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Top 10 Deck-

Avoid these common problems, and build a longer-lasting, safer deck

BY GLENN MATHEWSON

The process of building decks is not nearly the same today as it was a decade or more ago. While the outdoor environment and the endless design possibilities have remained constant, emerging technologies and new products and materials require a stronger sense of industry codes and best practices for you to be able to build a deck properly.

As a deck builder and former inspector and plans analyst, I have seen a lot of inferior deck-building practices from professionals and do-it-yourselfers. I've also seen an abundance of bad information that perpetuates problematic designs and poor construction practices. A badly built deck is more prone to failure than a correctly built one, and it's dangerous for those who use it.

Here, I highlight the most common errors I see in deck building and offer solutions to help ensure that your next deck is safe and that it lasts. □

Glenn Mathewson is a consultant and educator with buildingcodecollege .com. Photos by the author, except where noted.

MISTAKE 1

FAILING TO INSTALL A CONTINUOUS HANDRAIL ON STAIRS

The post in the middle of this flight of stairs interrupts the top of the railing, which was designed to serve as the handrail. An unsightly continuous handrail had to be added.

The error: For construction or aesthetic purposes, builders regularly install handrails interrupted with newel posts. It's also common to see a guard's top rail used as a handrail.

The solution: Code provision R311.7.8.4 requires that a continuous handrail be installed on any set of stairs that has four or more steps. A continuous guard free of midspan posts extending through the top can be used as a handrail, but only if it meets specific geometric requirements. To be considered a handrail, the guard's top rail must be graspable by those walking up and down the stairs.

If a post interrupts a guard's top rail, a true handrail must be added to the guard running along the stairs.

Always follow manufacturer guidelines for appropriate fastener types and sizes, and use stainless-steel or galvanized fasteners if you are using pressured-treated lumber.

Drawings: Dan Thornton.
Top photo, this page: courtesy of Woody Roberts.

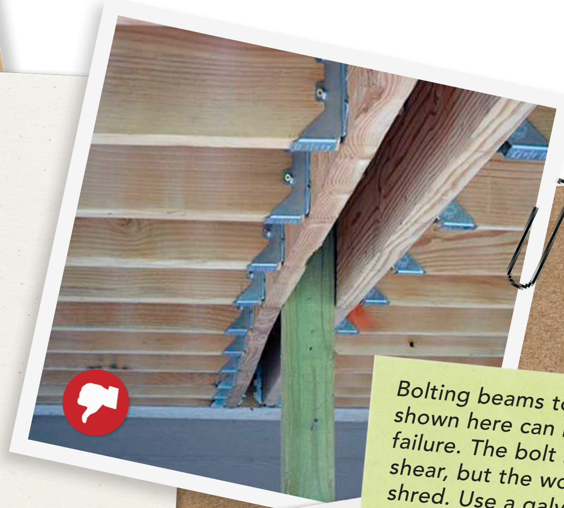
Building Mistakes

MISTAKE 3

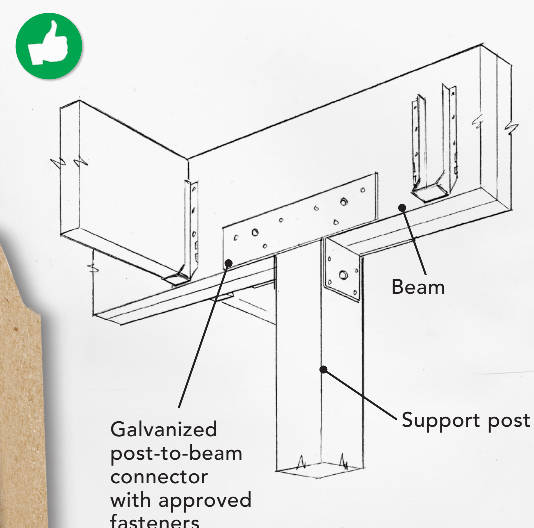
BOLTING BEAMS TO THE SIDES OF POSTS

The error: A tragedy brought to us from the aisles of big-box stores: directions to deck builders to bolt deck beams to the sides of support posts. The average backyard deck has relatively few posts. Fewer posts result in greater loads at beam connections. It would take a huge load to shear a $\frac{1}{2}$-in.-dia. machine bolt, but long before that occurs, the wood around the bolt would be crushed and distorted, resulting in a failed connection.

The solution: Each ply of a multispan beam, whether single or multi-ply, must have full bearing on intermediate posts. This can be accomplished by notching a 6x6 to accept a 2-ply beam and bolting the beam to it, or by the use of an approved post cap. With all the hardware available to handle various direct-bearing applications of different-size beams and posts, there is no excuse for disregarding this code requirement.



Bolting beams to posts as shown here can result in failure. The bolt may not shear, but the wood can shred. Use a galvanized-steel post cap, and keep the beam firmly seated atop its support post.



MISTAKE 2

INSTALLING HARDWARE INCORRECTLY AND USING THE WRONG FASTENERS

The error: Incorrect fasteners in hangers are a notorious mistake. For example, deck screws are not a proper way to attach joist hangers, and using $1\frac{1}{4}$-in.-long 10d nails where $3\frac{1}{2}$-in. 16d nails are required is a sure sign that manufacturer instructions were not followed.

Fasteners that don't have the correct corrosion-resistance rating will fail quickly when installed in treated lumber. Also, using only one-half of a two-part post-to-beam connector and installing undersize bolts in 6x6 post bases are common installation errors.

The solution: For hardware to work as the manufacturer claims it will and the way the inspector expects it to, follow the manufacturer's installation instructions. Proprietary hardware is not specified in the code; therefore, it is considered an alternative. Alternatives are approved via testing or engineering, and that information must be provided to the building official. The only way to be sure hardware will perform as expected is if it is installed as it was tested or designed. Beyond code compliance, valid product warranties depend on proper installation.

MISTAKE 4

OVERSPANNING COMPOSITE DECKING

The error: The maximum span of wood-and-plastic composite decking generally depends on the type of plastic used in the product. It's important to follow the span limits of a specific product as outlined in the manufacturer's installation instructions, which some builders fail to review. Overspanning composite decking is most commonly a problem when deck boards are run diagonally over joists or when they're used as stair treads.

The solution: Floor joists for a deck are typically installed at 16 in. on center, which won't properly support some composite-decking products when installed on an angle. In new construction, be sure floor joists are installed at the correct spacing. In existing decks, adding more floor joists is the only remedy. Similarly, additional stair stringers might have to be added to stairs where composite decking is used for the treads. Stair treads must be able to resist a concentrated load of 300 lb. over an area of 4 sq. in. This requirement puts a lot of pressure on the actual tread material to support concentrated loads. Some composite products are limited to an 8-in. maximum span when used as stair treads, which require the support of six stringers in a 36-in.-wide stairway.

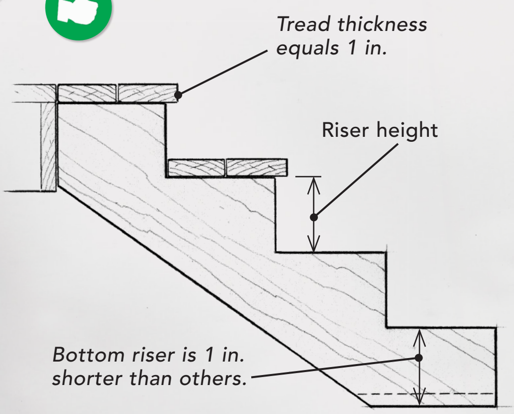
To meet the span tolerance of this diagonally installed composite decking properly, additional joists and hangers had to be added to the existing deck framing.

MISTAKE 5

BUILDING STAIRS WITH INCORRECT RISER HEIGHTS

The error: Often, the bottom step on a set of deck stairs is roughly 1 in. taller than the rest. Code allows a maximum variation of only 3/8 in. between riser heights. This guideline often confuses inexperienced carpenters, who insist that they cut every notch in the stringer the same.

The solution: Every notch cut into a stringer has an identical riser height except for the bottom one. The steps notched out of the stringer in the middle of the flight have treads placed above and below each step, effectively adding the same tread thickness to each riser height so that they remain constant. The bottom step doesn't have a tread below it, though, so you must subtract the thickness of the tread from the height of the bottom riser, which is the bottom of the stringer.



Once you've determined the stairs' rise and run, the stringer layout is straightforward. One detail, how-ever, is easy to overlook. The bottom riser needs to be one tread thickness shorter than the rest.

MISTAKE 7

ATTACHING DECK LEDGERS POORLY

The error: The majority of deck plans end with a straight, continuous line at the ledger, rather than details as to what the ledger is connecting to. Unfortunately, the way a ledger attaches to a house is one of the most critical elements in deck construction, and many builders get it wrong. For example, they bolt ledgers straight to brick, stucco, or EIFS cladding. These practices violate the code.

One of the more egregious ledger mistakes is connecting the ledger to a rim joist nailed to the end grain of cantilevered floor joists—those that support a kitchen bump-out, for example.

The solution: Detailing a ledger properly depends on the building type, the cladding material, and the site conditions. Of all the parts of a deck, the ledger can rarely be treated the same from job to job. Long before construction begins, considerations must be made as to, for example, whether stucco needs to be cut back with new weep screed installed or whether a few courses of lap siding need to be removed to bolt and flash the new ledger properly.

Code requires that band joists supporting deck ledgers bear fully on the primary structure capable of supporting all required loads—in other words, they can't be part of a cantilevered floor. A better option in that scenario is to build a freestanding deck that doesn't rely on the cantilever to support it.

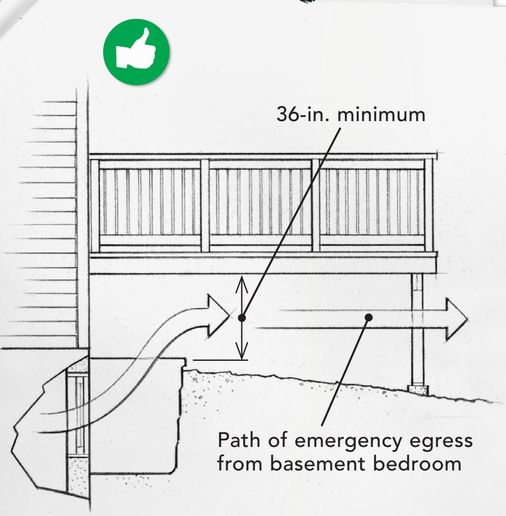
If sistering deck joists to floor joists isn't an option, adding a beam, posts, and footings can help to relieve some of the stress placed on the fasteners connecting the ledger to the end grain of the cantilevered floor joists.

MISTAKE 6

IGNORING CLEARANCES AND INHIBITING ACCESS

The error: Although well constructed, some decks create code violations and safety hazards just by how they interact with the house. For example, some stairs on multilevel decks end up near windows that the builder has not replaced with tempered-glass units. Other decks are built too close to the house's main electrical service panel or the service conductors overhead—which need to be at least 10 ft. above a deck or 3 ft. to the side of a deck, according to code (E3604).

The solution: No matter what features exist on the exterior of a home—windows, air-conditioning compressors, low-hanging soffits, exterior lights, outdoor receptacle outlets, dryer vents—identify the required clearances before starting a deck design. While some features will influence the shape and location of the deck, other features may require only that appropriate access be integrated into the design of the deck.



Some clearances around a deck are code-required, like providing a minimum 36-in.-tall escape path from a basement egress window, while others are simply practical, like ensuring access to hose bibs. Each clearance should be considered with equal diligence.

MISTAKE 8

When set above an area's frost line, footings can heave (top photo). Piers set below the frost line with bell-shaped bases (bottom photo) stay in place and distribute the deck's weight. Even where the ground doesn't freeze, footings must be set 12 in. into undisturbed soil and not directly on grade (middle photo).

SETTING PIERS IN DISTURBED SOIL

The error: When it comes to digging footings for their deck piers, some builders are lazy. Usually, a deck's foundation piers are not set below the region's frost line. To avoid deck-ledger failures, freestanding decks are becoming popular, but the piers nearest the home's foundation are often set atop backfill.

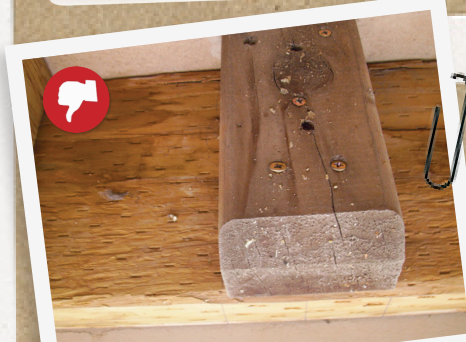
In areas where the frost depth is not an issue and precast foundation blocks are commonplace, they're often set on top of the exposed grade.

The solution: Just about every deck is built on an isolated-pier foundation system. Foundation systems are required to extend a minimum of 12 in. into undisturbed soil (R403.1.4). In cold climates where the earth is subject to freezing, pier foundations for non-freestanding decks must extend to a depth below that which is likely to freeze—in some places deeper than 48 in. This prevents the soil below the pier from freezing and heaving the pier upward.

To install deck piers properly, the piers must bear on undisturbed soil and be set below the frost line in cold-climate regions. However, if the piers are in a backfill region, as is the case with piers nearest the house on a freestanding deck, the footing depth may have to be as deep as 10 ft. to reach undisturbed soil and to comply with code.

Precast foundation blocks must be set at least 12 in. into the ground. However, even in the middle of a lot, the topsoil is tilled roughly 6 in. prior to seeding, so it's likely that the footing needs to be at least 18 in. deep to comply with code. Assume that all deck piers and foundation blocks require some digging.

MISTAKE 9



Don't notch posts or use nails or screws to fasten them to deck framing, as shown above. Use bolts. More specifically, use blocking and bolts, as shown below, to create a stronger guard system than one with posts connected to rim joists that are nailed only to the end grain of the joists.

Photos this page: top left and bottom left, Brian Pontolilo; bottom right, Andy Engel

MISTAKE 10

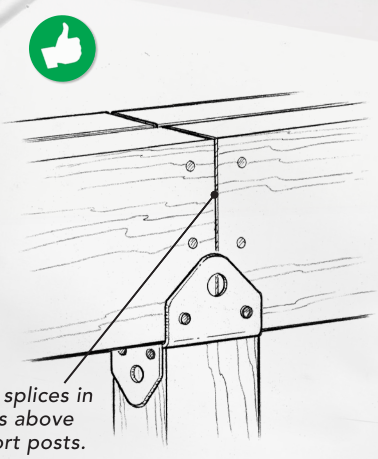
MAKING BEAM SPLICES IN THE WRONG PLACES

The error: When a long built-up beam spans multiple posts, many builders run one ply long and extend it beyond the support posts. Many builders believe this practice is good because splices of opposing beam plies are greatly separated as opposed to being only inches apart on top of a post. Unfortunately in these cases, an engineer's evaluation or a rebuild of the beam is required.

The solution: Beams are under two stresses: bending and shear. Shear forces act perpendicular to the length of the beam and are greatest near the bearing ends.

Bending changes the beam's shape, a force called deflection, and is greatest in the center of the beam span. The code lists maximum allowable limits for deflection. In deck beams, the deflection limit is typically reached long before shear limits are a consideration. Any reduction in bending resistance also increases deflection potential and ultimately ends in code noncompliance.

Beam splices that miss the bearing point by a small amount don't greatly affect bending or deflection, and the shear strength of one fewer ply is likely still sufficient. In these cases, the cost of an engineer's review might just get you the OK to build. If a design calls for a splice in the center of a span, it will be smarter and cheaper to build the beam so that splices land atop posts.



Make splices in beams above support posts.

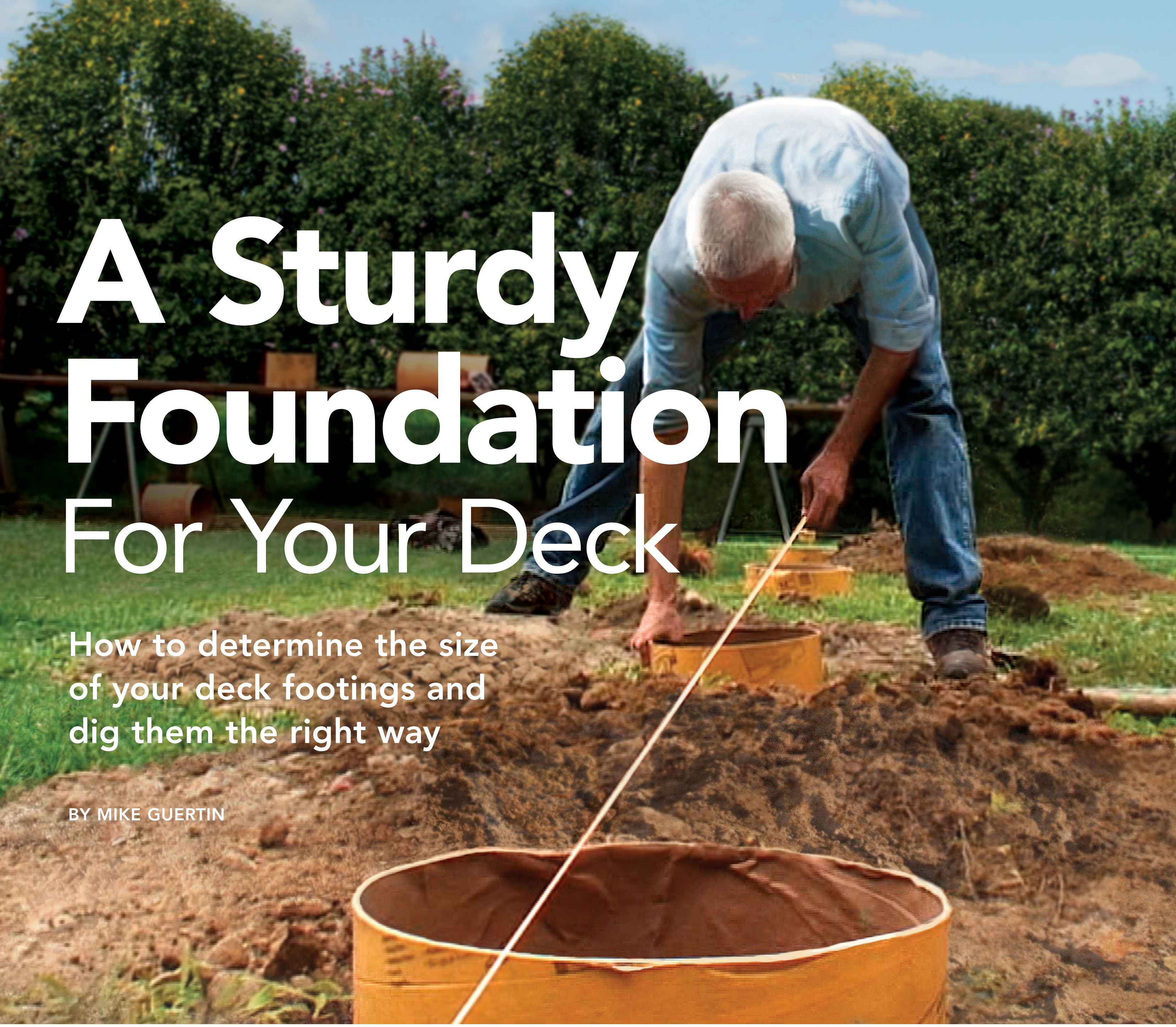
Beams suffer the greatest amount of deflection at the center of their post-to-post span. Therefore, strong beams are spliced atop posts. If you can't stagger splices over different posts, then placing them over a single post is permissible.

INCORRECTLY ATTACHING GUARD POSTS

The error: Insufficiently connecting a guard post to a deck is among the most dangerous deck-building errors. Fastening guard posts to deck rim joists or floor joists with wood screws is not acceptable. While some builders get the guard-post-to-rim-joist connection correct, they don't always ensure that the rim joist is attached to the deck framing properly.

The solution: The code (Table R301.5) requires a guard to be designed and constructed to resist a concentrated load of 200 lb. in the outward and downward directions along its top. Depending on the design of the guard assembly, a stout guard-post-to-deck connection can be accomplished with blocking and through-bolts or with horizontally oriented hold-down hardware. In some rail designs, most of the load resistance is handled by the post connection to the deck. In those instances, the post should be attached to the joists, not the rim, because the rim is not usually fastened to the joists in a manner capable of transferring the load. Rims are typically nailed into the end grain of the joist, the weakest possible connection for withdrawal resistance.

The design methods for guard assemblies are as vast as the imagination, and homeowners admire that creative expression. However, serious consideration must be made as to how the guard is ultimately assembled. The strength of a guard system is provided by a lot more than just the post-to-deck connection. The concentrated load must be resisted at any point along the top of the guard. With a common 5-ft. to 6-ft. distance between the posts, the load must transfer through the connection of the horizontal rails to the post. When a continuous top cap runs across the posts, it acts like a horizontal beam to help distribute the load over a larger area. When a post is run long, through the top of the guard's top rail, there is a considerable increase in the leverage the post puts on its connections.



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.

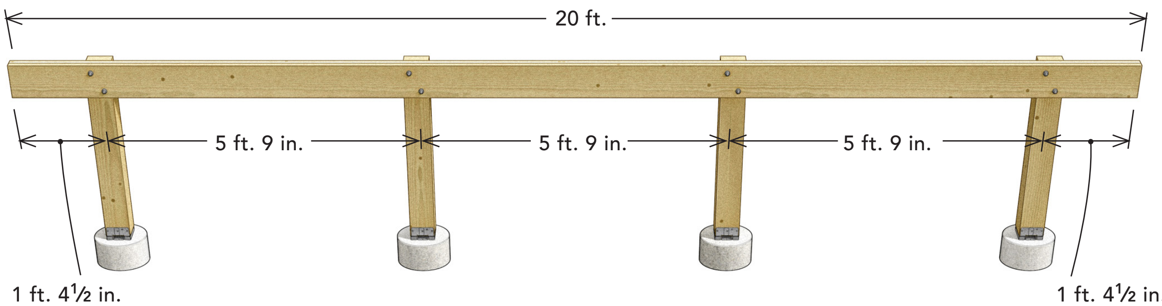
CHOOSE A BEAM

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?

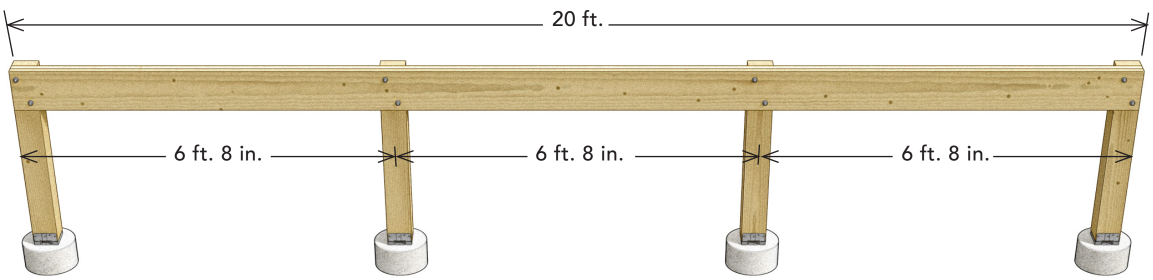
After answering those questions, I choose a beam configuration, such as a double 2x8, from the IRC's Table R507.5 (Deck Beam Span Lengths) and determine the number of footings needed based on the size of the deck. I prefer a double 2x beam because it can rest on notched 6x6 posts. The 2½-in.-thick leg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

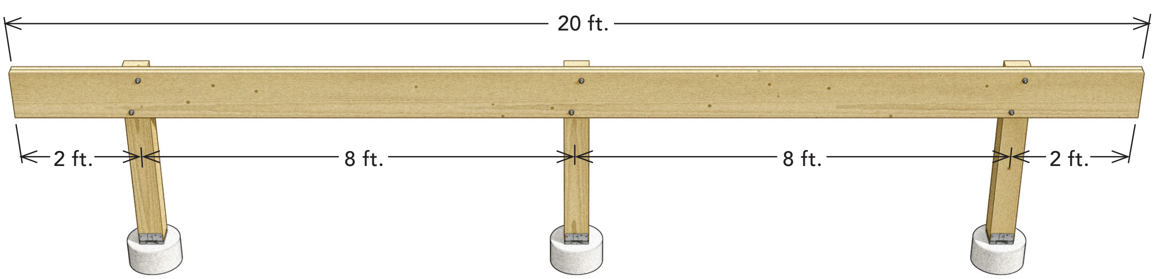
Three beam options for a 14-ft. by 20-ft. deck



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

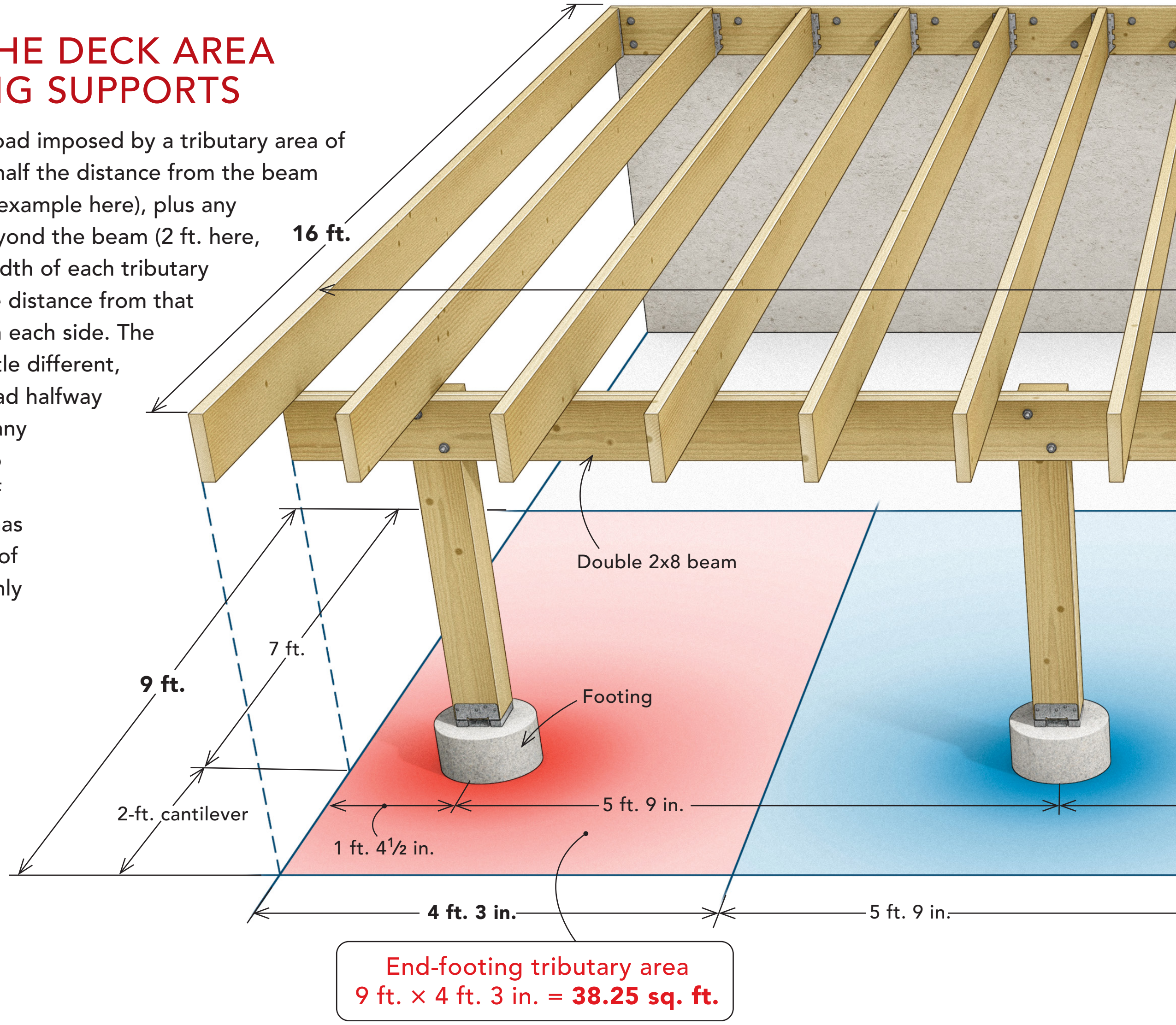
	Joist spans less than or equal to:						
Beam size	**6 ft.**	**8 ft.**	**10 ft.**	**12 ft.**	**14 ft.**	**16 ft.**	**18 ft.**
2-2x8	8 ft. 9 in.	7 ft. 7 in.	6 ft. 9 in.	6 ft. 2 in.	* 5 ft. 9 in.	5 ft. 4 in.	5 ft. 0 in.
2-2x10	10 ft. 4 in.	9 ft. 0 in.	8 ft. 0 in.	7 ft. 4 in.	6 ft. 9 in.	6 ft. 4 in.	6 ft.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

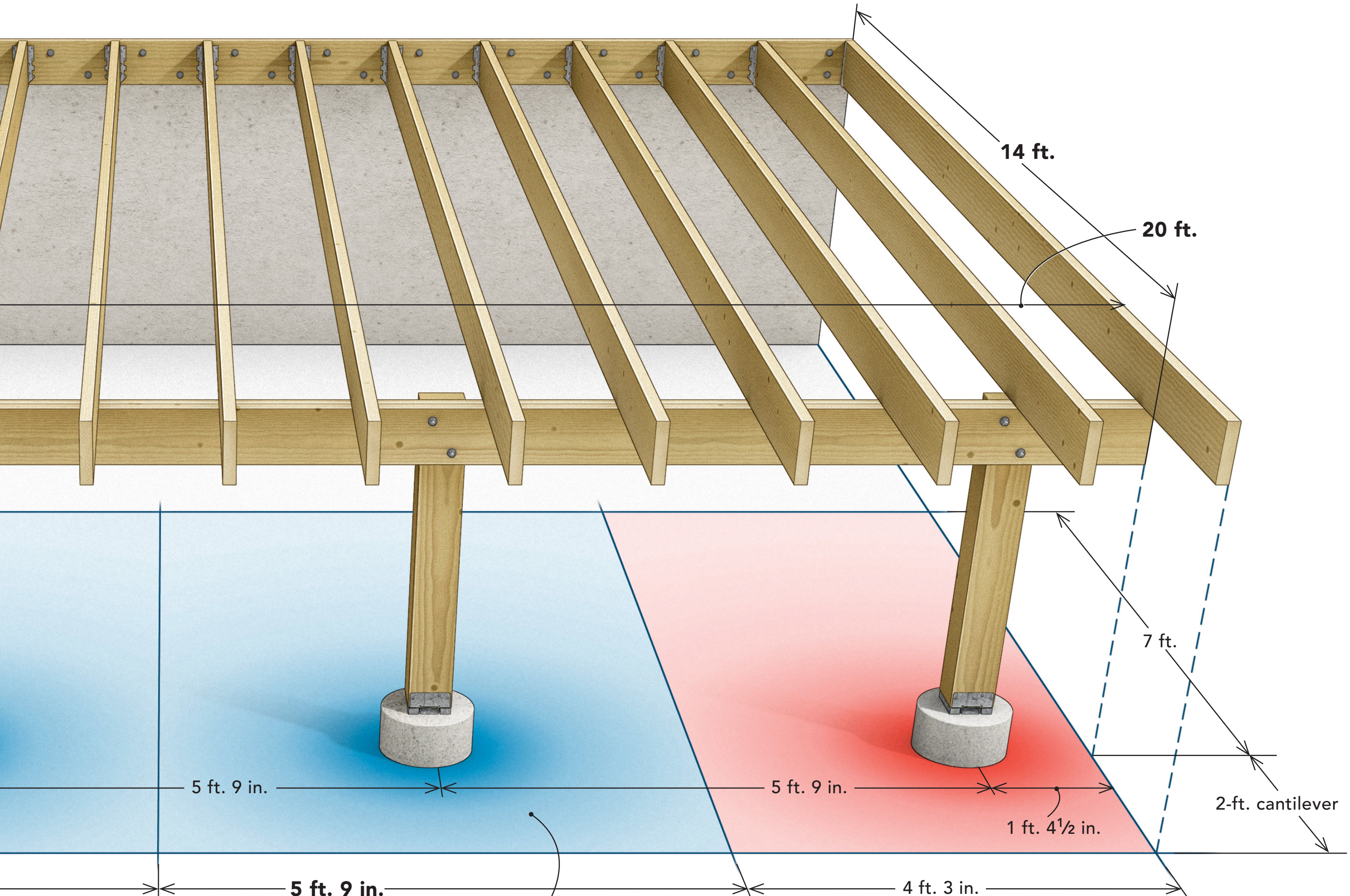


CARDBOARD TUBES ALONE MAY BE INADEQUATE

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 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.



Center-footing tributary area
9 ft. × 5 ft. 9 in. = **51.75 sq. ft.**

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 FailSafe 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

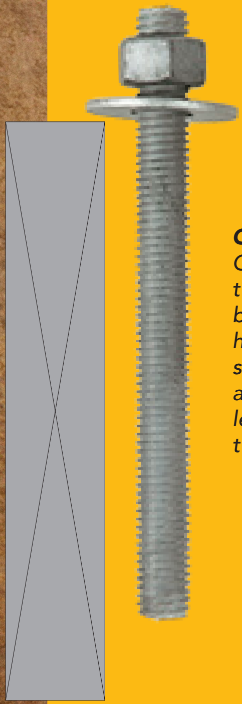
Frost lines and soil type affect footing depth. In areas not subject to freezing, footings must be at least 12 in. below the undisturbed ground surface. If there is any fill or the soil was disturbed where the footings are placed, the footing holes must be dug at least to the level of undisturbed soil. 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 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.

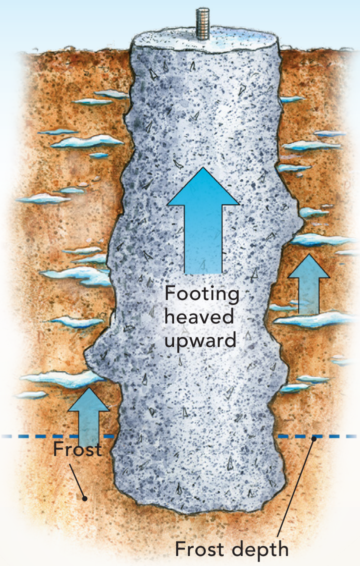
PIN FOOTINGS

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

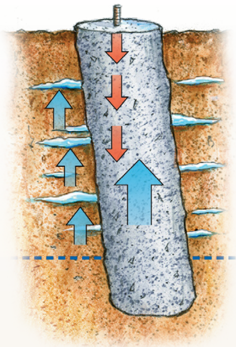


START WITH A GOOD HOLE

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.

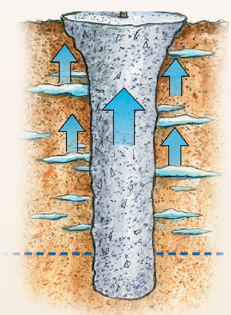
Side issues

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.

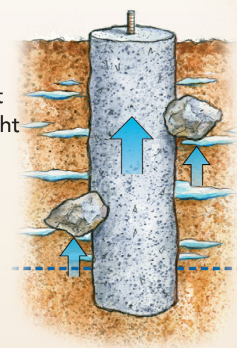


Slanted: The force on a slanted footing loads the side rather than the bottom of the footing, causing it to sink and rotate. Also, frost can heave up against the side.

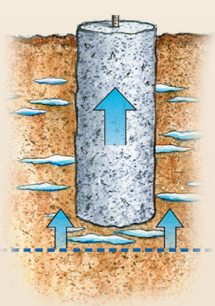
Inward taper/flared top: Footing forms prevent inverted-cone and mushroom shapes, the worst designs for footings. These shapes often have narrow bases that can sink under load, and frost pressing upward on the top can tilt the footing. Footing forms alleviate the problem even when the hole is dug overly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



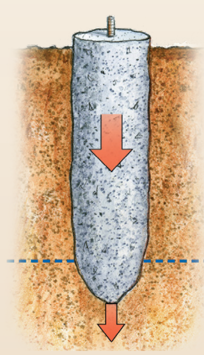
Debris: Rocks, roots, pipes, and other projections that impinge on the straight sides of footings can give purchase for frost to heave or tilt footings. They also leave defects in the footing that can lead to concrete fractures.



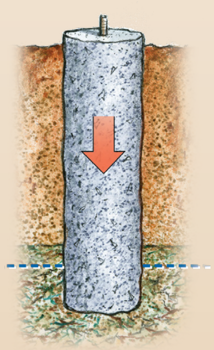
Bottom problems



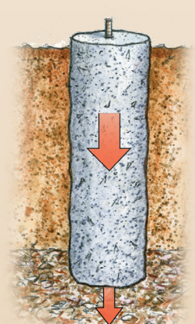
Too shallow: Decks connected to a house must be supported by footings that reach below the frost line to soil that won't freeze. Otherwise, when moisture in the earth freezes and expands, it can push shallow footings upward. Frost depths vary, so check the local building department for your conditions.



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.

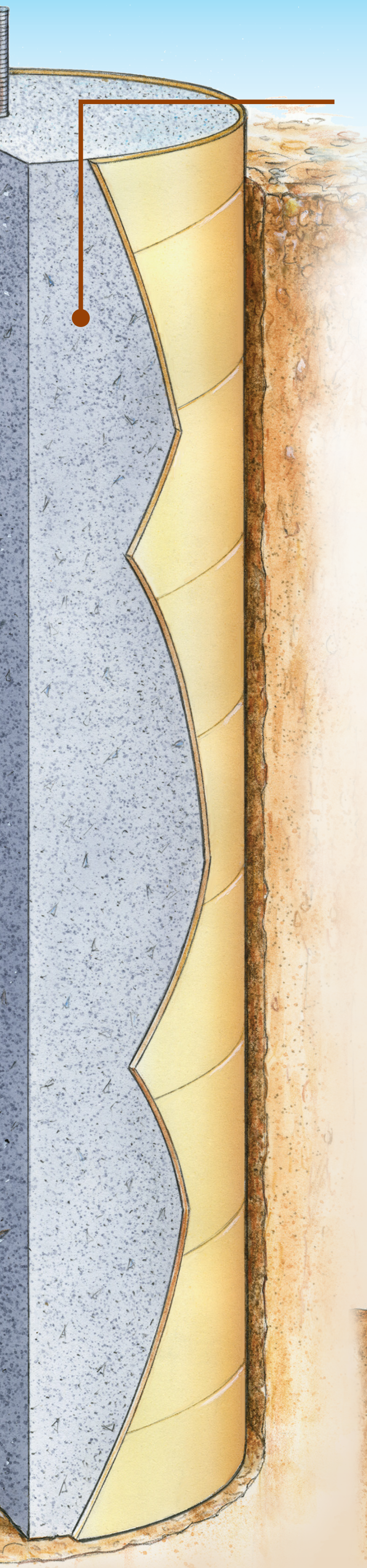


Unstable soil: Topsoil (loam) contains organic material (decayed plant matter and unconsolidated mineral matter) and a lot of air. Highly compressible and unstable, it can't reliably support a load. Footings must be dug through the topsoil, which can be several feet thick, even if that means going well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

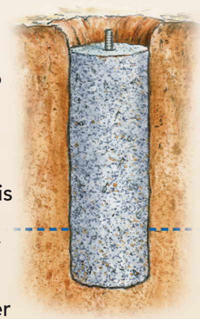
Too wet: Soupy concrete dilutes compressive strength. As the extra water dries away, tiny holes remain and weaken the concrete.

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.

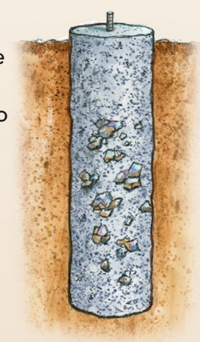
Avoid these setting mistakes

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.

Critical Deck

A look at the forces at work on a deck and the

BY JUSTIN FINK

Twenty years ago, the most advanced pieces of hardware you'd find on a typical deck would be bolts and joist hangers. But for the last several years—due in part to increased public awareness surrounding catastrophic deck failures, as well as complaints about the woefully inadequate treatment of decks in code books—decks have been a hot topic among code officials and builders. As more recent versions of the IRC are adopted, decks are subject to code provisions that are more explicit and comprehensive than ever before.

Many of the most critical connections rely on metal hardware. Curious about the purpose and function of all this hardware, we invited Simpson Strong-Tie's David Finkenbinder, an engineer and product designer of deck connectors, to spend a few days on a job site as we documented the building of a typical ledger-attached raised deck.

During the build, we peppered David with questions about how the hardware was designed to counteract the forces at work on a deck, and which details builders often get wrong. Here are some of the lessons we learned, which include pieces of information that are not typically accessible to builders in the field.

Justin Fink is a former editor. David Finkenbinder contributed to this article. Photos by the author, except where noted.

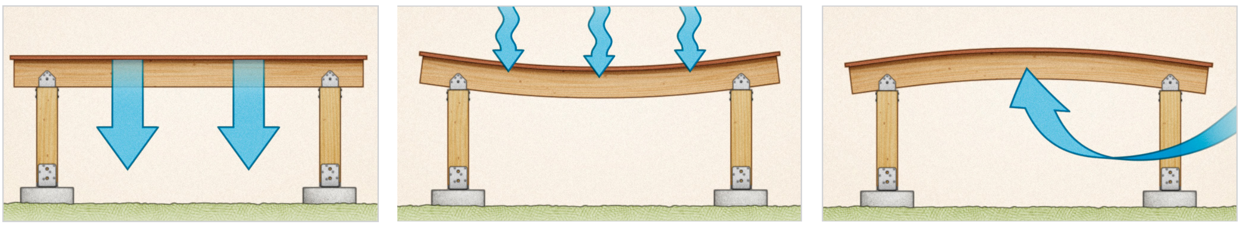
Connections

hardware designed to keep things in check

FORCES AT WORK

If decks only had to resist gravity, engineers would have it much easier. In reality, a deck not only has to support and transfer its own weight, but it must also support its occupants, the forces of their movements, and the forces of nature. To protect decks from failure and occupants from injury, building codes require reinforcements, including hardware and metal connectors. Some pieces of hardware are continuously at work, and others are there only to provide insurance against failure during periods of high stress.

Elevation view



Gravity loads Gravity loads act vertically. They are transferred from the deck into the house framing via the ledger, and down to the ground via the beam, posts, and footings. A deck's dead load is the total weight of the deck and its individual materials, including beams, joists, decking, and railings (typically calculated at 10 lb. per sq. ft.). Live load is everything added on top of the deck, such as the weight and movement of people (typically 40 lb. per sq. ft.), and the weight of stationary items such as furniture and grills. Although not technically a gravity force, occasional uplift from strong gusts of wind or steady uplift created by overhanging framing are also best included in this category.

PRIMARY PROTECTION Ledger fasteners • joist hangers • post bases • stringer hangers • hurricane ties

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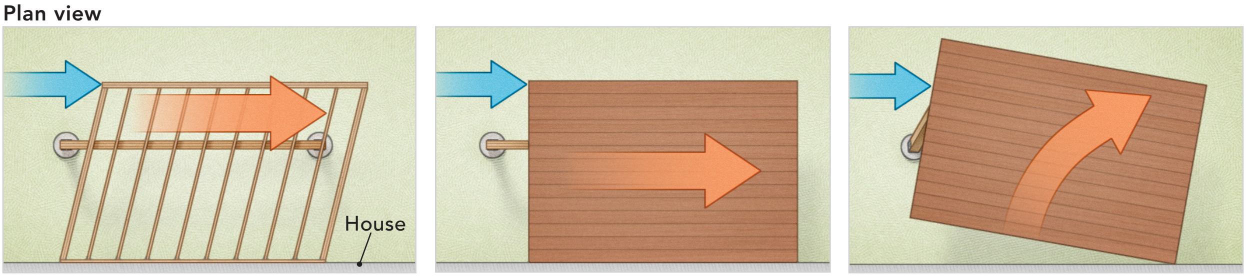
Lateral loads Direct-bearing connections exist where wood is resting directly on top of wood, or where those pieces are separated only by a metal plate. In these cases, the hardware is there to ensure that the pieces of wood stay connected when subjected to horizontal forces. Such forces may include wind, earthquakes, and human activity on the deck. The codes that protect a deck against lateral loads are based on ongoing research but are essentially judgment calls based on what engineers consider safe tolerances.

Plan view



Racking In seismic events, the ground moves, and everything above tries to move with it. The same thing happens when people dance, or run and then quickly stop. Their momentum is transferred from their feet down into the deck. A deck isn't perfectly stiff, so these racking forces make it flex.

PRIMARY PROTECTION Decking (if through-fastened) • angled post braces (or posts set into concrete footings)

Sliding When hit by strong winds, a deck wants to slide, just like a box being pushed to the side. The risk here is either that the unified box of framing components will shift off the beam, or that the posts will shift off the footings.

PRIMARY PROTECTION Ledger fasteners • joist hangers • post bases • post caps • hurricane ties

Pulling away If the deck can't rack, it will try to slide. If it can't slide, it will try to break free in a sort of lateral tipping motion. This creates large compression forces at one end of the ledger and a lot of tension at the other. Because joist hangers and ledger fasteners are not designed to resist this force, a separate connector is needed.

PRIMARY PROTECTION Tension ties

Joist hanger

Post cap

Post base

Stringer hanger

Hurricane tie

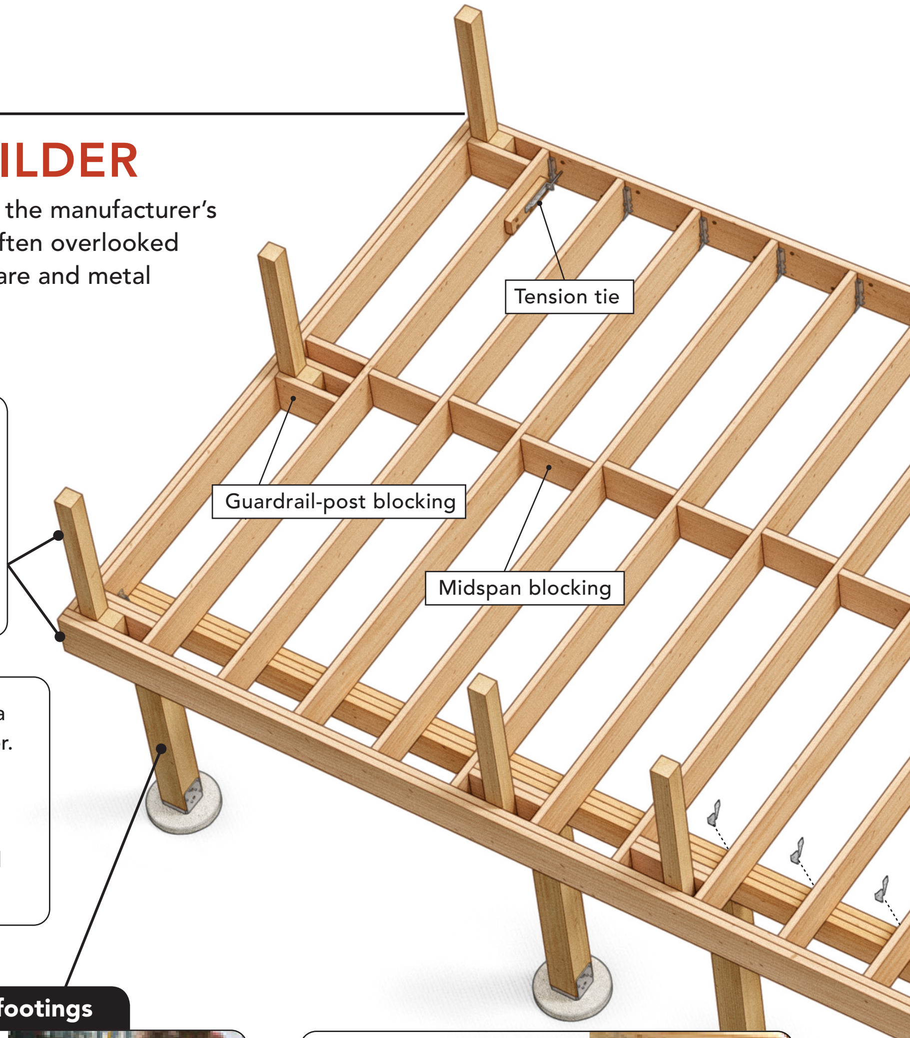
Tension tie

Product photos: Dan Thornton.
Drawings: Christopher Mills.

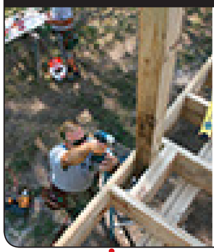
NOTES FROM THE FIELD

KNOWLEDGE FOR THE BUILDER

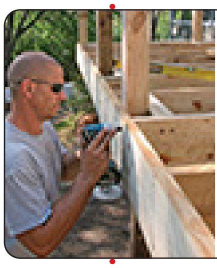
Although no substitute for specific code requirements or the manufacturer's installation instructions, here are some helpful insights, often overlooked caveats, and general advice for properly installing hardware and metal connectors on a typical deck.



Rim and guardrails



Guard posts must be attached so that guards can withstand 200 lb. of concentrated live load applied at the top in outward or downward directions (or any direction if the guard is also a handrail). Tension ties and blocking are the most common solutions.

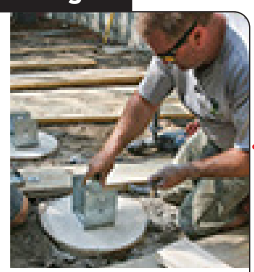


Working together with midspan blocking, a deck's rim keeps the joists from rolling over. To do its job, the rim must be fastened to the joists with 3-in.-long #10 wood screws, or 10d 3-in. threaded nails. If a double rim is used, these fasteners should be installed before the second layer is applied.

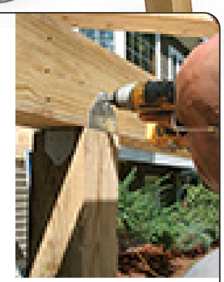
Guardrail posts attached to a rim are only as strong as the rim's attachment to the joist ends. Posts in these locations should be tied to joists with blocking or tension ties, too.

If guardrail posts are being reinforced with tension ties approved for that application (such as Simpson's DTT2, right), the joists must be 2x8 or larger. Smaller joists don't provide enough depth for the fasteners to resist the leverage applied to the railings.

Beam, posts, and footings



Clearance from the post base to the edge of the footing varies by the type of connector and anchor. Generally, the shallower the anchor embedment, the closer to the edge of the footing you can get. Keep in mind that minimum edge distances are a separate issue from sizing a footing to carry deck loads, and honest calculations for these two criteria usually result in a need for larger footings than are commonly used.



Post caps, regardless of type or thickness, are not designed to provide sway resistance. If you need to resist racking forces in a tall deck, the posts must be stiffened with angled wood bracing between post and beam or by sinking the posts into the footings.

Even when installing beams so that they bear directly on posts, you can't rely on toenails for this connection.

FOUR GENERAL REQUIREMENTS

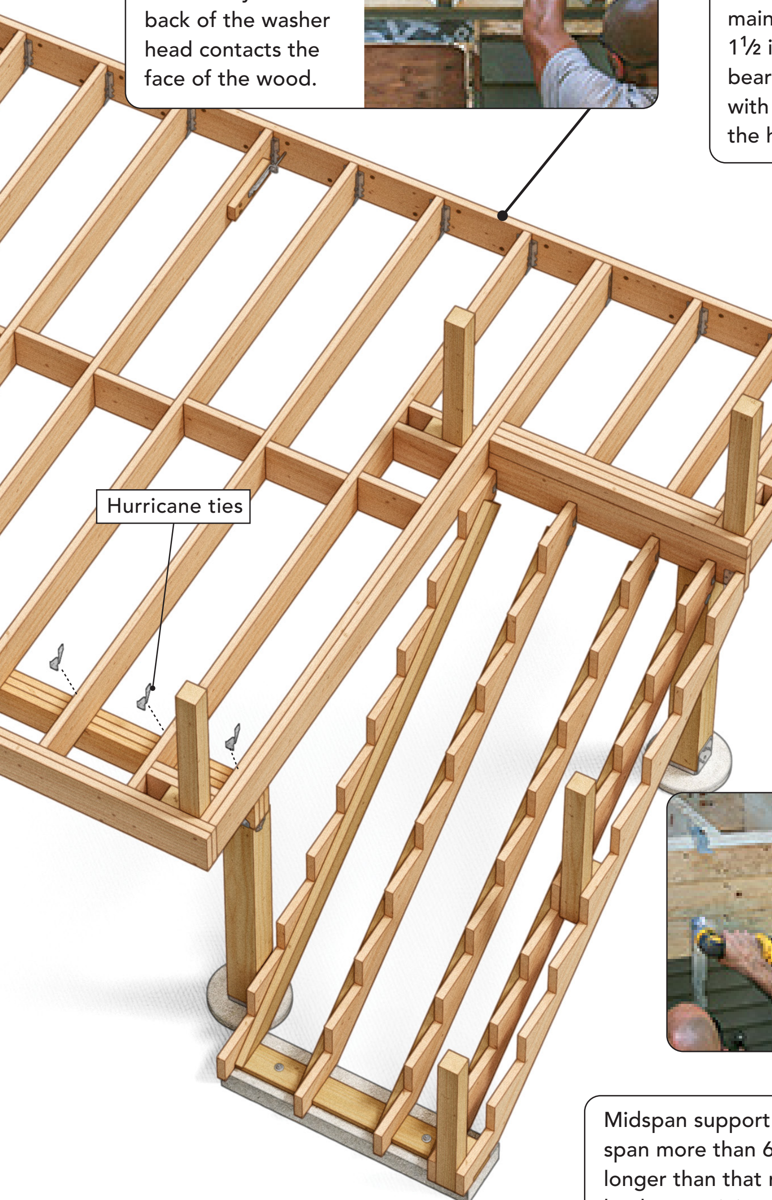
Before diving into the details of each metal connector, learn these golden rules for deck hardware.

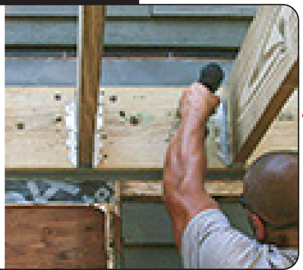
1. The right connector. Connectors are designed and tested for specific applications. There are no tested values to support their use—either in their original form or an altered form—for reinforcing other connections.

2. The right finish. The mistake inspectors see most frequently is the use of metal connectors with one type of weather resistance (galvanization or stainless steel) and fasteners with another type.

3. The right fasteners. In many cases, using hardware screws rather than nails is allowed. These screws are specifically designed with a ductile (softer) core, which allows them to bend under load rather than snap. You can't use deck screws or other general-construction screws.

Ledger, joists, and stringers

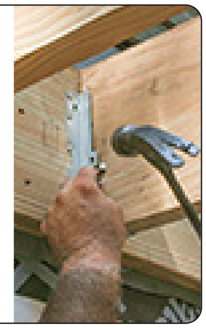




Overdriving ledger screws reduces their holding strength. They should be driven only until the back of the washer head contacts the face of the wood.

Joists must be cut to sit within ⅛ in. of the ledger, and to satisfy code, must maintain at least 1½ in. of full bearing contact with the seat of the hanger.

Hangers must match the joist they support. Hangers that are undersize place all of the forces into the bottom of the ledger, which can split off.

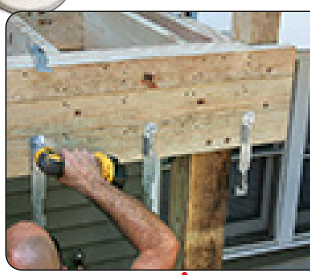


Much of a joist hanger's capacity relies on the 45° fasteners, which must be 3 in. long to pass through the joists and into the ledger.

Deck frames must be tied back through the ledger and into the house framing, usually using tension ties. The number needed and the placement of these connectors depends on the type used.

Only inverted flange hangers are tested for use at ledger ends. Never bend or cut a standard hanger for this spot.

Toenails are a fast way to attach the joists to the beam but aren't a long-term solution for preventing movement. Hurricane ties are a more durable way to reinforce the connection between the joists and beam.

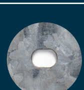
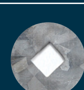
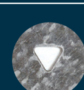
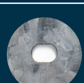
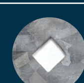


Stringer hangers have minimum bearing requirements. If the first step is below the deck surface, then a wider header or dropped header will be needed.

Midspan support is required for notched stringers that span more than 6 ft. (measured horizontally). Distances longer than that require midspan support posts that land on a minimum 6-in.-thick footing.

You don't need joist hangers at the rim opposite the ledger unless it's also acting as a flush carrying beam.

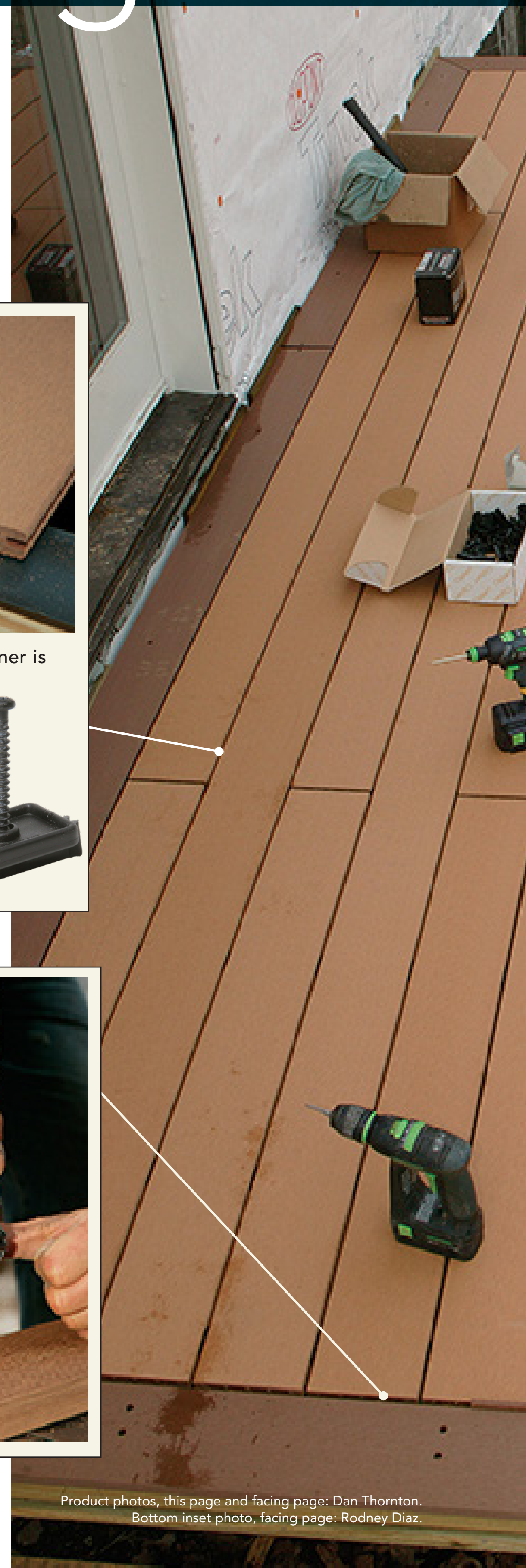
4. The right fastening pattern. Achieving the designed strength of a metal connector means using the proper number of fasteners. The punched holes in each connector—the only places where fasteners should be driven—are shaped by the manufacturer to match fastening guidelines (see key, right).

	Always fill	For ease of nailing in tight locations (e.g., skewed joist hangers)	To temporarily fasten a connector to ease installation	Fill to achieve maximum strength
Simpson Strong-Tie				
USP Structural Connectors			N/A	

Install Decking With

Use a biscuit-style fastener to secure composite boards with grooved edges designed for hidden fasteners

BY MIKE GUERTIN



I generally order decking in lengths that minimize waste for a given deck size. Unfortunately, the deck width of 16 ft. was set before the decking was ordered, and it was only available in 12-ft. lengths. This left us two options: install full-length boards with a 4-ft. piece alternating left and right, or use two 8-ft. pieces cut from full length boards. To minimize waste, and for looks, we used the former option.

A single-board border encloses the field decking. We installed the border first, then filled in the center. We placed the first board 1/2 in. away from the house to allow water to drain.

The decking has grooved edges. To avoid showing a groove, we had to rip one edge of the darker boards used along the perimeter. We fastened the field boards with the manufacturer's biscuit-style hidden fastening system, and screwed and plugged the edge boards.

To keep the decking parallel, we measured the distance from the last board to the rim beam every few courses. It's also a good idea to eyeball the decking to keep it straight.

Editorial adviser Mike Guertin is a contractor in East Greenwich, R.I. Photos by Andy Engel.

DECKING ANATOMY This biscuit-style fastener is screwed to the joist and engages the grooves of the adjacent boards. Leave the screws a little loose so that the leading edge of the fasteners easily engages the groove of the next deck board. After the following board is placed, the fastener screws can be tightened. Note the deck board's hollow structure, which adds strength without excess weight.

SLOTTED SCREW HOLES PERMIT MOVEMENT Drill 1/8-in. pilot holes 16 in. apart along the border decking, then elongate the holes from the underside with a drywall spiral cutter. Cut the slots progressively longer (up to 1/4 in.) toward the ends of the boards. Do not slot the center hole on each board.

Product photos, this page and facing page: Dan Thornton. Bottom inset photo, facing page: Rodney Diaz.

Hidden Fasteners

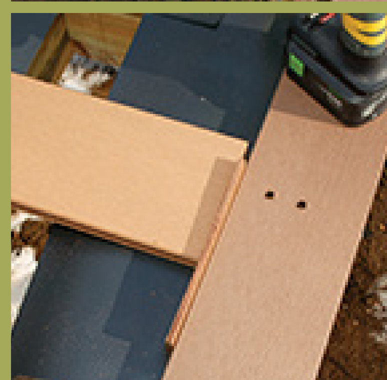
CAP THE JOISTS FOR LONG-TERM PERFORMANCE

To shed water, cap all single joists with 3-in. staple-on plastic tape (York Wrap, yorkmfg.com), and the doubled rim beam with a 6-in. tape. This reduces the amount of water that can wick into splits in the wood where preservative may not have penetrated or be as fully concentrated.

The other hidden fastener. *Unlike the field decking, the border can't be attached with hidden fasteners and must be face-screwed through pilot holes that are then plugged.*

GAP THE DECKING IN COLD WEATHER

Composite material expands and contracts along the length of the board with temperature changes. To accommodate this seasonal movement, install the decking with a ¼-in. gap at each end when the weather is cold. In warm weather, install without gaps.



A Field Guide for
Prefab Railing

Manufactured deck railings are fast to assemble and look great

BY JOE CIARALDI

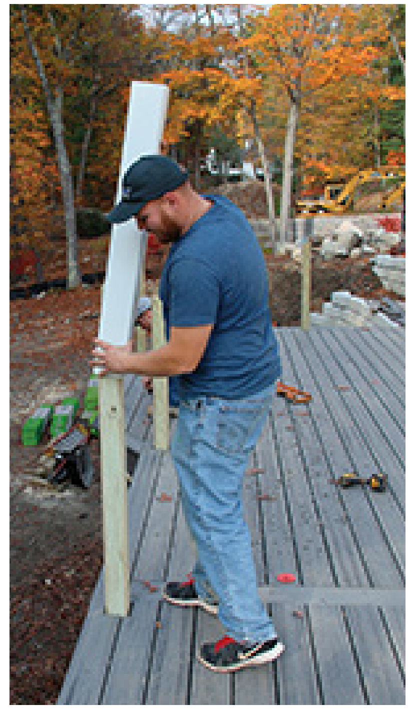
My Salem, New Hampshire-based remodeling company builds a lot of decks. Given our harsh New England weather and insistence on high-quality products, we almost always install manufactured railing parts rather than using wood. We've used several brands over the years, and all have performed well. Generally speaking, the way the various manufactured railing systems are constructed is pretty similar, but we prefer the Trex Transcend line because of the wide range of available rail and baluster styles and colors. The top and bottom rails, post sleeves, and balusters are made of a durable composite material designed to withstand rot, warping, fading, or splintering. The railing components come boxed and prefinished, and installation is straightforward. Best of all, our clients like the look of the finished railings, the maintenance-free system, and the option to integrate low-voltage lighting if desired.

A relatively simple white guardrail free of curves, angles, or sloping sections runs about $175 per section in material costs. Colors cost more, as do more complicated layouts. The railings depend on 4x4 pressure-treated posts spaced every 6 ft. to 8 ft. The rail lengths are based on the on-center spacing, so they are actually 67½ in. and 91½ in. long, which is important to keep in mind when you're ordering components and installing the posts. Because Trex designed the rails to work with multiple baluster styles, you'll find that baluster kits include style-specific matched inserts that snap into the universal top and bottom rails to space the balusters. We're careful to accurately order all the parts plus one or two extras of each because it usually takes a few days for our local lumberyard to deliver an order. □

Joe Ciaraldi is an award-winning carpenter and deck builder with Professional Building Services in Salem, N.H. Photos by Patrick McCombe.

START WITH STURDY POSTS

Before installation, I run each post through the tablesaw to remove all four corners, making space to run low-voltage lighting cable. I fasten the structural posts to the joists and rim joist using self-drilling FastenMaster Thrulok fasteners. Then I reinforce the posts with blocking fastened to nearby joists with structural screws. Once the blocking is in place, I use additional Thrulok fasteners to connect the posts to the blocking. Fibrex sleeves make the pressure-treated posts maintenance-free.



Slide on the sleeves. *The 4½-in.-square post sleeves are sold in 39-in. and 108-in. lengths. Cedar shims are used to plumb the sleeves once they're on the posts.*

String the posts. *Once the sleeves are on the posts, stretch a string across the posts to ensure they are in line. If one or more is out of line, remove the sleeve and use a flat bar to shove the post over. A plastic shim or two is sometimes needed to hold the post in place before reinstalling the sleeve.*

Follow the template. *With the four-sided base trim already slipped over the sleeve, use the included cardboard template to guide the placement of the plastic rail-support brackets. The rail-fastening kit includes zinc-coated, self-drilling screws.*

FIT THE RAILS AND BALUSTERS

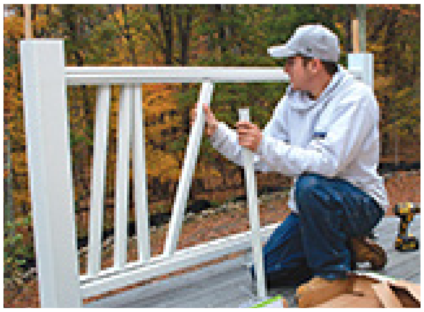
The rails, rail inserts, and balusters all work together to create a sturdy, code-compliant guardrail system. Once I've cut both rails, I fasten the bottom rail and place the top rail on support brackets, leaving it unfastened. I then install the balusters.

__Cut the rails.__ Cut the top and bottom rails 3⁄16 in. short to allow for the trim pieces at each end. It's best to cut the rail section inserts at the same time to ensure the parts are the same length. Removing equal amounts from both ends evens the baluster spacing.

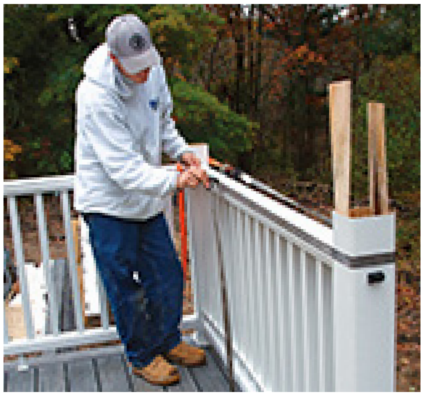
__Fasten the intermediate support.__ To prevent the rail from sagging, fasten the intermediate support to the underside of the bottom rail. When the rail is in its installed position, extend the support's telescopic foot to the decking. A pair of set screws with matching caps hold the support in its extended position.

__Connect the rails.__ With the U-shaped trim placed halfway onto the rails, drive screws through the brackets into the bottom rail and then the top rail, securing them to the post. Once the screws are driven, push the trim fully onto the rails.

__Install the insert.__ Designed to accommodate both round and square baluster styles, the rail sections include PVC inserts to space and secure the balusters. After the top rail is secured to the bracket, snap the lower insert into the lower rail and place the upper insert on top of it to prep for the baluster installation.



Fit the balusters. *The balusters are precut to make a 36-in.- or 42-in.-high code-compliant guardrail. Slip the balusters through both rail inserts and angle them to fit into the top rail's receiving channel.*



Pull it tight. *Top and bottom rails must be cut to an exact length to ensure the posts stand perfectly straight. If necessary, draw the posts together with a ratchet strap to tighten the fit before fastening the top railing.*

Slide up the top insert. *Once all the balusters are in place, slide the upper insert (which was placed on the lower rail) upward and snap it into the top rail. It's often necessary to move it gradually, switching from one end to the other.*

Curves require a special setup

ONE OF THE ADVANTAGES OF COMPOSITE RAILING PARTS is that they can be heated to form curves. The ability to easily incorporate curves into our decks helps differentiate us from the competition, so about 10 years ago we bought a CustomCurve heating oven from Trex. This $10,000, 9-ft. long, propane-powered oven can hold two pieces of decking or railing on slide-out racks that make it easy to get the parts in and out.

Depending on the part, it can take anywhere from a few minutes (for inserts) to two hours (for deck boards) to get the material soft enough to bend. Before bending, we place 1x4 PVC stock on both sides of the piece to prevent scuffs and encourage a fair curve. We set up the clamping table for the specific curve using a paper template made by scribing the deck frame. The table—also part of Trex's CustomCurve system—has an aluminum top that accepts clamps to hold a curve while it cools. We've found the table can sometimes flex, throwing off the curve, so we added steel framing underneath to reinforce it.

WHAT ABOUT SLOPED RAILING?

Although it's installed much like straight railing, sloped railing for stairways requires a different hardware kit. The stair hardware has longer trim pieces for rail ends and an intermediate support cut to match the rail's slope.

Scribe the fit. *With the rail resting directly on the treads, scribe the rail length and the angle of the miter using the posts as a guide. Reduce this measurement by 3⁄16 in. to account for the U-shaped trim that will be installed on both ends.*

Mark the brackets. *Place the bottom rail on a 2x4 and temporarily attach the bracket to the post sleeve with double-sided tape. Then remove the 2x4 and move the lower rail out of the way.*

Fasten the brackets. *With the bottom rail out of the way, you can now fasten the bracket to the post. The mounting bracket is sloped to match the rail (see below).*

Pilot holes help. *Although the screws are self-drilling, pilot holes are helpful to get the screws started, especially when you're fastening the top and bottom rails to the support bracket.*

TOOLBOX

Rail brackets do double duty

High-strength plastic rail-support brackets connect the top and bottom rails to the structural post. They include corrosion-resistant self-drilling screws.

Sloping rails use the same bracket as straight rails, but you have to use two instead of one at every rail-to-post connection. The two brackets are joined by means of a sliding dovetail molded into the plastic.

Clip the long points. *The sloped balusters have mitered ends and are meant to work with any code-compliant stair's rise and run. But clipping ⅜ in. off both long points allows the baluster to sit deeper in the receiving channel for a sturdier connection.*

Trim in place. *We wait until the end of the railing install to trim the post sleeves. The easiest way to do this is with a cordless multitool equipped with a fine-toothed woodcutting blade. Any slight irregularities in the cut will be hidden by the post cap.*

Cap it off. *Post caps come in flat and pyramid styles (prices start at $12). Both styles are designed to accept low-voltage lighting. Secure each cap with a bead of silicone where it meets the top of the post.*

Mounting Deck Stairs

Dedicated footings and the right hardware make a secure stringer attachment

BY MIKE GUERTIN

On the decks I built in the past, I never gave much thought to how secure the connection was between the stairs and the deck frame. I cobbled together an attachment using whatever was at hand: screws, nails, blocks of wood, and occasionally, angle brackets or field-modified metal hardware. Judging from what I've seen of others' work, I wasn't alone.

I started taking this connection seriously after seeing that a ½-in. gap had developed between the stringers and the frame on an older deck I was examining. Years of use, seasonal expansion and contraction of the wood, and frost heave at the bottom of the stairs had worked the nails out of the stringers' end grain. Now I look at the stringer attachment on every deck I inspect. Rarely are the stairs mounted securely, and many connections are downright scary. Not only is the stringer attachment suspect, but so is the capacity of the deck frame where the stringers mount. Most deck frames are designed for uniform loads, such as people and furniture. Impose a concentrated point load such as a stair without additional support, and you are likely overloading the frame.

Granted, the load is minimal when, for example, there are just two steps from grade to deck, and the risk of injury is pretty low should such a stair fail. But as the distance between the ground and the deck increases, so do the load and the risk. How tall must a set of stairs be before you take the connection seriously? I avoid that question altogether. To ensure that stairs of any size are supported properly, I frame a dedicated support system for the stairs and secure them with hardware specifically designed for stringer attachment. It doesn't take much more time or material to make a solid, durable stair connection than it does to cobble together a risky one, and no one ever complains when you don't cut a corner.

The case for independent stair support

Design loads for stairs parallel those for decks: generally, a combined live and dead load of 50 lb. per sq. ft. Let's take the example of a set of stairs that's 3 ft. wide, with eight treads that are 10 in. deep and a rise from grade to deck surface of 5 ft. That's 20 sq. ft. and a total load of 1000 lb. Half of this load is borne by the footing at the bottom, which leaves a 500-lb. load at the top. Adding that

1 CONNECT THE POST

To support the stair as well as the eventual railing, run a 4x4 post from a footing through the frame to the railing height. With posts mounted inside the framing, use through bolts to resist thrust from the stairs. Posts mounted outside the deck frame can be fastened with structural screws since the thrust on the header will push the post against the frame.

Slick and quick through bolt. *FastenMaster's ThruLok requires no wrenches. Drive it most of the way with a drill, thread the special nut on the back side, and finish tightening.*

2 FASTEN THE HEADER

A single 2x8 (or larger) that's 7 in. wider than the outside of the stairs serves as a header. Secure it to the posts with structural screws.

Faster than lags. *Structural screws such as FastenMaster's LedgerLoks offer strength similar to ½-in. lags, but they install with a drill or impact driver and require no washers.*

3 HAMMER IN A JACK

To fully support the header, run 2x4 jacks between it and the footings. Join the jacks to the posts with structural screws.

load from the stairs to an end joist sized for the deck load only will overload that joist. You might double the joist to handle the load, but what about the ledger, the beam, and the footing? Standard ledger-fastening details don't allow for concentrated loads such as a double joist. Also, the beam and the footing may not be able to handle the additional load imposed by the double joist supporting the stairs unless specifically designed to do so.

Mounting the stairs to a deck's rim joist invites similar questions: How is the rim joist mounted to the joists, and can that connection handle the concentrated load? Were the beam and the footings sized to account for the stair load? You can certainly beef up the ledger-to-house connection, the joists, the beam, and the footings to handle stair loads, but since the code doesn't provide a prescriptive solution, that might require an engineer. The alternative is to support the stairs independently with their own posts and footings.

Footings and posts support stairs

There are usually 4x4 posts for railings at the top of stairs anyway, and I just extend these

4 BOLT A 2x4 TO THE LANDING

Wedge anchors drilled into the concrete secure a 2x4 cleat that will connect to the bottoms of the stringers.

Easy concrete anchors. *Wedge anchors rely on a cone-shaped bolt head that pulls up as the nut is tightened on the bolt. The bolt head pushes on the inside of a steel sleeve, expanding it inside a hole drilled in the concrete.*

5 USE DEDICATED HANGERS

Stringer hangers provide a reliable connection to the header. For aesthetics, set the end hangers so their flanges are to the inside of the stringers.

Connector screws don't pull out. *Connector screws offer much higher withdrawal strengths than nails. Unlike many other kinds of screws, they also offer shear strength similar to nails, which often makes them a superior choice for attaching structural connectors.*

Stringer hangers are simply better. *Made by both Simpson Strong-Tie and USP Structural Connectors, stringer hangers provide a simple and reliable connection. Fasten them with structural-connector screws by the same manufacturers.*

posts down to a pair of independent footings to support the stair load. It doesn't matter if the posts are mounted inside or outside the deck frame. I secure the posts to the footings with metal post bases and anchor bolts.

For most stairs, the footings only need to be 6 in. to 8 in. dia. The maximum code-allowed span for unnotched southern-pine stringers accommodates about 16 10-in.-deep treads. In this scenario, half of the treads are supported by these posts, and half are supported by the landing at the bottom. That's about 40 sq. ft. for a 3-ft.-wide set of stairs, which, multiplied by the 50-lb.-per-sq.-ft. design load, equals a total design load of 2000 lb., half of which needs to be carried at the top of the stair. The load on each footing is 500 lb., and 8-in.-dia. footings can handle about 575 lb. based on the code's default soil-bearing capacity of 1500 lb. per sq. ft. These footings need to be as deep as the other footings for that deck.

Two through-bolts secure each post to the end joist or rim joist. To make an attachment point for the stringers, I bolt a 2x8 or larger board to these posts as a header, then support it further with 2x4 jacks that run to the

6 JOIN THE POSTS AND STRINGERS

Blocking behind the posts reinforces them and the stringers. A threaded rod between the posts pulls them together, sandwiching blocking along the front.

Tension rod squeezes out a solid connection. *A long, ½-in. bolt joins with a 3-ft. piece of threaded rod and a connector nut to create a tension rod that pulls the rail posts tight against continuous blocking.*

footings. (The jacks should be treated and rated for ground contact.) In order to comply with hardware manufacturers' required minimum of 3½ in. between the edge of the stringer and the end of the single-ply header, I make the header at least 7 in. wider than the outside of the stairs.

I attach the stringers to the header with Simpson Strong-Tie's LSC adjustable stair-stringer connectors or USP Structural Connectors' CSH concealed stair hangers. I fasten the angle-shaped hardware to the header with structural-connector screws so that the point where the plumb cut meets the bottom of the stringer will align with the bend point on the hardware. The side tabs on the hardware go on the inner face of the outside stringers so they aren't visible. The stringer is fastened to the hardware with screws through the side-tab holes and with a single screw through the bottom of the hardware.

I use structural-connector screws because the 2012 IRC says that stairs can't be fastened using nails subject to withdrawal (R311.5.1). The stringer is attached using a metal connector, but the connector is commonly fastened with nails driven straight into the header. These nails are subject to withdrawal and may come loose over time. Mounting the connector with screws reduces the risk of withdrawal. Both Simpson and USP have structural screws for their hardware.

Securing the bottom of the stairs

There are no metal connectors made specifically to secure stringers directly to a stair landing or footing. I dig and form a concrete slab to serve as a footing for the stringers, as well as for a landing. The footing portion is directly beneath the bottom cut of the stringers and is 12 in. to 16 in. thick, 16 in. deep, and a few inches wider than the stairs. The landing portion is 6 in. to 8 in. thick and extends at least 3 ft. from the finish nosing of the bottom step.

Using wedge anchors, I attach a 2x4 cleat to the slab so it fits between the outer stringers, flush with their fronts. Screws through the outside stringers attach them to the cleat. I notch the middle stringers to fit around the 2x4. A hot-dipped galvanized ½-in.-dia. threaded rod (jamestowndistributors.com) and blocking tie the posts to the stair. □

Editorial adviser Mike Guertin is a contractor in East Greenwich, R.I. Photos by Andy Engel.