Strong and Simple Stairs

Whether it's four steps or four flights, the framing basics for safe, comfortable stairs are the same

BY JOHN SPIER

Stair construction can intimidate even the most seasoned carpenters, and I'm often asked to give impromptu job-site lessons in stair design and construction. I tell people that there are lots of ways to build stairs, but regardless of the method you choose, every set of stairs requires the same basic approach to get from one level to another safely, comfortably, and legally.

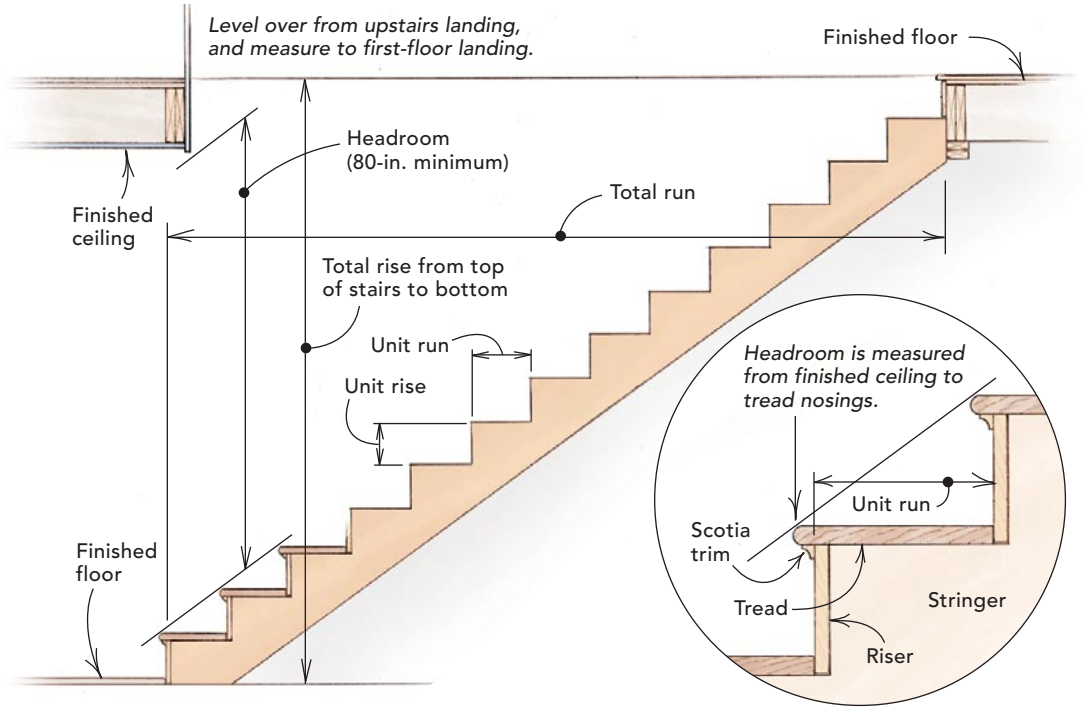
Stair math

The size and proportions of the staircase are determined by the design of the building and the openings in the floors. My first task is figuring out the details, and I always start with the building code (sidebar p. 70), which gives me the parameters for the riser height, the tread depth, and the allowable ratio between them. Code also dictates other restrictions such as headroom, stair width, railing requirements, and landing dimensions.

Stair mathematics begins with one verified dimension: the total rise, or the distance from one finished floor to the next. I make sure to include the thickness of floor finishes in my calculations. Floors often are out of level, so I never take a simple vertical measurement from one floor to the next. Instead, I use a long level to measure the exact

STAIR FORMULAS

Two formulas commonly are used to determine the proportions for interior residential stairs. The first, and most common, is (2 x rise) + (1 x run) = 25 ±1. This formula is incorporated into some building codes. The other formula is (rise) x (run) = 75 ±3. This formula is used for atypical applications like attic or landscape stairs. The example below shows the calculations for this stairway.



Rise calculations

102⅛	(total rise of stair)
÷ 7	(approximate riser height)
14+	(number of risers)
102⅛	(total rise of stair)
÷ 14	(number of risers)
7 5/16	(exact riser height)

Run calculations

(2 x rise) + (1 x run) = 25 ±1
14⅝ + (1 x run) = 25 ±1
25 – 14⅝ (2 x rise) = 10⅜ ±1
(Run can range from 9⅜ to 11⅜)

13 unit runs @ 10⅛ = 131⅝ total run

Don't just measure floor to floor. *To get the right dimension from the top of the stairs to the bottom, first level over to a point above where the stairs land (photo left). Then measure down to get the total rise of the stair (photo right).*

STAIRS AND THE BUILDING CODE

Builders have understood for thousands of years that stairs should conform to certain standard dimensions and proportions. Today, those standards are quantified in building codes, and any stairs that you build need to pass an inspection based upon those codes.

Different jurisdictions use different building codes, but the most common are the BOCA (Building Officials and Code Administrators International), also called CABO; and the newer IRC (International Residential Code). In addition, most states and some municipalities apply local amendments to the codes, some of which may apply to stairs. A visit to your local building official will get you a copy of the specific code you need to meet. Mercifully, most of these codes are similar and are less than a page long.

Residential-stair code typically specifies a maximum riser height of 7¾ in., a minimum tread depth of 10 in., a minimum stairway width of 36 in., and a minimum headroom clearance of 80 in. In addition, there are standards for nosings, slopes, riser angles, handrails, winders, and landings.

Exceptions to code regulations aren't uncommon. The State of Rhode Island, where I live and work, has an amendment that allows riser dimensions up to 8¼ in., and tread widths down to 9 in. This relief is often crucial in designing stairs for smaller homes. In addition, the IRC allows discretionary latitude to code-enforcement agencies for stairs in renovated or historic buildings.

TIP: Pliers instead of gauges

Locking pliers that have a lot more surface riding on the stringer stock are more accurate than stair-gauge stops; and they're always handy.

distance from the floor where the stairs start to the next floor where they end (photos p. 69).

When I've figured the total floor-to-floor dimension, a simple set of calculations gives me the individual riser height (stair formulas, p. 69). A construction calculator that works in feet and inches is great for calculating stairs (photo below), although you can do it longhand or with a regular calculator. For this stair, I started by dividing the total rise, 102⅛ in., by 7 (approximate riser height), which gave me just over 14, which should be the number of risers. I then divided 102⅛ in. by 14, for an individual riser height of 7 5/16 in.

After I have the number of risers and their exact dimension, I figure the run, or depth, of the treads with this formula: (2 x rise) + (1 x run) = 25 (plus or minus 1). For this stair, 25 minus 14⅝ in. (2 x rise) gave me a tread depth of 10⅜ in. I try to limit the run dimension to around 10 in. so that I can use standard 11¼-in. tread stock. In this case, I chose 10⅛ in. for the run.

The number of treads is one fewer than the number of risers. So I multiply the number of treads (13) by the run dimension to get the overall run of the stair (in this case, 131⅝ in.). I take a quick measurement to make sure that the stair is long enough to reach the ends of the floor openings, but short enough to leave plenty of headroom. If I find a problem, I may need to go back and recalculate the stair with one more or one fewer riser until I get comfortable stairs that fit the space.

Quick calculations. *A construction calculator that figures in feet and inches is the quickest way to find rise and run dimensions.*

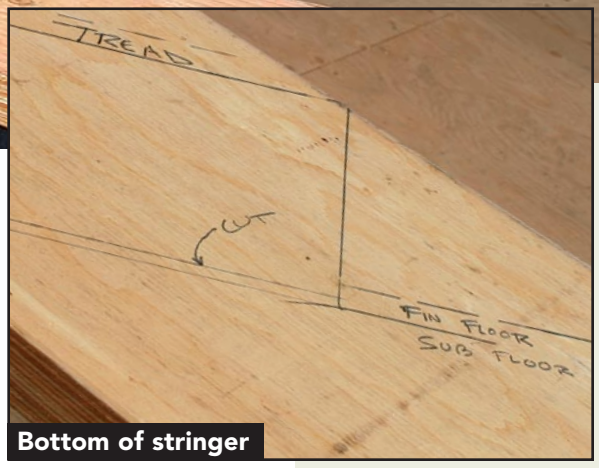
Engineered stringers don't shrink

A few years back, I read a *Fine Homebuilding* article by a carpenter who laminated strips of ¾-in. plywood for stringer stock. I thought it was a great idea. Then it occurred to me that an LVL (laminated-veneer lumber) stringer would be even better, and that's what I've been using ever since. Laminated-strand lumber (LSL) is fine, too, and I'm tempted to try pressure-treated parallel-strand lumber (PSL) for exterior stairs sometime. Meanwhile, there is nothing wrong with kiln-dried 2x12s for most applications, and in a pinch, I've even used regular "green" lumber.

Regardless of the stock I choose, I always check for crown. More often than not, even engineered lumber isn't perfectly straight.

I set the stringer stock on sawhorses and set up a framing square to mark the cuts. Instead of stair gauges, I use two sets of long-nose locking pliers ("Tip," above), which provide a longer, more accurate bearing surface on the stock's edge. I mark one stringer with standard

Top of stringer



Bottom of stringer

TIP: Say goodbye to 2x stringers

Stringers made from 2x stock tend to shrink, which makes treads sag, while those made from laminated-veneer lumber (LVL) remain stable. LVLs aren't always straight, so check for crown before laying out stringers. LVLs come in standard 1¾-in. thickness, in standard widths, and in almost any length. On the downside, LVLs cost more than 2x stock, so be sure of your measurements before cutting.

rise-and-run cuts from one end to the other (top photo, facing page); then I count risers and make modifications to the top and bottom ends of the stringer to allow for the size of the stair opening as well as for the thicknesses of the flooring and treads (bottom photos).

Double-check before cutting

Because LVL stock is expensive and I may not have extra pieces, I check my work in several ways before I do much cutting. First, I mark the anticipated landing points of the stringer in the stair opening (photo top left, p. 72) and measure the distance between them (photo top right, p. 72). Checking these dimensions on the stringer before cutting helps to prevent a mistake such as one too few steps and allows me to make adjustments.

When I've done the initial checks, I cut only the ends of the first stringer for a test fit. If the lower end of the stair lands on a framed floor instead of a slab, I notch the bottom edge of the stringer to wrap around the edge of

Stringer layout

Mark off the steps. *With the rise and run set on the framing square, the steps are marked out by sliding the square down the stringer stock (top photo). Be sure to mark out the right number of steps.*

Adjust the ends. *To find the distance from the top of the stringer to the floor above, be sure to include the finished floor and the finished tread (photo bottom left). The same is true for finding the cutline at the bottom of the stringer (photo bottom right).*

the framing. I try to make the horizontal part of the notch at least 4 in. long for proper bearing. The notch helps to keep the stringer in place during installation, and it provides a better point of attachment.

I test the stringer on both sides and check the fit and headroom of the ends. I also make sure that the tread cuts will be level (photo bottom left). When I'm satisfied with the fit, I mark the studs along the bottom edge stringer for the 2x4 spacers (photo bottom right). The spacers create a gap between the stringers and the wall studs for finish and trim, which makes the treads easier to fasten later.

Check before you cut

1. *After finding the right measurement to the top of the stringer, mark that distance on the header joist at the top of the stair for the top landing point.*

2. *A quick measurement between the top and bottom landing points verifies that the stringer is the right length.*

3. *After cutting just the top and bottom of the stringer, test to make sure the stair treads will be level before cutting out the steps.*

4. *Before taking the stringer down to cut the steps, mark along the lower edge for the 2x4 spacers.*

Two cutting strategies

Next I cut the steps from my test stringer (photos facing page), which becomes a pattern for the remaining stringers. Finished interior stairs up to 3 ft. wide need only two stringers. Wider flights, porch stairs, or open-riser stairs may need three or more stringers. If the stringers are supported by walls over most of their length, I cut though the notches with a circular saw. If a stringer is unsupported, though, I finish the notch cuts with a handsaw, a jigsaw, or a reciprocating saw for maximum strength.

While I have the pattern stringer on the horses, I trace its lower edge on the two 2x4 spacers and cut them to length. To install the stairs, I first nail the 2x4 spacers to the walls along the marks I made when I test-fit the stringers. Then I nail the outside stringers to the spacers. The center stringer goes in last, and a level ensures that the riser and tread cuts are aligned perfectly.

A short part of the lower section of this stair was open on one side, so I laid out a short stringer from my pattern, leaving the top end long. After the main stringers were nailed in, I set a 4-ft. level on the tread cuts, aligned the level with the tread line on the short stringer, and scribed the top edge against the wall framing.

With all the stringers secured, the final step is putting in temporary treads made of scrap 2x8. I make these treads about an inch shorter than the full width of the stringers so that they don't get in the way of drywall and trim installation.

I attach the treads with as few nails as possible, usually one nail per stringer location. On some projects, though, where people need to be comfortable on the stairs, I install bigger 2x10 treads. Sometimes I even add temporary ½-in. plywood risers to provide another level of strength, stability, and visual comfort.

I've been on plenty of jobs where everyone on site climbed ladders from floor to floor until the finished stairs showed up with the trim crew. Whenever possible, I try to build the stairs to each floor while the rest of the crew is still setting the joists. By the time the joists are ready for plywood, we all can walk up and down the stairs. □

John Spier and his wife, Kerri, own Spier Construction, a custom-home building company on Block Island, R.I. Photos by Roe A. Osborn.

TIP: Stairs on slabs

Stair stringers that land on a concrete slab should rest on pads made from scraps of asphalt shingle, felt paper, or flashing membrane to keep moisture from wicking into the stringer from the concrete floor.

Cut the stringers and build the stairs

1. *After the first stringer is cut, it becomes the template for the other stringers. If the stringer is to be supported by a wall, such as the side stringers, the lines can be overcut with a circular saw to create the notch.*

2. *For the unsupported center stringer, complete the cut with a handsaw or a jigsaw to avoid weakening the stringer.*

3. *On both sides of the stair, 2x4 spacers for the drywall and the skirtboard are nailed in first along the line scribed during the test fit.*

4. *Then the side stringers attach directly to the spacers.*

5. *To make the stringer for the open bottom section of the stair, the top of a short stringer is scribed to the framing while a level keeps the treads lined up.*

6. *Temporary treads of 2x8 lumber attach with a single nail at each stringer location. The temporary treads are kept back from the edges of the stringers so that they won't interfere with wall finish and stair trim.*

ONLINE CONNECTION

For more photos of the stair-building process, visit www.finehomebuilding.com.