Laminating Stringers for Curved Deck Stairs

A full-scale plywood template doubles as the base for the bending frame

by Mike Guertin

Curved stairs can add interest to a deck, and they sometimes solve design and layout issues. They can also be a profitable upsell, and they're not that hard to build; after you've done a couple, the process becomes ingrained and goes quickly.

My method has four basic steps: layout, stringer assembly, tread and riser assembly, and finish work. None of the work requires specialized tools or jigs, and everything can be done on site. The key to my process is a set of temporary 2x4 stud walls that I use as a layout tool and as the form for laminating the curved plywood stringers.

Like any stairs, curved ones have to meet code. The main section in the 2012 IRC that covers curved stairs is R311.7.5.2.1, "Winder Treads," but other sections also apply. In general, the requirements are

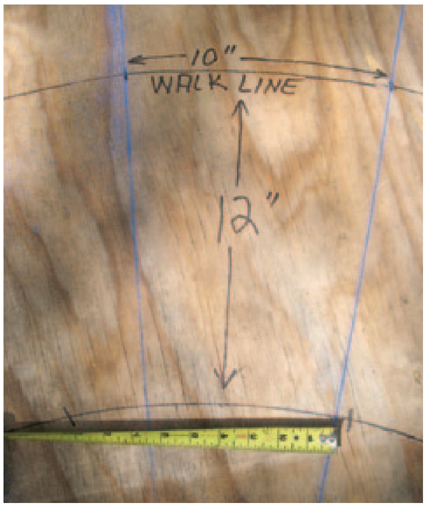


Figure 1. Swinging a tape from a wooden stake, the author lays out the inner and outer arcs of the stair at full scale on a double layer of plywood (above), then swings the walk line a foot inside the inner arc. Tread locations are marked at 10-inch-minimum intervals (right). Chalk lines snapped from the stake through the tread marks on the walk line (below) define the size and shape of the treads. The author verifies that the minimum tread width is at least 6 inches.

the same as for straight stairs, with a few additions that address the different shape of the treads. On curved stairs, the minimum depth of the treads at their narrow end is 6 inches, and the minimum depth at the "walk line" is 10 inches. The walk line is measured 12 inches in from the narrowest part of the treads and follows an arc that's concentric to the one at the inner stair edge. Though the code doesn't specify a maximum depth, keep in mind that extra-deep treads — more than 14 inches or so — can make stairs uncomfortable to climb. Your local code may have different requirements, so be sure to check.

Building the Bending Frame

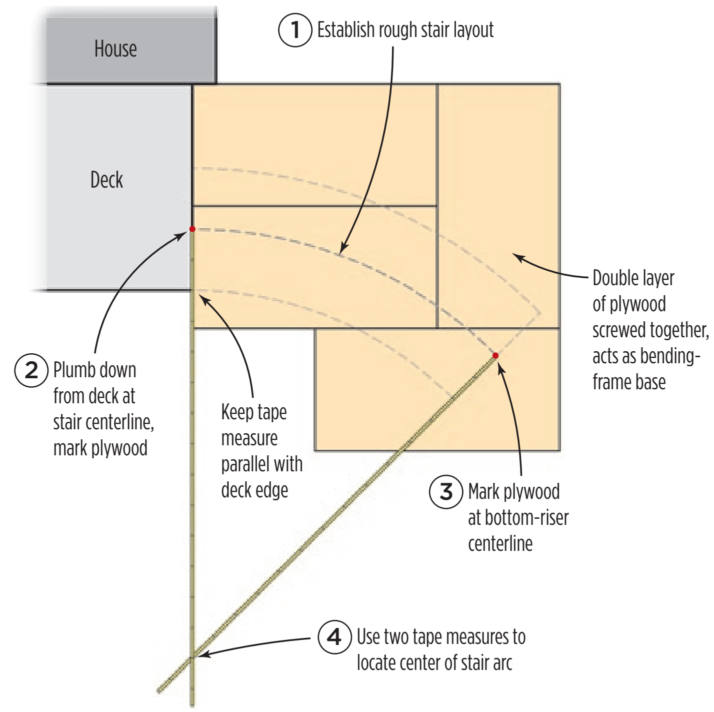
I calculate the number of risers and treads as I would with straight stairs. General layout includes locating where the stairs will leave the deck, picking a curve for the stairs, and targeting an area for the bottom landing. To rough out the stair's arc, I walk heel-toe-heel-toe in the imaginary center of the stairs, starting at the deck and curving in the direction of the planned landing. This establishes the approximate radius at the center of the flight and locates the bottom riser within a foot or two.

Bending-frame base. Once I've determined the stair's basic footprint, I lay out and assemble the frame for bending the stringers. As a base, I place two layers of plywood over an area about a foot wider than the stairs will cover; the plywood serves both as a template and as the bottom plate for the frame walls. I overlap the joints by at least 6 inches and screw the layers together at 2-foot to 3-foot intervals.

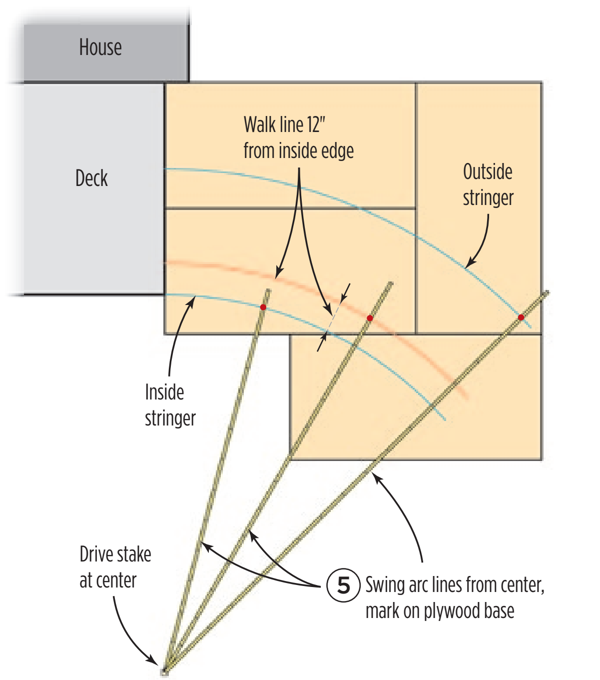
Template layout. Next, I mark arcs on the plywood at the radii of the inside and outside stringers and walk line (**see Figure 1**). To find the center of the arcs — a point equidistant from the top and bottom of the stairs — I first plumb down from the middle of where the stairs will land on the deck, and mark the plywood base below. Next, I mark the plywood at the middle of the planned bottom-riser location. Then I

Laying Out the Curved Stringers and Bending Frame

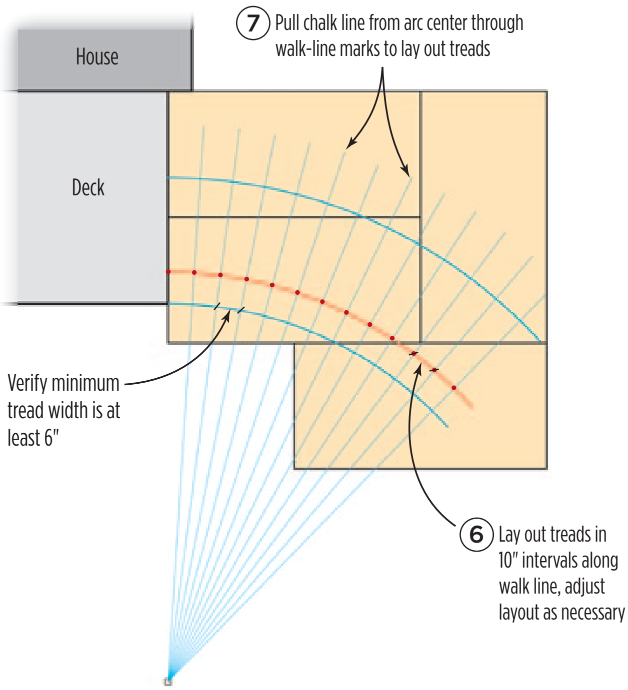
Rough Layout



Stringers and Walk Line



Tread Layout



Bending Frame

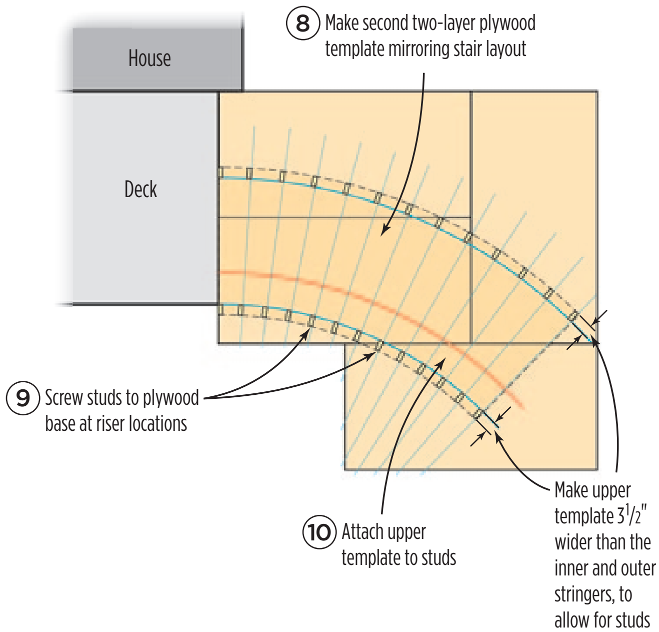


Figure 2. After scribing the stair on the plywood on the ground, the author makes a mirror image of the layout from a double layer of plywood, adding 3½ inches — a stud width — to both edges (above). He then supports the upper template on temporary posts at deck height (right).

pull tape measures from these two marks, keeping the tape from the first mark parallel with the deck edge and sliding the other tape along it. When the measurements match up, I've found the center of the stair arc.

I drive a stake at that point, hook my tape measure on it, and swing three arcs on the plywood, from the deck edge to the bottom landing area. The first arc defines the inside of the curve, the second arc — 12 inches out from the first — marks the walk line, and the third defines the outside edge of the stairs.

I step off the treads at the walk line with equally spaced tick-marks 10 inches (code minimum) or more apart. I generally limit tread depth at the walk line to 12 inches for comfort. The final tread/riser mark pinpoints the bottom landing. I pull a string from the radius stake to the outer stair line at the last tread/riser to make sure I like how the angle of the bottom riser relates to my plan for a bottom landing.

If the last tread doesn't land where I expected it to, I make adjustments. There are a few different ways I can do this. I can increase or decrease the riser height to change the number of treads. I can change the tread measurement at the walk line to extend or contract the bottom tread. Or I

Figure 3. Straight, wane-free studs screwed to the plywood templates behind each riser line provide a bending form (above). Once built, the form is plumbed and securely braced (right).

Figure 4. Using a story pole, the author marks the tread elevations on the bending frame (above). He then installs the stringer laminations, aligning the top edges with the marks and gluing and screwing them together (right).

can change the radius of the stairs to make the arcs tighter or broader. All are easy changes to make before the actual building begins.

I also check that the minimum tread depth is at least 6 inches by snapping two chalk lines from the radius stake through two successive tread marks at the walk-line arc.

Once I'm happy with the geometry of the stair, I pull a chalk line from the radius stake all the way across the outer stair-edge arc and snap lines on the plywood at each tread mark along the walk line to define the stair treads.

Plywood top. For the top of the bending frame, I make a second plywood assembly that mirrors the base. I transfer the complete tread layout (though there's no need to mark the walk line), and trim the edges 3½ inches wider than the inner and outer arcs to allow for attaching the 2x4 studs (**Figure 2**).

Walls. I build the bending frame at least 5 feet high — even if the stairs are shorter than that — so I can work below the top of the assembly comfortably. It's important to use straight studs without any wane, for accurate stringer layout. I toe-screw the studs to the plywood base along the inner and outer arcs, aligning them with the deck side of each riser line (**Figure 3**). I place the upper plywood assembly on top of the studs and fasten it like a giant top plate, then plumb the corners of the frame and brace it.

If for any reason you need intermediate stringers, you'll have to build form walls in the middle. These walls would need to be disassembled as the risers and treads are installed, as will become clear later on. On my projects, though, two stringers are usually adequate, because I build the risers to act as beams that support structural treads, which in turn support the finish material.

Building the Stringers

The stable frame makes it easy to lay up the stringers, and its studs double as layout guides for the risers. I generally rip 16-inch-wide strips of ½-inch pressure-treated plywood for the stringers, enough for four plies with joints offset by 2 feet. While 16 inches may seem excessive, it's necessary because the tread cuts are quite deep at the outer stringer.

The face of each stud represents a riser position. To establish the line representing the top of the stringer, I make a story pole and use it to mark the tread elevations on the face of each stud (**Figure 4**). Because I'm usually working on ground that's not exactly level, I establish a level reference line on the inner and outer frame walls using a laser level.

It's important to allow for the rough and finish tread thicknesses. I figure 1½ inches for a structural 2-by tread, ½ inch for spacer strips (for drainage beneath the finish treads), and 1 inch or 1¼ inches for the finish tread material — usually decking.

Laminating the stringers. Before assembly, the plywood strips at the top and bottom of the stringers have to be trimmed to match the deck frame and the landing surface. I make cardboard templates for the plumb cut at the top and the horizontal cut at the bottom to use as guides.

To start the process, I align the top edge of the first plywood layer to the tread marks on the studs and tack-screw it in place. If needed, I use clamps to draw and hold the layer tight to the studs while I'm driving the screws. Since the tack screws will have to come out later, I drive them at an angle to the studs through the top and bottom edges.

I then apply a generous squiggle of exterior-grade construction adhesive to the first layer and screw on the second layer with 1-inch-long galvanized or stainless screws. I offset any joints in the laminations by at least 2 feet, and glue and screw the third and fourth layers with successively longer screws driven from both sides. I install the screws for the first, second, and third layers about 8 inches apart along the top and bottom edges. Once the fourth layer is in place, I drive long screws from both outside faces in a 4-inch to 6-inch grid. To make sure I don't hit any screws when making the riser cuts later on, I keep all the fasteners at least an inch away from the face of every stud.

Riser and tread cuts. To lay out the riser and tread cuts on the stringers, I hold a straightedge against the faces of matching studs on the inside and outside frame walls and mark across the tops of the stringers. The point where the line crosses the edge of the stringer is the outside corner of the riser-tread cut lines (**Figure 5**).

I wait a day or two for the adhesive to cure before cutting the stringers. I set the bevel on my circular saw to match the slight angle where the risers meet the stringers. The tread cuts are flat — no bevel. To make sure I don't overcut the inside corners, I use a recip saw to finish the cuts.

Structural Treads and Risers

Structural treads of pressure-treated 2-by and risers made from two layers of pressure-treated plywood tie the stringers together and provide a solid base for finishes (**Figure 6**). I make a tread pattern from cardboard or thin plywood and rip the wedge-shaped rough treads from 2x12s. The wide end of the treads is usually bigger than a 2x12, so I glue and pocket-screw the drop from the taper cut to the rough tread. I typically make the treads a little long, then cross-cut them to length; the ends are slightly curved but can usually be cut with a circular saw.

The risers stabilize the stringers and support the treads, so I use a minimum of 1⁄2-inch plywood. I rip the riser stock to the same width as the riser height and cut the risers to the same length as the outside dimension of the stairs. Rather than trying to account for the slight bevel at each end, I just cut the risers square and 1⁄8 inch short.

Figure 5. Plumb and level lines mark the treads and risers (left). The author makes initial cuts with a circular saw and finishes up with a recip saw to avoid overcutting the inside corners (above).

I attach the inner riser layer to the stringers first, using screws and construction adhesive. I then install the tread below, and screw the inner riser to its back from behind. The inner risers also support the front edge of the treads above, so I'll run a bead of construction adhesive along the top of the riser before installing the tread. The second riser layer laps the front of the upper tread, and is screwed and glued to it. This helps to keep the treads from warping.

Eventually, as I work up the staircase, the top of the bending frame will interfere with tread installation. At that point, I just install the risers and wait until the frame is dismantled to install the treads.

Install the Finishes

I let the riser and tread adhesive cure for a day or two before I remove the frame. The rough staircase emerges from the frame ready for intermediate support posts and the finishes — skirts, risers, treads, and railings — though sometimes you'll find a screw tip poking through a stringer face that needs to be filed or ground off flush. On large staircases, the outside stringer needs to be supported before the studs are removed, which you can do by cutting and fastening a couple of 2x4s and setting them on blocks until permanent posts and footings are placed. Finally, I install the top treads and risers — the ones I couldn't reach before.

Curved stair stringers often need intermediate supports, and I extend these supports upward to double as guardrail posts. I space posts along the arcs at equal intervals — between 4 feet and 6 feet apart — and set them on footings (**Figure 7, next page**).

It usually takes as long to apply the finishes as it does to build the curved stair frame — or longer, depending on the details. Skirtboards can be either closed or mitered into the risers. Closed skirtboards require less work and look better over time. I clamp, glue, and screw synthetic or rot-resistant wood skirts

Treads and Risers

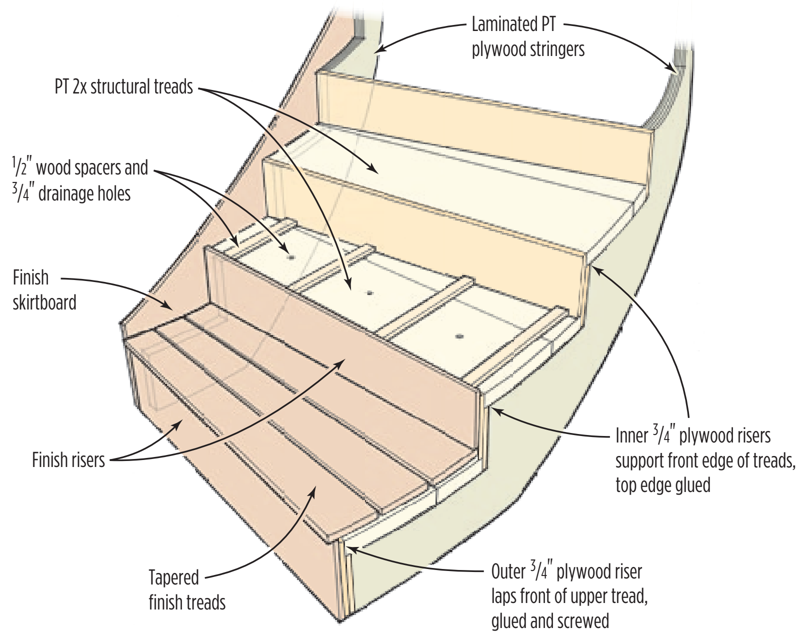


Figure 6. The risers are made from two layers of 3⁄4-inch plywood lapped so as to support the front and back edges of the 2-by structural treads (illustration). The author starts installation at the bottom (top photo) and works up the stair as high as he can until he has to remove the bending frame (above).

Figure 7. When stringers require intermediate support, the author uses tube forms to grade (top), then extends the wooden posts up through the framing to double as guardrail posts (above). He uses fascia material for the finished skirtboards and decking for the treads (right).

alongside the stringers, shimming where needed to maintain a fair curve.

Water that gets beneath the treads needs a way to drain, so I bore a few 3/4-inch holes through the structural treads and lay minimum 1/2-inch wood strips over the rough treads as spacers for the finish treads. I rip the finish decking strips on a taper and ease the edges. This looks much better than having a couple of straight decking strips and a wedge-shaped closing piece meeting the riser at the back of the tread. (Remember that this won't work with the new "capped" composite decking products, because easing the edges exposes the material's substrate.) I also space the finish riser boards 1/4 inch from the structural risers for drainage.

Bending and laminating curved rails is an article in itself. Done correctly, a curved rail should have the same helical shape as the stringers — which means more lamination or some careful shaping. A useful workaround, however, is to cut rails out of wide 2-by stock to match the curve of the stair, as was done on this project (see photo, page 57). Rails made this way will have a slightly odd slope as they turn up the stair, so the technique only works if the intermediate posts are less than 4 feet apart.

Cost considerations. The job shown here was finished with clear red cedar trim and railings. It cost the customer about $3,000 more than the same set of stairs built in an L-shape. The job took two men four days, or eight days total: a day for layout and building the bending frame; a day to laminate and cut the stringers; a day to make and install the rough treads and risers; a day to dismantle the bending frame and install the tube footings; and four days to make and install the finish skirts, treads, and railings.

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