Building a Curved Balustrade

A carpenter uses router templates, laminations and fiberglass packing tape to trim a staircase.

by Jeffrey Janssen

When I got a call from Ken Aguilar about installing the newels, the balusters and the handrails in the house he was building for himself, he gave me no clue about the custom nature of the work I was about to undertake. I envisioned a stock installation of manufactured stair parts—the kind of work I do all the time. Off I went to meet him, armed with my briefcase full of catalogs from various stair-part manufacturers.

When I saw the plans, my first impulse was to throw out the whole briefcase. The staircase was a switchback design with a curved landing that created a kind of pulpit overlooking the kitchen (top photo, facing page). Nothing called for in the drawings was stock; every part—from the laminated 6x6 newel posts to the curved handrails—would have to be fabricated from clear, vertical-grain Douglas fir.

Laminated newel posts—The stairs had already been rough framed when I took the job. My first task was to build and install the newel posts before the drywall was hung. Each post was made from four clear, vertical-grain Douglas-fir 2x6s, laminated face to face. The plans actually called for attaching the 2xs with finish nails, but I used biscuits and yellow glue for strength and alignment. I knew the nails would interfere with planing and detailing the newels.

I removed the fence from my Porter-Cable biscuit joiner because the distance from the 2x6 edges was greater than the fence would allow. I used a straightedge clamped to the 2x6s to register the tool, locating the biscuits 1½ in. from the boards' edges. Pairs of biscuits were cut at 6-in. increments along the length of the 2xs.

Because the newels were so massive, and because they had to support the unusually large handrails, I notched the newel posts and anchored them into the stair framing so that they would be as strong in function as they were impressive in size.

Sheathing the curved walls with plywood—After the posts were set, my next step was to create the curved wall. The plans called for a curved wall with a radius of slightly less than 4 ft. The concave and convex sides of the curved wall were to be paneled with horizontal rows of clear, vertical-grain Douglas fir.

The curved wall had been built by the framers with 2x4 studs spaced approximately 16 in. o. c., with curved top and bottom plates cut from ¾-in. plywood. One of the difficulties with a curved wall framed with vertical members is that the studs do not scribe a true arc, but rather they are a series of straight segments whose end points touch the arc.

Consequently, the planks applied horizontally on the convex side would form segments with high points rather than true curves, especially over time as the wood conformed to the framing. The simple solution was to apply two layers of ¼-in. plywood horizontally over the studs of each side of the curved wall to create a solid substrate that would mitigate the effects of the segmented arc on the finished surface. I used construction adhesive to glue the plywood to the studs and to glue the two plywood layers together. And everything was screwed in place with 2½-in. square-drive, coarse-thread wood screws.

I used ACX plywood because it has no plugs in its face veneer, so there would be fewer weak spots to crack as the plywood bent around the curve. Even so, there was some cracking of the grain on the face of the concave side of the wall, which required some smoothing with a belt sander before the paneling was applied. After a piece of plywood broke in half during installation, I found that the plywood bent easier if the sheets were ripped into 2-ft. by 8-ft. strips. Ripping the sheets probably lessened the tension on the inner ply, which runs perpendicular to the outside ones.

Detailing the posts. A simple U-shaped plywood box that fits around each square newel post served as a template to guide the router as it cut the vertical details of the newels.

Bending boards—The plans called for the curved wall to be covered with shiplapped ¾-in. thick Douglas fir. I knew the only way to bend material that thick was to steam bend it with boat-building techniques more suited to a shipyard than to the inside of a shop. And I knew the time and the expense of creating a steam-bending apparatus for just this one application would send the price of the job even higher. I had some other ideas lurking in the back of my head. So I began to experiment.

The trick was to achieve the desired look as drawn in the plans, yet make the installation easier than called for. I knew a thinner material would resist the bend less than a 1x6 would. After experimenting with Douglas-fir boards and a surface planer, I found that a 6-in. wide board about 7⁄16 in. thick would make the concave bend—but with no small effort. The next step was to use a finish blade on my circular saw to cut kerfs on the back of each board—⅛ in. deep, spaced ¾ in. apart—to minimize pressure on the back of each board. With the kerfs cut, the boards bent around the concave side of the wall without a single crack. I used panel adhesive and two 2-in. finish nails from a pneumatic nailer to hold the fir to the curved plywood substrate. For extra holding power, I predrilled and countersunk two screws at the ends of each board where they would later be covered with trim.

Sticky situation, sticky solution—Applying the boards to the convex side of the wall turned out to be much more troublesome. As I tried to bend the boards into place, almost every one developed a small crack where grain ran out on the back edge, and then, as the final pressure was applied, the board would literally explode, shearing across the grain in two or more places. Similar results occurred with stock planed thinner, and kerfing the backside only

Photo this page: Gary Moon

Curved fir. A unique curved stair, which draws attention to itself for its shear size and complexity, fits neatly into the overall plan of the house.

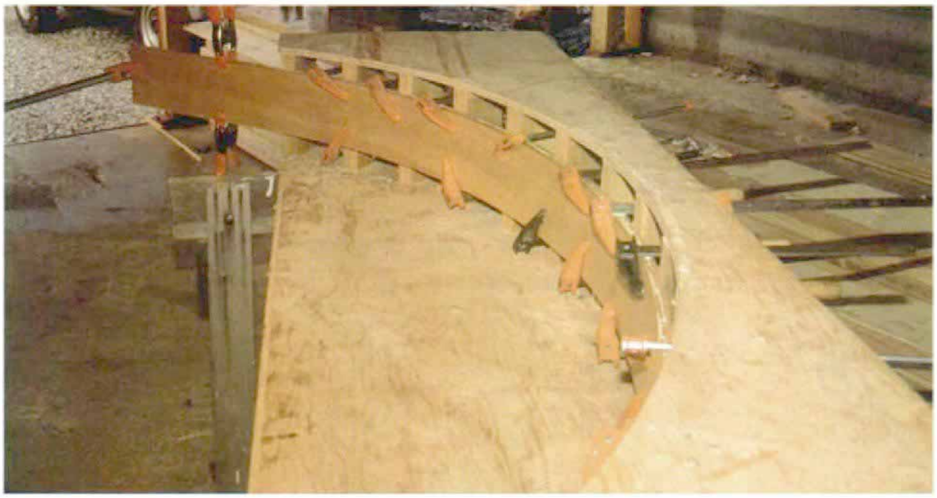
Fiberglass reinforcement. Even after the boards were planed down to 7⁄16 in., they broke when the author tried to bend them into a tight curve. He decided to back each board with 2¼-in. wide fiberglass packing tape, which held the board together as it was bent into the curve.

Braced in place. Each board was fastened with trim-head screws and construction adhesive. By clamping a 2x6 to the center post at the top of the landing, the author was able to pressure fit the Douglas-fir paneling against the curved wall until the construction adhesive set up.

Top and bottom left photos, this page: Jefferson Kolle

Laminating the wall cap. A strip of ½-in. plywood, which is nailed to the outside of the curved wall, creates a form against which the wall cap can be laminated. The plywood strip is spaced away from the wall slightly so that the laminated wall cap will be wider than the wall (note the first three strips extending past the newel post). The laminations are pneumatically nailed in place.

Laminating the handrail. The author built a curved form from 2x4s and plywood against which he could clamp the 12 laminations that together make up the curved handrail. To facilitate clamping, the curved form is constructed so that bar clamps will fit easily between the 2x4s.



hastened the destruction. Another solution was needed. I moved onto another task and mulled over the situation.

One afternoon I went to the post office to mail a package. And in my hand I found a possible answer: fiberglass packing tape. This type of tape has continuous fiberglass threads running through it, and it is extremely strong. I took the widest tape I could find (2¼ in.) and set to work.

Using a 7⁄16-in. thick board, I ran two parallel strips of this tape down the full length of the board, on its backside, right out to the edges (bottom left photo, p. 69).

When I flexed a board into position, the packing tape dispersed the pressure over a large area and prevented cracks. The remaining boards went up without incident. To hold the taped boards in place while the construction adhesive dried, I clamped a 2x6 to the newel post and pressure fit short pieces of wood between the 2x6 and the paneling (bottom right photo, p. 69).

Detailing the newels—With the major hurdle of the wall covering cleared, my next step was to detail the newel posts. First, I cut the tops of the posts into rough curves with a long, sharp blade on an orbital jigsaw. I made one cut from each side of each post, chiseled off the remaining waste and then used a belt sander to smooth and round off each post top.

The plans called for each post to be detailed with a series of router cuts—two horizontal cuts around the top of each post and a thin rectangle along each length. For the horizontal cuts, I made a simple, open-ended box out of ½-in. plywood, 5¼ in. square on the insides, held together with square-drive screws.

I clamped the box on each post at the appropriate height, which was determined by the height of the top of the posts from the stair treads. The box served as my router guide for the horizontal lines cut with a ⅛-in. carbide-tipped mortising bit around the top of each post.

To cut the side details, the same router bit was used. I made a U-shaped plywood template and clamped it to the posts (photo p. 68). Unfortunately, there was some variation in the distance between the tops of the posts and the bottom of the router detail because of differences in the rise and the run of the two sets of stairs and in the location of the newel posts relative to the landing. Rather than make a template for each required length, I made one to cut the longest required groove. I cut small blocks to shorten the channel in which my router collet traveled, then taped them into the template as necessary to adjust the length of the routed detail.

Wall caps—Cutting the wall caps for the straight sections of the buttressed staircase was pretty straightforward. Some careful measuring and angle taking allowed me to fit the caps between the newel posts. But the curved caps on the landing posed more of a conundrum. For the curved wall cap, I used a piece of 1x wide enough to rip it into thin strips to laminate into the curve. I ripped the pieces 7⁄16 in. wide and numbered each strip for relocation next to its original partner. By aligning the pieces in the order in which they were ripped from the board, the laminations would be less apparent.

I decided to laminate the thin pieces of fir in place on top of the wall. The wall cap had to be wider than the top of the curved wall so that the cap could be notched around the newel posts. To make a laminating form, I tacked a piece of ½-in. plywood against the concave side of the curved wall and spaced it off the curved wall so that the laminated cap would be wider than the wall itself (top photo, this page).

After some experimentation, I found that the 7⁄16-in. strips would not bend around the curve without breaking; the grain was just too brittle to stretch that much in such a thin piece.

I wanted to add only enough flexibility to the strips to bring them into the shape I desired. There was no need to steam the strips. I figured all I had to do was soak the strips for a bit to elasticize the bonds between the wood cells. I capped one end of a length of 4-in. PVC pipe and filled it with enough water to cover the strips placed in the pipe. I taped another cap to the other end of the pipe and let it sit for a few hours at room temperature.

When I took the strips out of the pipe, they were flexible enough to bend into the plywood form without breaking. Because the wall caps are wider than the posts, I let the first strips run long and nailed them directly to the plywood form with a pneumatic brad nailer.

I glued each strip to its predecessor with Titebond waterproof glue (Franklin International, 2020 Bruck St., Columbus, Ohio 43207; 800-877-4583) and nailed it with brads for temporary holding until all the layers were in place for final clamping. After the glue set up, I unscrewed the plywood form from the curved wall and pulled the form off the laminated cap. I pulled the brads (that held the first strip of the cap to the form) through the cap and glued a thin cover strip on the cap to hide the brad holes. Then I removed the curved wall cap so that I could clean it up. With a little careful guiding, I was able to plane the curved, laminated cap to remove any height difference in the laminations. After a little finish sanding, I attached the cap to the curved wall with finish screws.

The handrails—The straight sections of the handrails were made out of three 2x6s sandwiched together with the center board standing about 2 in. proud of the other two. This design creates a graspable protrusion on top, and the resultant slot on the underside provided a channel for the 1½-in. square balusters. Before attaching the straight sections of the handrail with biscuits and glue, I planed all the surfaces and eased the edges with a ¾-in. roundover bit. I also routed a finger-width groove in the protruding center section.

The curved rail is laminated out of 12 layers, four for each piece of the uneven sandwich. In preparing the material for the curved handrail, I picked four 2x6s for grain consistency and coloration and took them to a local lumber mill with the instructions to resaw each piece of 1½-in. stock into three pieces 7⁄16 in. thick.

Perhaps the most critical part of this operation was to ensure that the resawn pieces were glued back together in the order in which they were sawn. I asked the mill to keep track of the order in which the boards were sawn. My goal was to create a laminated handrail that appeared to be made out of a single piece of wood. (To make up for the saw-kerf waste generated during the resawing process, one piece from the fourth resawn 2x6 was added to each of the three sections of handrail to attain a finish width of 1½ in. I laminated the fourth piece into each rail section where it would be the least obtrusive to the overall grain pattern.)

To glue up the three sections of handrail, I made a form with 2x4s and plywood on which I had transcribed the arc of the concave curved wall (bottom photo, facing page).

Using Weldwood Plastic Resin Glue (DAP, Inc., P. 0. Box 277, Dayton, Ohio 45401; 800-327-3339), I glued up the laminations two at a time and left them to set up completely before applying the next ones.

After gluing up the first section of handrail, I removed it from the form. Then I added strips of ¼-in. plywood to my form to account for the decreased circumference of the middle section. After the middle section, I added more plywood to the form before laminating the third section. Because the curved handrail had the same sandwiched profile as the straight sections, I made each curved piece of the sandwich separately. This enabled me to ease the edges of each section of handrail with my router before assembling the sections with biscuits and glue.

Cutting the curved rails to length—Of some note is the template I used to figure the length and angle of cut for the installation of the curved rail. I only had one chance for a perfect fit; it wasn't as if I could go to the lumberyard and buy another section of curved handrail.

To make my template, I used two 2x8s: one for determining length, one for determining angles (drawing above). After roughly measuring the length of a straight line between posts, I clamped one of the 2x8s onto the posts, and using a straightedge, I transferred the angles of the posts' relative positions to each other along a straight line. Using the straight line between posts as my length, I used a bevel square to transfer the angles I'd scribed on the 2x8. I cut the 2x8 to length at the proper angles and then tacked it to the posts. A second 2x8 was screwed perpendicular to the bottom of the first.

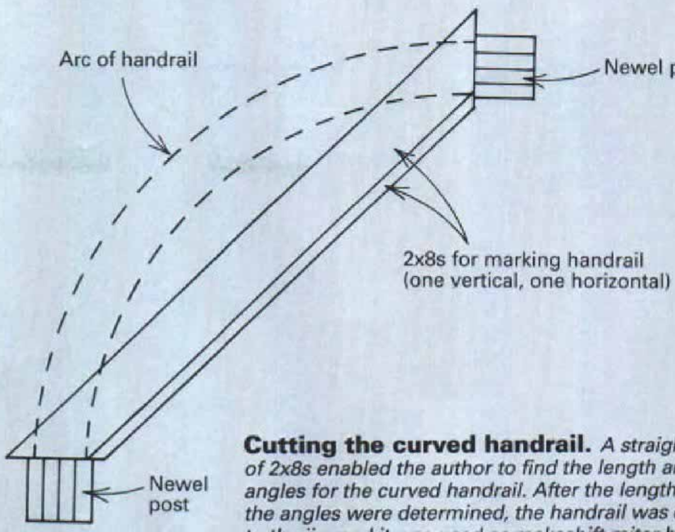
Once I was satisfied that the template was true to the posts in three dimensions, it was then a matter of clamping the curved rail to the template and transferring all of the lines to the handrail (photo above). Using the template ends as a guide, I cut the handrail with a Japanese Dosuki handsaw. This saw cuts on the pull stroke, which makes it very easy to control, and which makes for extremely clean cuts. The cuts were perfect; the rail fit like a puzzle piece.

For installing all the handrails, I used square-drive, trim-head screws. Trim-head screws have threads like drywall screws, but their heads are much smaller. They're available from Grabber (John Wagner Associates, Inc., P. O. Box 4060, Concord, Calif. 94524; 510-680-0777). I like these screws because their heads can be sunk without predrilling, and they are easily filled. Also, they have more holding power than finish nails.

The balusters were a snap to install; their tops fit snugly into the slot formed by the offset-sandwiched handrails, and the bottoms were toenailed to the wall caps.

All of the staircase's surfaces were carefully sanded and lacquered. All that was left to do was for the carpet installer to cover the rough treads and risers. □

Jeffrey Janssen is a former carpenter who now teaches elementary school. He lives in Nevada City, Calif. Photos by author except where noted.



Cutting the curved handrail. *A straight jig made of 2x8s enabled the author to find the length and the angles for the curved handrail. After the length and the angles were determined, the handrail was clamped to the jig, and it was used as makeshift miter box.*

Drawing: Michael Hiotakis