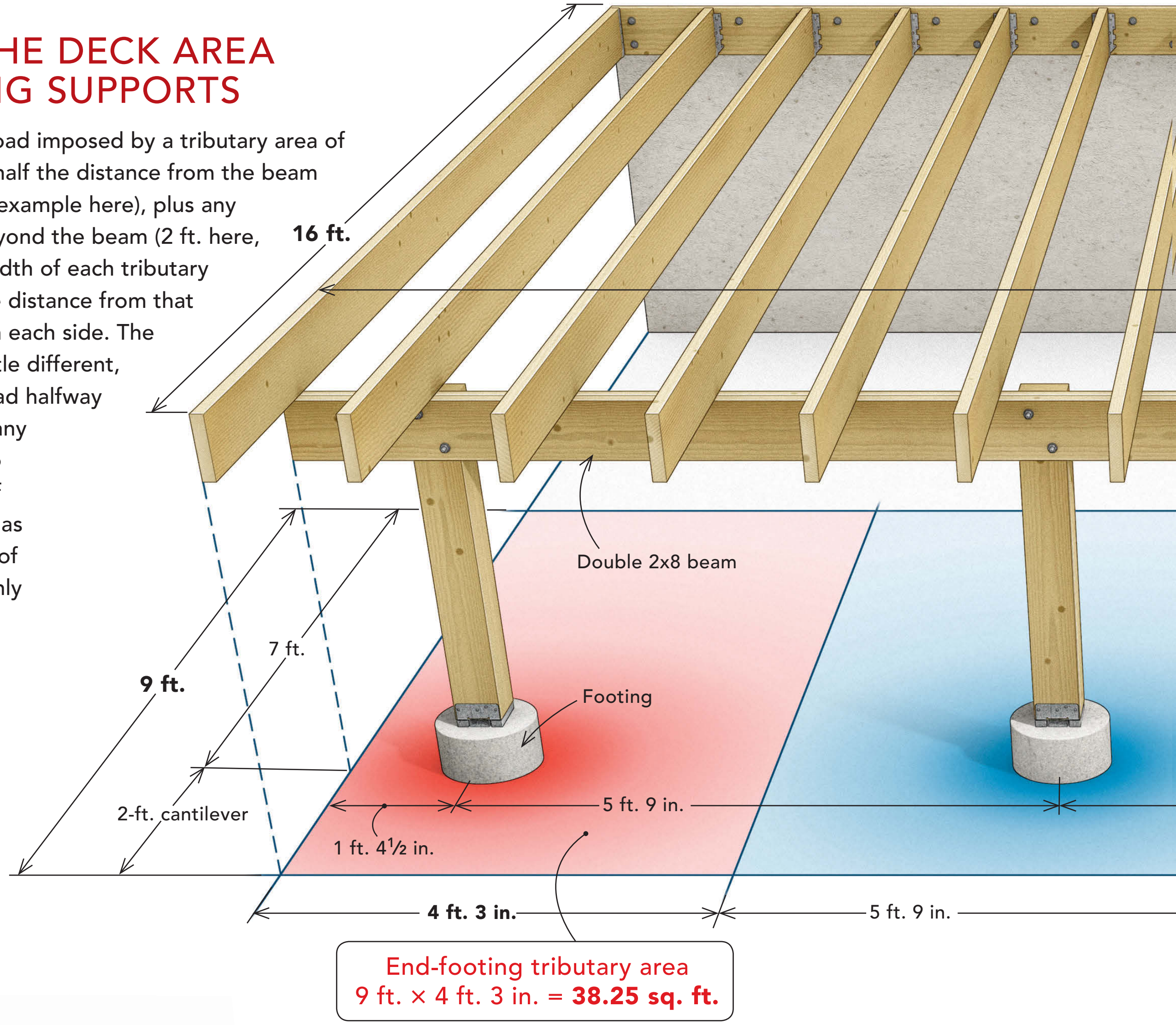
	Joist spans less than or equal to:						
Beam size	6 ft.	8 ft.	10 ft.	12 ft.	14 ft.*	16 ft.	18 ft.
2-2x8	8 ft. 9 in.	7 ft. 7 in.	6 ft. 9 in.	6 ft. 2 in.	5 ft. 9 in.	5 ft. 4 in.	5 ft. 0 in.
2-2x10	10 ft. 4 in.	9 ft. 0 in.	8 ft. 0 in.	7 ft. 4 in.	6 ft. 9 in.	6 ft. 4 in.	6 ft. 0 in.
2-2x12	12 ft. 2 in.	10 ft. 7 in.	9 ft. 5 in.	8 ft. 7 in.	8 ft. 0 in.	7 ft. 6 in.	7 ft. 0 in.
3-2x8	10 ft. 10 in.	9 ft. 6 in.	8 ft. 6 in.	7 ft. 9 in.	7 ft. 2 in.	6 ft. 8 in.	6 ft. 4 in.
3-2x10	13 ft. 0 in.	11 ft. 3 in.	10 ft. 0 in.	9 ft. 2 in.	8 ft. 6 in.	7 ft. 11 in.	7 ft. 6 in.
3-2x12	15 ft. 3 in.	13 ft. 3 in.	11 ft. 10 in.	10 ft. 9 in.	10 ft. 0 in.	9 ft. 4 in.	8 ft. 10 in.

Excerpt from the 2018 IRC, Table R507.6: Deck Joist Spans for Common Lumber Species

*Area depicted above

CALCULATE THE DECK AREA EACH FOOTING SUPPORTS

Each footing carries the load imposed by a tributary area of the deck whose depth is half the distance from the beam to the ledger (7 ft. in the example here), plus any cantilever of the joists beyond the beam (2 ft. here, for a total of 9 ft.). The width of each tributary area is the sum of half the distance from that footing to the footings on each side. The two end footings are a little different, though. They carry the load halfway to the next footing, plus any overhang of the beam. So while the tributary area of the two middle footings has a width of 5 ft. 9 in., that of the two end footings is only 4 ft. 3 in.

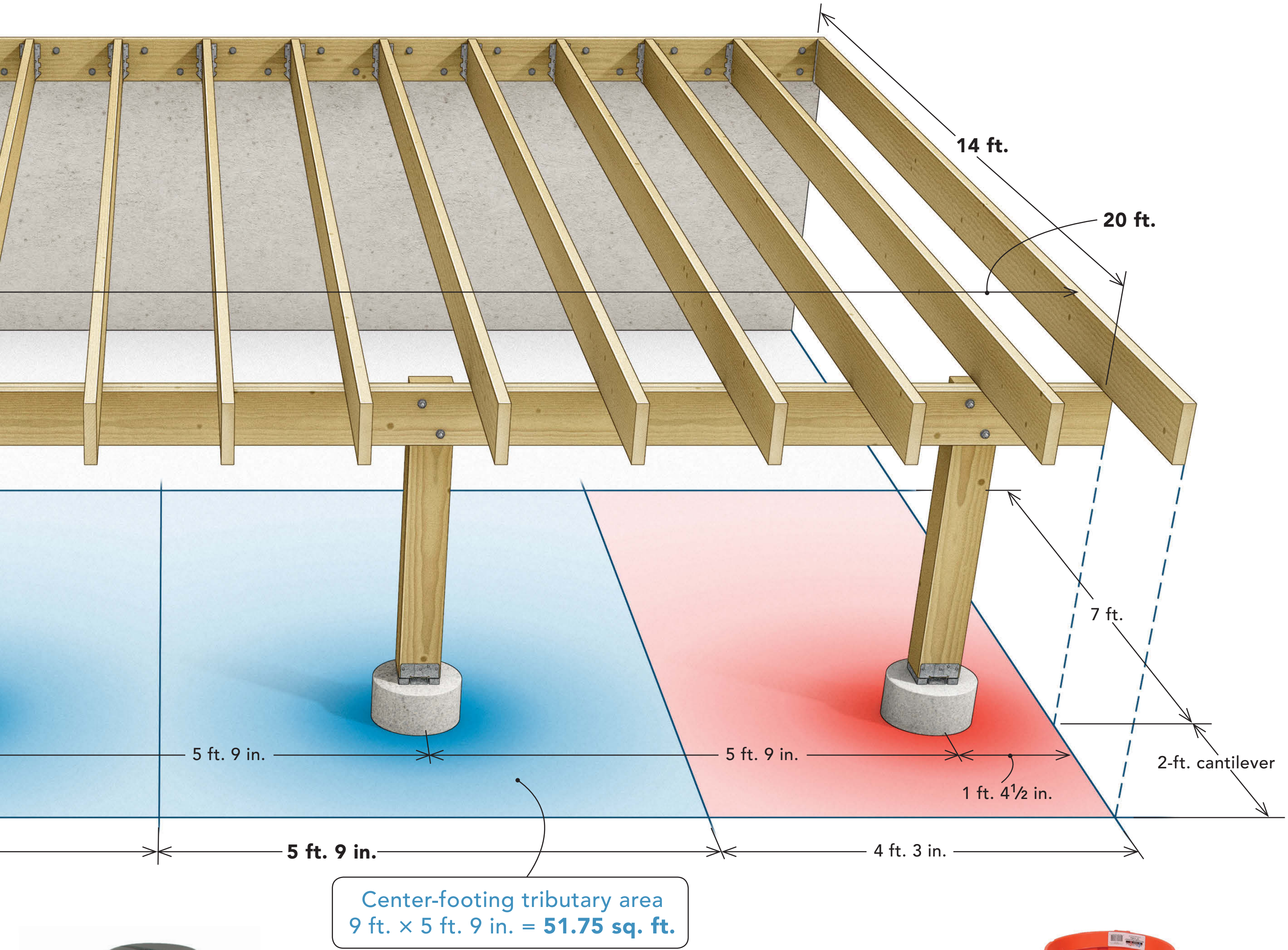


CARDBOARD TUBES ALONE MAY BE INADEQUATE

Cylindrical cardboard forms create smooth sides that reduce the chance of frost attaching to the concrete and heaving the footing, and they isolate the concrete from the surrounding soil to prevent it from mixing in and weakening the concrete. While many deck builders have long used these forms for footings with success, the minimum round footing diameter required in the 2018 IRC is 14 in., which is larger than most home centers carry.

For very small tributary areas such as stair landings, 14 in. is overly conservative, and the IRC has recently recognized that. The just-released 2021 IRC allows round footings with diameters as small as 8 in. for tributary areas up to 5 sq. ft., and you may be able to utilize those smaller forms with your building official's approval even if your jurisdiction uses an older version of the code.

While it's possible to use tubular forms on their own in some cases, they're more often used to create piers on top of other spread footings to reduce the amount of concrete needed. Along with the required footing size, pay attention to the manufacturer requirements for post bases when sizing piers or footings. Post-base manufacturers may require their hardware be set back several inches from the edge of the pier or footing, so you may need to upsize to meet the edge-distance requirements.



Bigger footing forms

The original form. *The Bigfoot is a plastic form that fits the end of a standard cardboard tube. The company also offers an entirely plastic alternative (shown) said to be less susceptible to frost heave.*

bigfootsystems.com

It's square. *The Square Foot forms, which work with cardboard tubes, make it easy to calculate the area of the footing.*

sqfoot.com

Designed for rebar. *The WP Fail Safe form incorporates a proprietary rebar system, particularly useful in areas with seismic and wind-uplift concerns.*

failsafepierfooter.com

Duct-tape compatible. *The Redibase form is used with standard cardboard tubes. It's designed to allow the joint to be sealed easily with duct tape to keep dirt out of the form.*

redibase-form.com

Tapered tube. *The Footing Tube includes a concrete-saving tapered plastic tube in addition to the bell-shaped footing form. It offers little bite for ice to grab and lift, and it allows backfill to be compacted prior to placing the concrete.*

foottube.com

SIZE THE FOOTINGS

Not all dirt is created equal. You need to know the bearing capacity of your soil before calculating footing size. The IRC lists the bearing capacity of five soil types, from "crystalline bedrock" at 12,000 psf down to 1500 psf for clay, silt, and mixtures that include them. Your building department may have soil maps that show local soil types and their bearing capacity. You also can have an evaluation done by a soils engineer, and may need to if the building official determines your soil's bearing capacity is likely below 1500 psf. Whether you're able to use cardboard tube forms or need to use one of the larger footing forms, you may not be able to find manufactured forms for the exact footing size you find in the IRC's footing size table. In that case, always go to the next-larger form size.

Find the minimum footing size. Since 2018, the IRC has included a table (Table R507.3.1) to determine the minimum footing size for decks. Below is an excerpt from that table, showing footing sizes for a deck with a 40-psf live or ground snow load built on soil with a load-bearing capacity of 1500 psf. To see the complete table, which includes footing sizes for decks with larger live loads and different soil load-bearing capacities, visit FineHomebuilding.com/decks.

Tributary area (sq. ft.)	Side of a square footing (inches)	Diameter of a round footing (inches)	Thickness (inches)
20	12	14	6
40	14	16	6
60	17	19	6
80	20	22	7
100	22	25	8
120	24	27	9
140	26	29	10
160	28	31	11

Frost lines and soil type affect footing depth. In areas not subject to freezing, footings must be at least 12 in. below the undisturbed ground surface. If there is any fill or the soil was disturbed where the footings are placed, the footing holes must be dug at least to the level of undisturbed soil. Compressive soil, expansive soil, and organic soil are a few common unsuitable types. Footing holes have to be dug through unsuitable soil to reach stable soil. When placed within 5 ft. of a house, footings must be at least the same depth as the house foundation to be sure they rest on undisturbed ground. Where the ground freezes, footings must be at least as deep as the local frost line. Your building department will know what this is, but it can be as deep as 60 in.

Photos facing page: far left, courtesy of Hilti; right, from top, Mike Guertin, courtesy of Pin Foundations, courtesy of Greg DiBernardo.

Footing-to-post connection

The post is tied to the footing with a connector such as a Simpson Strong-Tie ABA66Z or a MiTek PA66E-TZ, combined with a concrete anchor bolt.

Cast in place. *Standard foundation bolts are a common way to attach post bases, but they must be placed accurately in the wet concrete.*

Glued in place. *Chemical anchors that glue anchor bolts into drill holes offer great strength. Chemical anchors must be at least 3$\frac{3}{16}$ in. from the footing edge.*

Wedged in place. *Wedge bolts and sleeves fit into holes drilled after the concrete cures. Wedge anchors must be at least 5 in. from the concrete's edge.*

Alternative footings

GARBAGE BAGS

I make adjustable footing forms from heavy-duty garbage bags. First, I dig a footing hole a little larger than the cardboard form and about 1 ft. shy of my final depth. Then I widen the bottom of the hole to the size required by the footing-size calculation.

Using duct tape, I attach a garbage bag to the bottom of the cardboard form and slip it into the hole. Before backfilling, I fill the bag with concrete so that it spreads out and fills the widened area at the bottom of the hole. At that point, I backfill the footing tube and fill the inside of the tube with concrete.

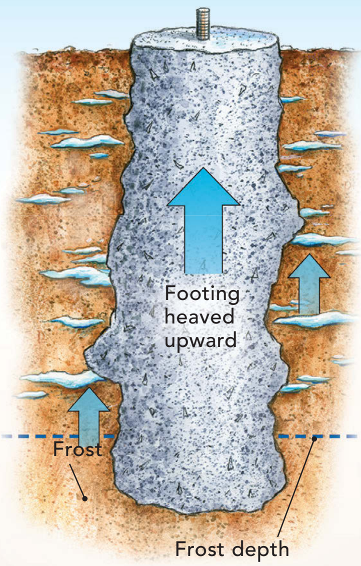
PIN FOOTINGS

Pin footings (diamondpiers.com) are engineered systems consisting of concrete anchor blocks cast with guide holes through which steel pins are driven diagonally into the earth. Each anchor block has an integral bolt on the top that is ready to accept post hardware. The pins are made of 1-in.-dia., schedule-40 galvanized steel. Residential models are sized for frost depths between 36 in. and 48 in., and commercial models can work with a 60-in. frost depth. The residential models have a load capacity of 2700 lb. when installed in 1500-psf soil and 3600 lb. in 2000-psf soil. The pins are driven into the earth in just minutes using a 1⅛-in. hex-shank demolition hammer.

HELICAL PILES

In areas served by a specialty contractor, helical piers can save a lot of digging. Galvanized-steel assemblies consisting of a helical plate (typically 12 in. dia. for decks) and a 2-in. pipe, residential helical piles are driven by a hydraulic motor on a small, dedicated machine. Once the pile reaches the minimum depth allowed by code, the operator monitors the hydraulic pressure required to drive the pile, which directly translates to the bearing capacity of the footing. Once the required bearing is reached, the pile is cut to length and a beam saddle is welded on. Depending on the contractor, you can end up with an engineer's report that verifies the load each footing can handle. One source for that service is technometalpost.com.

DIG THE FOOTINGS

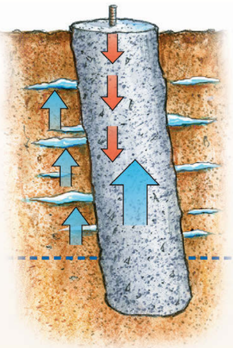


START WITH A GOOD HOLE

Building codes cover most of the basics about footing size, frost depth, and the bearing capacity of soil and concrete. Codes don't, however, tell how to dig a proper footing hole. A good hole is smooth, straight, and flat-bottomed; includes a footing form; and avoids the pitfalls below.

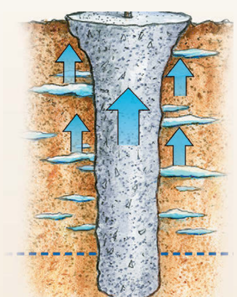
Side issues

No form: The smooth sides of a footing form minimize soil friction and act as a bond break, preventing heaving. If you don't use a form, concrete assumes the uneven shape of the soil. Frost can "grab" the rough sides and heave a footing even if the bottom is below the frost line.

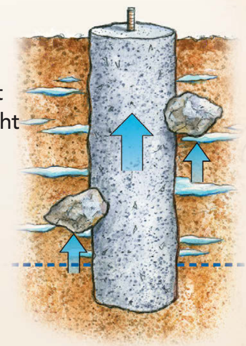


Slanted: The force on a slanted footing loads the side rather than the bottom of the footing, causing it to sink and rotate. Also, frost can heave up against the side.

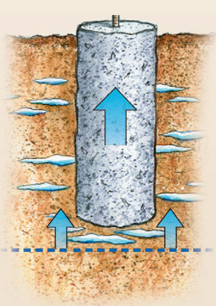
Inward taper/flared top: Footing forms prevent inverted-cone and mushroom shapes, the worst designs for footings. These shapes often have narrow bases that can sink under load, and frost pressing upward on the top can tilt the footing. Footing forms alleviate the problem even when the hole is dug overly wide at the top.



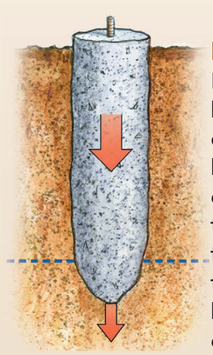
Debris: Rocks, roots, pipes, and other projections that impinge on the straight sides of footings can give purchase for frost to heave or tilt footings. They also leave defects in the footing that can lead to concrete fractures.



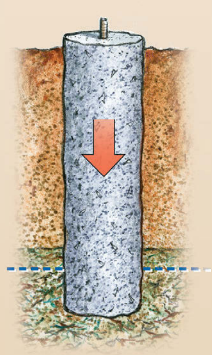
Bottom problems



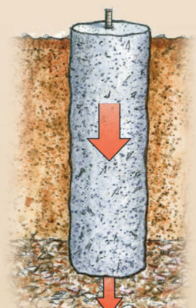
Too shallow: Decks connected to a house must be supported by footings that reach below the frost line to soil that won't freeze. Otherwise, when moisture in the earth freezes and expands, it can push shallow footings upward. Frost depths vary, so check the local building department for your conditions.



Rounded/pointed base: Footings are designed with flat bottoms for a good reason. If you dig them with round or pointed bottoms, then add a load, they can act like arrowheads piercing the soil. Make the bottom of the footing hole the same size as the footing form or larger. The bottom also must be flat and close to level.



Unstable soil: Topsoil (loam) contains organic material (decayed plant matter and unconsolidated mineral matter) and a lot of air. Highly compressible and unstable, it can't reliably support a load. Footings must be dug through the topsoil, which can be several feet thick, even if that means going well past the frost line.



Disturbed base: Footings can't rest on earth that has been disturbed by digging, even if that excavation took place many years ago. This is especially problematic for footings dug near a foundation wall. Even the couple of inches of loose soil at the bottom of a freshly dug hole must be removed or compacted by tamping.

Drawings: Don Mannes.

FINISH WITH GOOD CONCRETE

The minimum compressive strength of concrete used for footings should be 2500 psi. Air pockets and other defects can reduce compressive strength, so the importance of properly mixing and placing concrete can't be overlooked.

Get the mix right

Too dry: A stiff, dry mix may not consolidate fully, so the footing could be left with air pockets and fracture lines that can lead the footing to crumble under load.

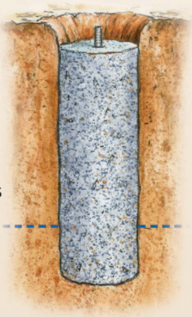
Too wet: Soupy concrete dilutes compressive strength. As the extra water dries away, tiny holes remain and weaken the concrete.

Just right: The concrete should be damp enough to hold together when squeezed into a ball and not crumble apart. It should keep a crown when shoveled and not spill off the edges.

Soil contamination: Soil can inadvertently fall into the concrete during placement, especially on footings poured directly into holes without forms. Soil contamination can weaken concrete and leave fracture lines. Use a footing form that's at least several inches above grade to avoid contamination.

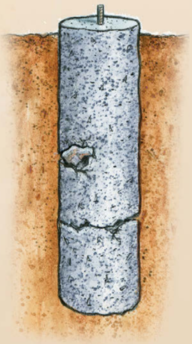
Avoid these setting mistakes

Footing top below grade: Footings poured so that the concrete is below grade invite surrounding dirt to fill over the top. This puts the post-base connector at risk of corrosion and the post itself at greater risk of decay. Pour the footing at least 4 in. higher than grade.

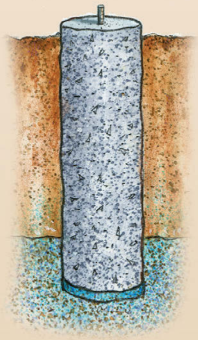


Uneven tops: It's hard to plumb and secure a post base properly on top of a footing with a sloped top. Make sure to screed and level off the top of the concrete before it cures.

Rocks in the mix: Avoid the temptation to toss stones into the concrete pour. Soil on the stones will prevent the concrete from bonding, and there's also a risk of creating air pockets and weak spots.



Air pockets/cold joints: This problem often occurs when using a stiff concrete mix, when a pour is interrupted and fresh concrete is placed on top of curing concrete, or when large aggregate doesn't consolidate into the mix. Don't pause for more than 15 minutes during each pour, and vibrate or rod the concrete to ensure that layers are intermixed.



Water infiltration: If you hit water as you dig the footing holes or leave rainwater in a footing hole before pouring, the concrete will be contaminated and weak. Water must be removed from the hole, or the concrete must be isolated from the water by using a plastic bag or waterproof footing form.