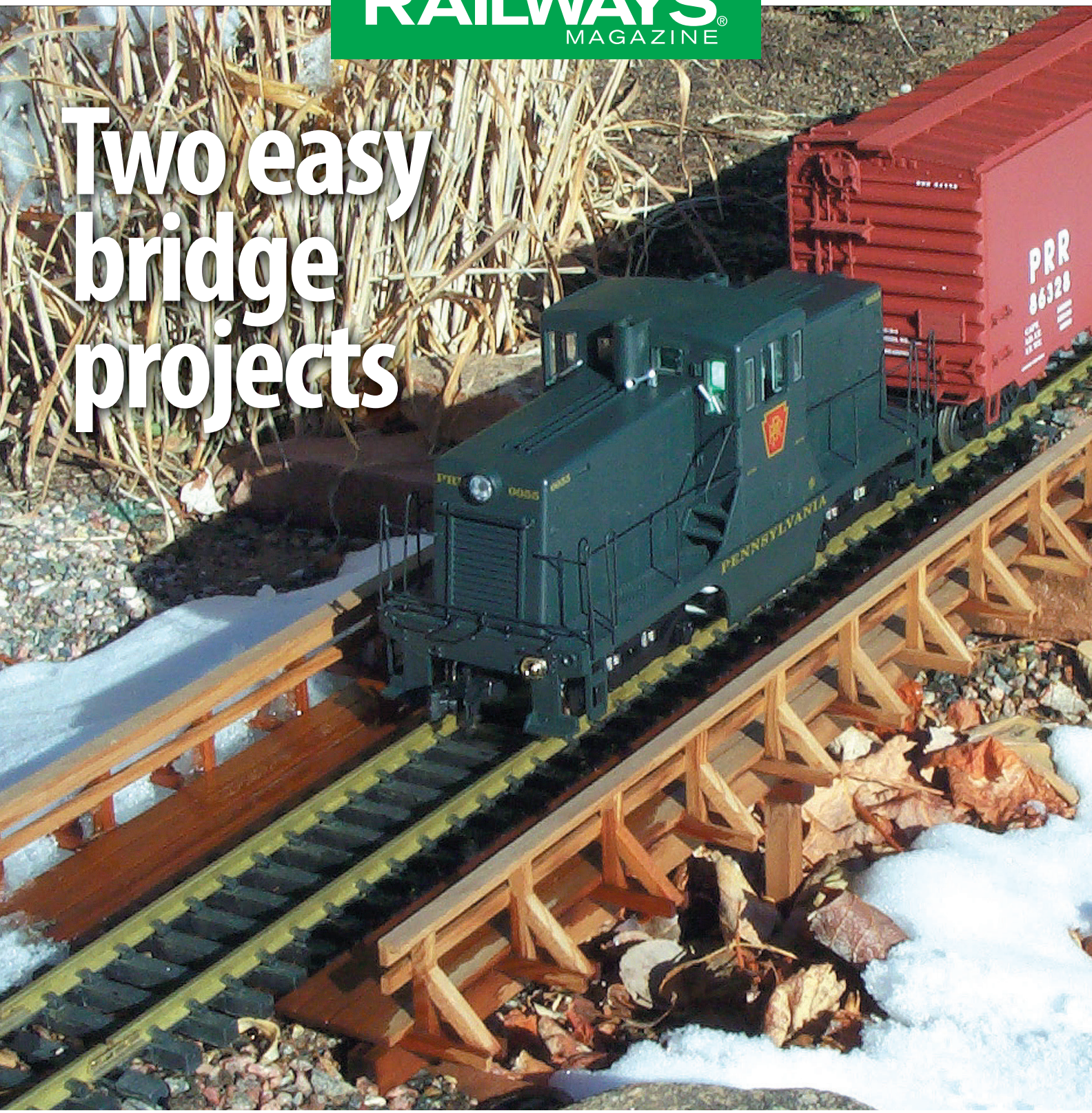
Garden RAILWAYS® MAGAZINE

Two easy bridge projects



Build a simple deck-girder bridge

Build a low deck bridge

Build a simple deck-girder bridge

Dimensional lumber provides the materials for this structure

by Richard A. Smith | Port Orford, Oregon Photos by the author

The Port Orford Coast Railroad needed a bridge in a hurry to span the 4'-wide chasm of Squirrel Gap and I wanted to build it from materials on hand.

The first thing to do was to determine the size of bridge needed—not only its length, but the depth of the girders as well. In an article years ago, I found that there are set ratios of length-to-depth for single span, plate-deck-girder bridges. For a heavy duty (usually standard gauge) bridge it is 10:1; for and "average" span (both standard and narrow gauge) it's 12:1; and 15:1 is a minimum for a light duty (narrow gauge or standard-gauge branchline) bridge.

These bridges were practically never deeper than 10' because of the difficulty in transporting larger girders to the site. Thus, the nominal maximum length for a single span would be 100' for a heavy-duty span, 120' or so for a medium or average span, and 150' for a minimal span, assuming all are 10' deep.

A shorter, 60' medium span would only need to be 5' deep to maintain the 12:1 ratio. In actual practice, of course, a bridge would be engineered for a specific location, unless it was moved from another site.

My bridge is essentially two 2 x 4s connected with spacer blocks between them to achieve the desired width across the girders. A 2 x 4 is 1½" thick x 3½" across. Thus, two of them on edge, connected with 1" spacer blocks, makes the total width over the girders about 4". Add to this the deck aprons that overhang the bridge on top by an inch on each side and you have a 6"-wide top surface. My bridge was built for 1:24 scale (approximately) but will accommodate 1:20.3 as well. For a wider or narrower bridge to better accommodate your particular scale, simply widen or narrow the spacer blocks and deck overhang accordingly. If a deeper girder is needed for a larger scale, simply rip down a 2 x 6 or 2 x 8 instead of using a 2 x 4. My bridge is meant to span a four-foot gap. You will have to adjust the length to suit your particular needs or use multiple spans.

I chose well-seasoned pine 2 x 4s of the best quality I could find for the basic bridge. Pressure-treated lumber would have been nice but I have been unable to find any decent quality 2 x 4s. Most were warped or had very coarse grain.

This sturdy, good-looking deck-girder bridge was made of wood following the guidelines presented in this article.

Construction

The bridge sides were prepared first by cutting the wood to a 6' length. This gave me 4' for the span, with two 1' "tangs" at either end (see illustration) that would be buried in shallow trenches at the ends of the bridge to better anchor and align the bridge with the track approaches. The 2 x 4s were next run through a jointer (a surface planer will do, or they could be sanded) to smooth what would be the outside surfaces of the girders and to square the corners. Last, the tangs were cut, using a tablesaw for most of the cuts and finished with a handheld sabersaw. The spacer blocks were ripped on a tablesaw from 2 x 4 scraps to 1" wide, then cut to 3½" lengths. Ten were needed. The 2 x 4s were thoroughly sanded and painted and set aside to dry. You can also paint the blocks at this time but I found it hard to see what I was doing during assembly with everything painted black.

Assembly consisted of measuring and marking the block locations on the insides of the 2 x 4s. One set of two spacer blocks, side-by-side every 16", was sufficient to secure the sides together, with single blocks between the tangs on each end. The blocks are secured to the inside of each 2 x 4 on opposite sides of each 16" mark with 2" galvanized, self-tapping screws and silicone adhesive. The two sides were put together with their respective attached blocks meshing with their opposites, like a gear. This allowed me to secure the sides together by screwing the blocks to each other from the inside, thus avoiding any screw heads showing on the outside of the bridge. The single blocks between each tang are simply screwed together from the outside, since they will be buried anyway.

The sides of the bridge were sanded once again and the entire assembly was once more painted top and bottom, inside and out. The sanding and painting were repeated until I was satisfied with the result. The smoother the sides, the easier it would be to make them look like steel.

The locations for the vertical girder braces were marked on both sides of the bridge, spacing them equally on 4" centers. A square was used to keep the lines perpendicular to the top edge. Thirteen braces were required for each side of my 4' span.

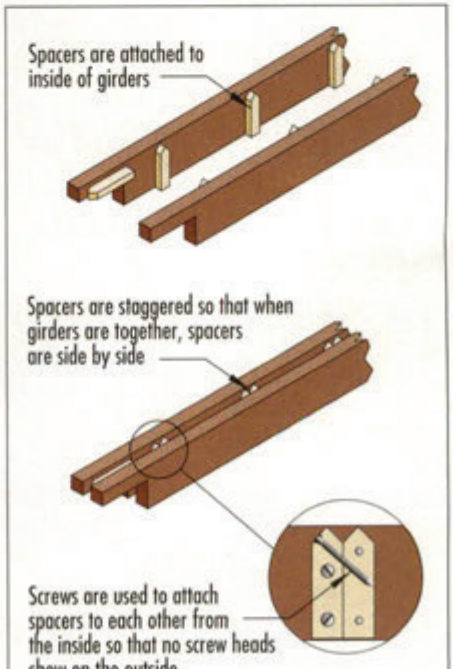
There are several ways to make these braces, but, once again utilizing what was on hand, I used the tongue from an 8'-long piece of ¼" fir tongue-and-groove flooring. It is worthwhile buying one because, besides utilizing the tongue, you will have a source of wonderful stripwood by ripping the remainder of the board later. An eight footer (96") worked out just right, as 91" worth of braces for the 4'-long bridge were needed (26 pieces at 3½" each).

Two 2 x 4s have been trimmed and cut to shape. The spacer blocks (left) will be used between them to provide proper separation.

The wooden side plates have been painted black, but the spacer blocks were left natural for now for ease of construction. The blocks' top edges have been beveled for attachment with screws.

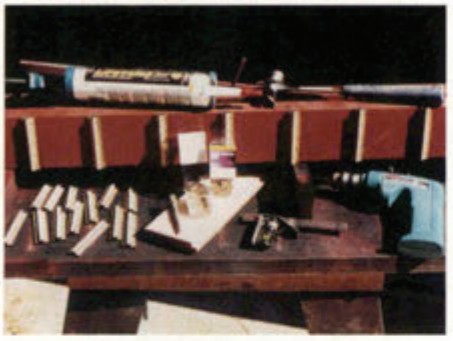
The tongue was too deep, so the end of it was ripped off on the tablesaw, leaving it about 1/16" deep. Next, the saw fence was adjusted to 5/16" and the edge of the board was ripped (with the tongue), leaving the 5/16" tongue plus a ⅛" flange beneath it to form a T-shaped piece. A good saw blade really helps to make a smooth, even cut. The resulting 8'-long "T" was then cut into 26 pieces, each 3½" long. The "T" bottoms were painted before attaching them to the bridge sides. Alternately, the girder braces could be built up from two pieces, but securing them becomes a bit more difficult.

The braces were glued to one side at a time with silicone adhesive, allowing each side to dry for 24 hours before going on to the next step. When the first side was dry, pilot holes were drilled into the flanges, slightly smaller than the brass escutcheon pins used to secure them, and to represent rivet heads. Ten holes were drilled (five on each side) in the flange of each brace. You can add more or less to your taste. This was time consuming, but well worth it for the looks alone and, of course, it further secures the braces. The escutcheon pins were started with a small hammer then driven home with a nail set large enough to encompass the head of the pin. The bridge was turned over and the

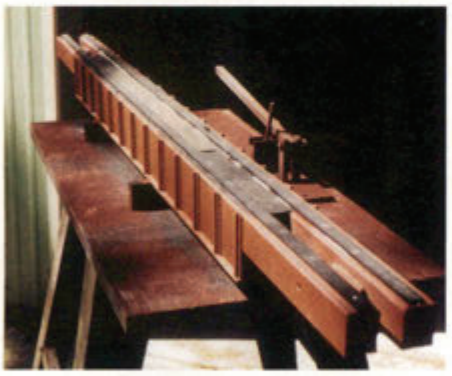


Attaching girders with spacers

When the sides have been attached to each other, no screw heads show from the outside.



The T-braces were cut from tongue-and-groove flooring. Then they were glued and nailed to the sides of the bridge.



Track supports have been added to the top of the primed bridge. Only the side aprons remain.

braces glued to the other side. After the glue dried, holes were drilled and pins inserted, as with the first side. The entire assembly was then given another coat of paint, this time primer red, to assure all surfaces were again covered.

A 1" x ⅛" piece of wood was applied to the bottom of the bridge on each side, overhanging just enough to cover the bottoms of the vertical braces to form a flange. The usual silicone adhesive with brass pins were used to secure them.

Next, the gap between the 2 x 4s in the middle four feet of the bridge was covered with black landscape fabric. It was glued and lightly tacked across the top of the bridge. This would both retain the ballast I would apply later and provide great drainage.

The next piece to go on was support for the track. This piece is not necessary if you have wood pieces wide enough to provide both track support and the aprons in one. That would require two pieces, approximately ⅛" x 2½" wide x 4' long, which I didn't have. So, they were made from two pieces instead—one ¼" wide for the track support and one 1¼" wide for the overhanging apron on each side. These were prepainted to assure coverage on the bottoms and attached to the bridge with silicone adhesive and 1" copper nails (brass escutcheon pins would do) on top of the landscape fabric, helping to further secure that material as well. Square fir strips, ⅜" x ⅜", were siliconed to the outside edges of the apron overhangs (prepainted all four sides) for ballast retention.

The entire bridge was painted black yet again. I was careful not to paint the landscape fabric in the center. While still wet, the bridge was lightly oversprayed, mostly from the bottom, with primer red (actually a reddish brown) to lightly weather it and simulate rust bleeding through. Just a few shots of flat brown were sprayed over parts of the rust to vary the tones a bit. A final dusting of black paint to tone down any spots that were too rusty completed the painting. All painting was done using flat black and primer-red spray cans, available in various brands at any hardware or home-supply stores.

When dry, the bridge was lettered with ¼" white, vinyl lettering for my railroad's name and ¼" white lettering for the bridge data.

The finished bridge, temporarily in place, still lacks abutments.

Abutments

The bridge was taken out to the site and positioned approximately where it was to go. A small trench was dug at either end to accommodate the tangs. The entire bridge, including tangs, was 6' long. A straight, eight-foot 2 x 4 was screwed to the tops of the bridge tangs where the screw holes wouldn't show later. This left a 1' overhang on each end that could be placed on top of the roadbed at either end of the bridge. This assured that the bridge would follow the grade evenly and it determined the height at the bottom of the bridge on both ends. Each end was measured from the bottom of the tangs to the ground (or footings, if you're using them). Then each end of the bridge proper (the 4' center section) to the ground was measured, which gave me the heights for the abutments. The bridge was then removed.

The bridge abutments are actually two pieces at each end. One is a cedar 2 x 4 that supports the tangs and is attached to each end of the 4' center section from behind. This abutment is prepainted black and will not show. It is used to allow the front abutment to be secured from behind. The other is a cedar 2 x 6 that is attached from behind by screws through the 2 x 4 abutment to keep any screw heads from showing. If you are building your bridge wider than 6", you might want to provide a wider front abutment.

The longer rear abutments were attached to the bridge as soon as they were cut to size and painted. The wider, shorter front abutments would show, so needed a facing. You can use any type you like, but here is a new, cheap, and effective method I used to detail them as cut-stone type.

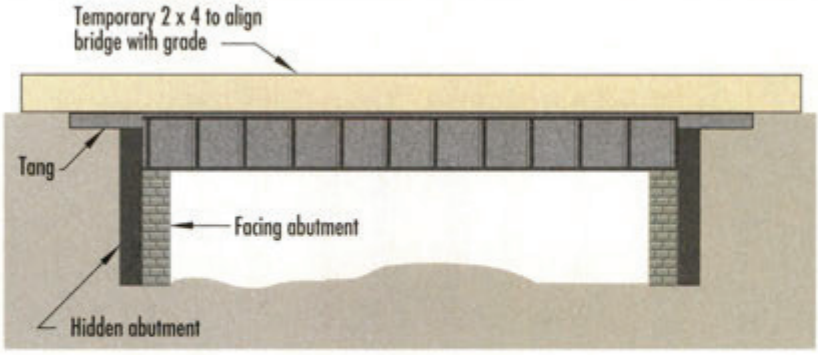
"Stone" facing

Trex is a non-structural material intended primarily for use as decking. It is made from recycled plastic and wood fibers. It is predominately grey in color and, like rock, has some "marbling" in it that varies from batch to batch. It also somewhat reflects the colors of the surrounding terrain, helping it to blend in realistically. It is not necessary to paint it, but it can be painted to represent any type of rock you wish. The abutments shown in the pictures have stone facades made of Trex. Except for rust stains beneath the bridge, they are unpainted. I had a couple of 2 x 6 pieces left over from a project and decided to put them to use.

Each board was crosscut into ¼" slices. Each slice yielded about six blocks. The slices were a bit irregular because of a built-in "crown" on the board tops, so they had be squared up on the tablesaw. After squaring, the slices were about 5¼" x 1½". These slices were then each cut into six, ¾" x 1½" blocks. For a better look, the facing corners of each block were eased at a 45° angle to give visual separation to the blocks, especially when placed close together. Individual blocks blend into one another otherwise. A sander was used to do this, but a router table or moto-tool should work as well.

My abutments are made of cedar, but you can use other material as you wish. Three sides were planed on the jointer (or you can sand them) to square the corners and smooth the faces to allow even application of the stone blocks. They were painted grey and given three coats.

Next, guidelines were drawn across the front and sides of the abutments, providing space for the grout lines. The individual blocks were applied with silicone adhesive, following the lines. After the silicone dried, the joints were grouted with gray, silicone concrete patch. It's a job to clean the stone faces after grouting with this stuff but it can be done with plenty of damp rags and elbow grease. It has to be done before it sets up on the block fronts. It looks great when finished. A more formal, finished look is achieved by eliminating the grout lines and joining the blocks tightly together, as long as all the facing corners are eased neatly at 45° to emphasize the joints. Trex should hold up fine without any protection, but the blocks were given a spray of Dullcote just in case.



Bridge installation

The outer abutments were set beneath the bridge and clamped to the black abutments, which are already attached. About six pilot holes were drilled through the black abutments, into the rear of the stone abutments. (Adhesive could be used here, too, if you wish.) The two were attached with 2½" galvanized screws. The bridge was then ready for installation.

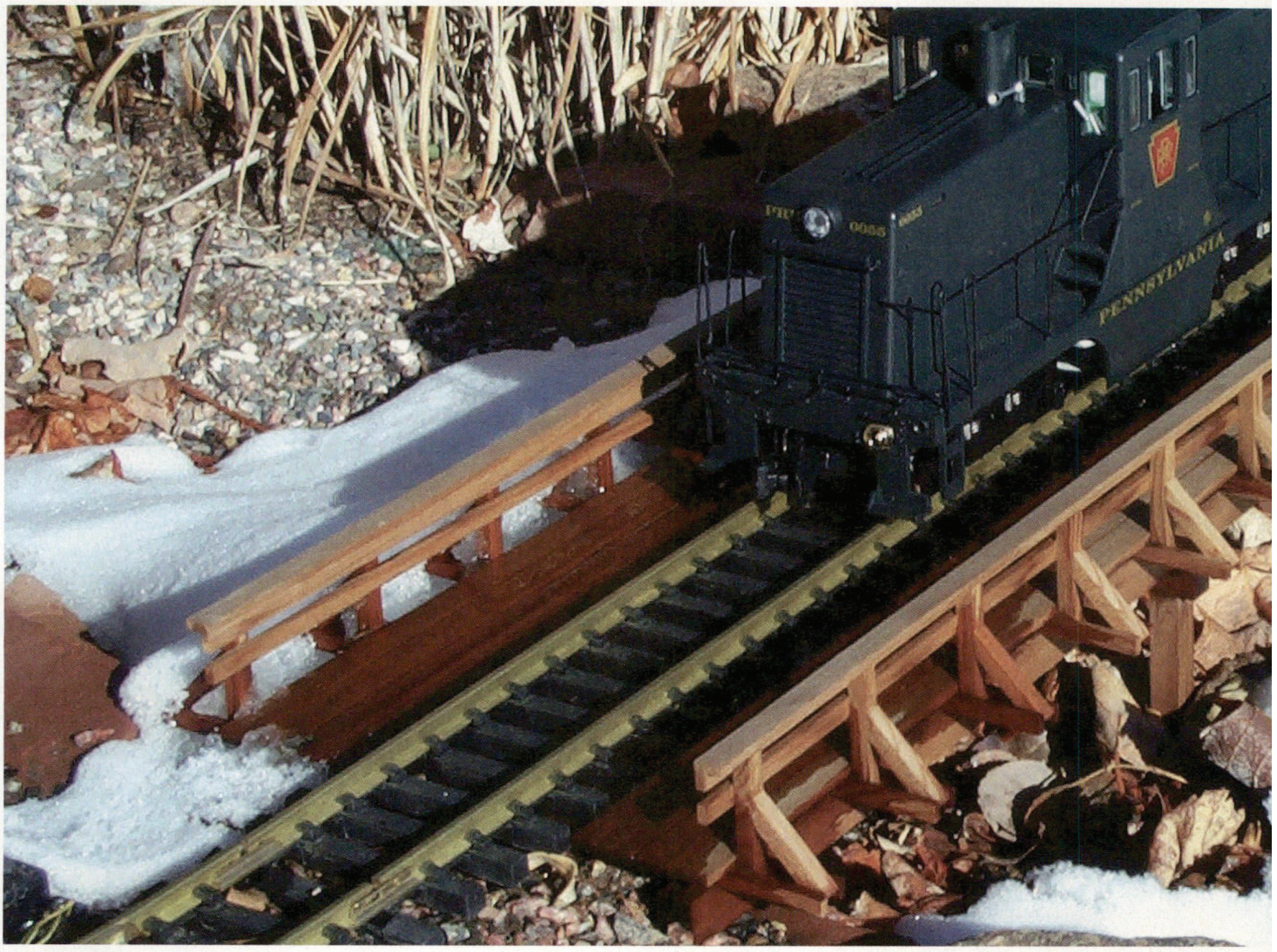
Installation

The bridge was set in place, aligning the tangs with the roadbed on either side. The eight foot 2 x 4 temporarily screwed on top kept everything at the proper height. The tangs were filled in between at either end, as well as beneath and behind the abutments, with earth and rock. (At this time, pour concrete footings, if you wish.) The abutments rested on soil, and everything was tamped in well. The combination of double abutments and buried tangs resulted in a pretty solid bridge right away. Once the bridge was permanently installed, the temporary eight foot 2 x 4 was removed and the screw holes filled with lots of silicone adhesive.

Finally, track was laid across the bridge, attached to the bridge with track nails. Ballast was added for the finishing touch. The project was complete, ready for the company photographer to record the first train crossing the new bridge. II

RIGHT: Bridge abutments are made in two pieces. The rear piece provides support for both the bridge and the decorative piece in front. "Stone" facing is made from Trex.

BELOW: The finished bridge, with abutments backfilled, in use on the author's railroad.



Build a low deck bridge

A simple, 1:29-scale project for a common structure

by Marc Horovitz | Denver, Colorado Photos by the author

A GARDEN RAILWAYS PROJECT BEGINNER

While a spectacular bridge across a deep chasm or mighty canyon is dramatic and attractive in a garden railway, full-size railroads are much more often faced with the problem of getting their tracks across low washes, depressions, gullies, and arroyos. To do this, they often use inexpensive timber structures that are simple to build. Bridges of this type can be seen in use today in many parts of the country. This article replicates a standard-gauge bridge in 1:29 scale and was inspired by a brief article by Jan Heine in the Spring 2002 issue of the *LGB Telegram*.

Figure 1 (p. 66) and the finished bridge may look complex, but in fact it is not. All of the pieces are simple, made from standard sizes of stripwood, and there are no tricky parts. Just take it one step at a time, be patient, work carefully, and you'll get there.

Preparation

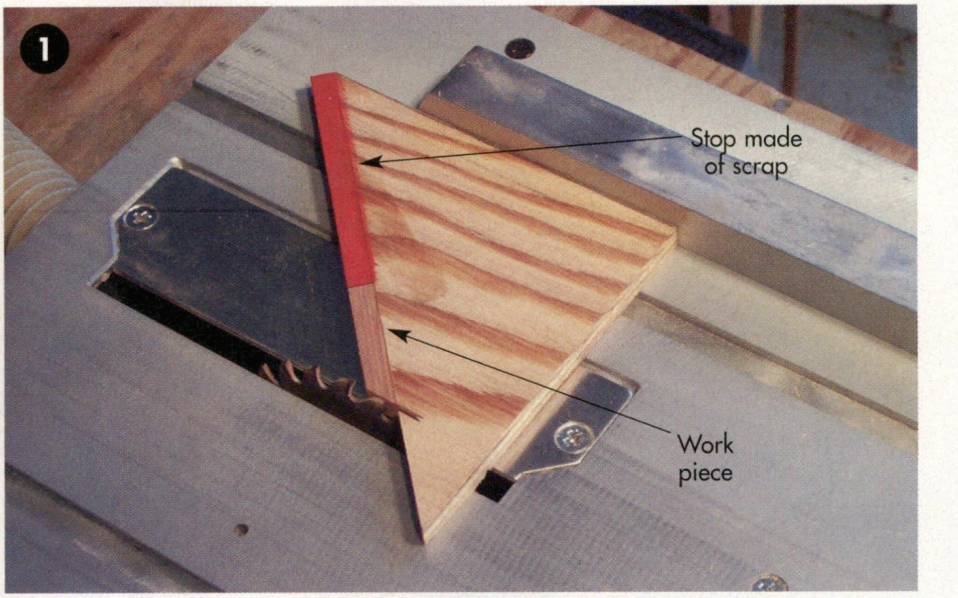
The first thing you'll need to do is buy or cut all the necessary parts for the bridge. I suggest cutting your own (see "Make your own stripwood" in the April 2003 issue of *GR*). When choosing wood to cut, look for a piece with straight, close grain and no knots. I recommend either redwood or cedar for their natural rot resistance and easy workability. Work from a piece of 1" x 4" or 1" x 6". I cut all the wood necessary for

Above: A GE 44-tonner takes its train over the bridge on a snowy day in February.

my bridge from a 1" x 4" x 6' piece.

Cut the stringers (part A) first. Their vertical dimension is ⅝", which should be the same as the thickness of the board from which they are cut. If the board varies in thickness a little either way, that's fine. Cut them a half inch or so too long—we'll trim them up later.

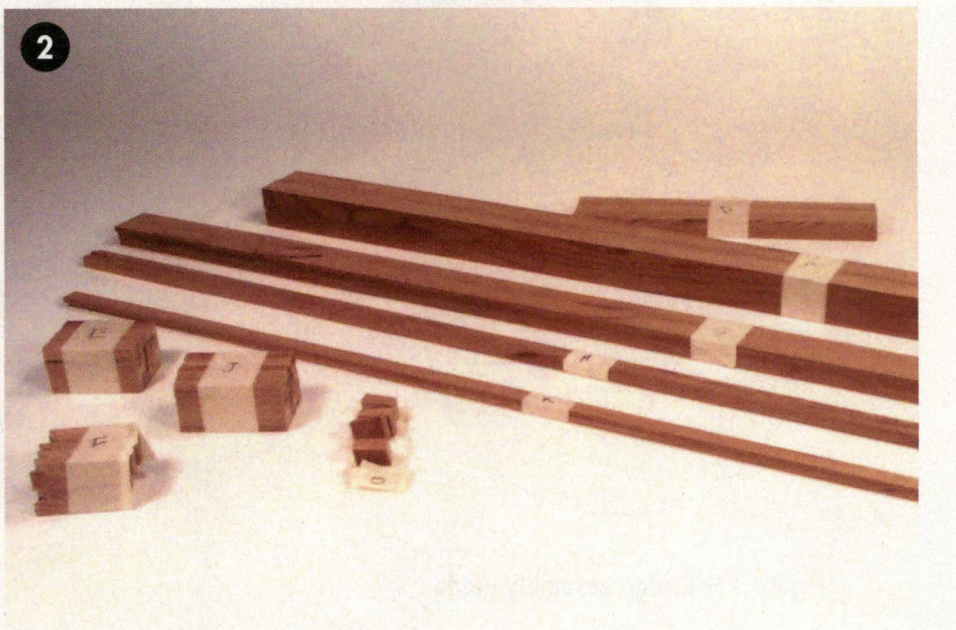
Cut all of the other parts according to the cutting guide. The only non-square cut is the 45°-angle on one end of each brace (part F). Here's how I cut mine. I took a piece of ¼" plywood and cut off one corner at 45° using the miter gauge, making sure that the 45°-angle side was at least 2" long. This will become a little fixture. I glued a small block of scrap on the edge at one end of the angled cut (**photo 1**). Then, with one of the legs of the triangle against the fence, I positioned the fence so the blade would just trim off one end of the



A triangular scrap with a block glued to it is used to accurately cut the 45° angle on the braces.

Cutting guide

Pt. #	Name	Qty.	Size
A	Stringer	4	½" x ⅝" x 24"
B	End spacer	4	½" x ¼" x ⅝"
C	Spacer	18	½" x ¼" x 2¼"
D	Cross beam	10	¼" x ¼" x 7½"
E	Post	20	¼" x ¼" x 1¾"
F	Brace	20	¼" x ¼" x 1⁷⁄₁₆"
G	Decking	8	⅛" x ½" x 24"
H	Rail	4	⅛" x ¼" x 24"
J	Side support	40	⅛" x ¼" x 2"
K	Top rail	2	⅛" x ⅜" x 24"



All of the wood has been cut, bundled, and labeled. This makes handling it much easier down the road.

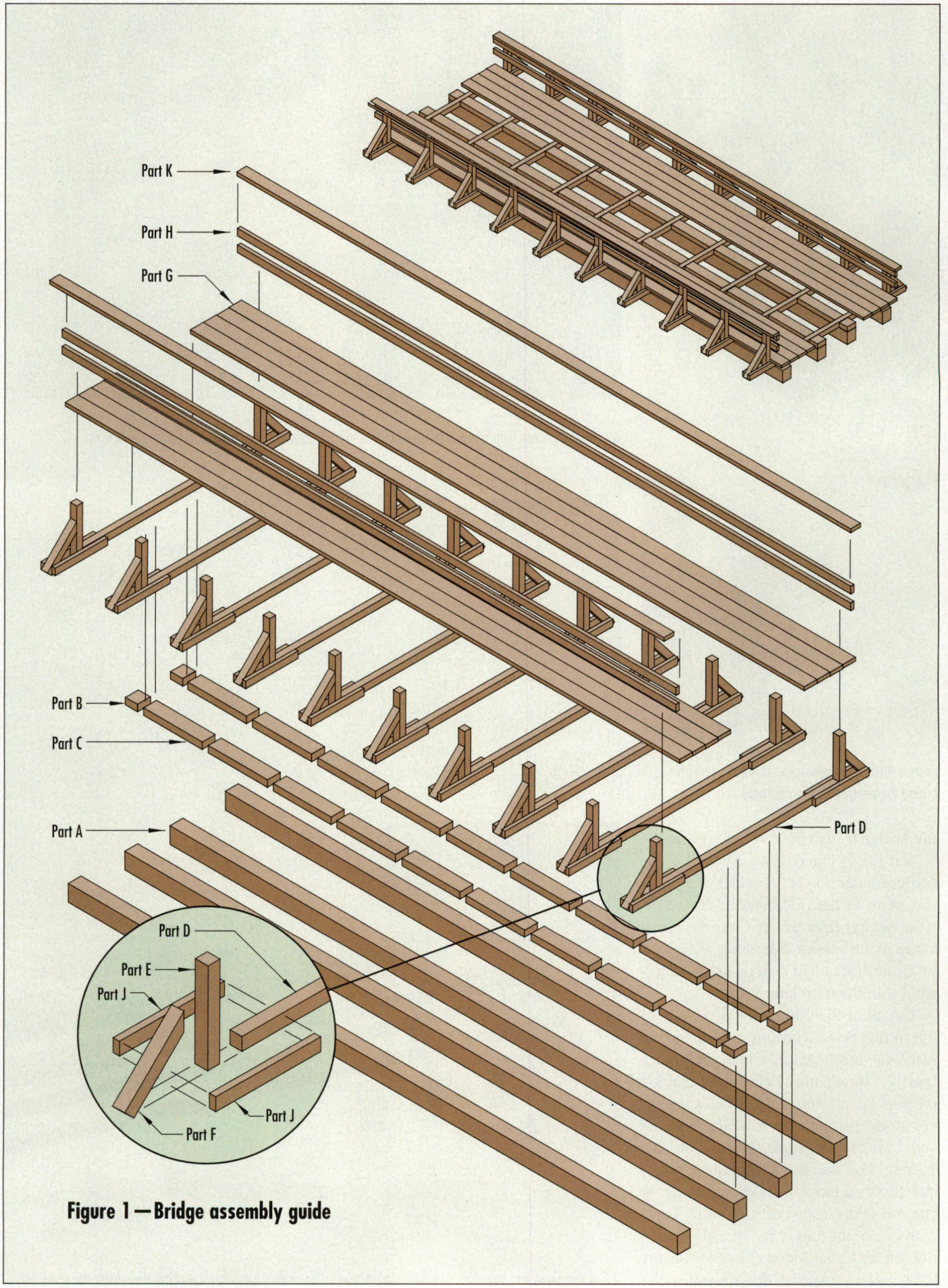


Figure 1—Bridge assembly guide

brace at 45°. By using this jig, I made sure that every piece was identical. You could also use a miter box and razor saw to cut the angles by hand.

When I finish cutting all the pieces, I like to "package" them (**photo 2**). This keeps them from getting lost and helps me keep my sanity.

Fastening

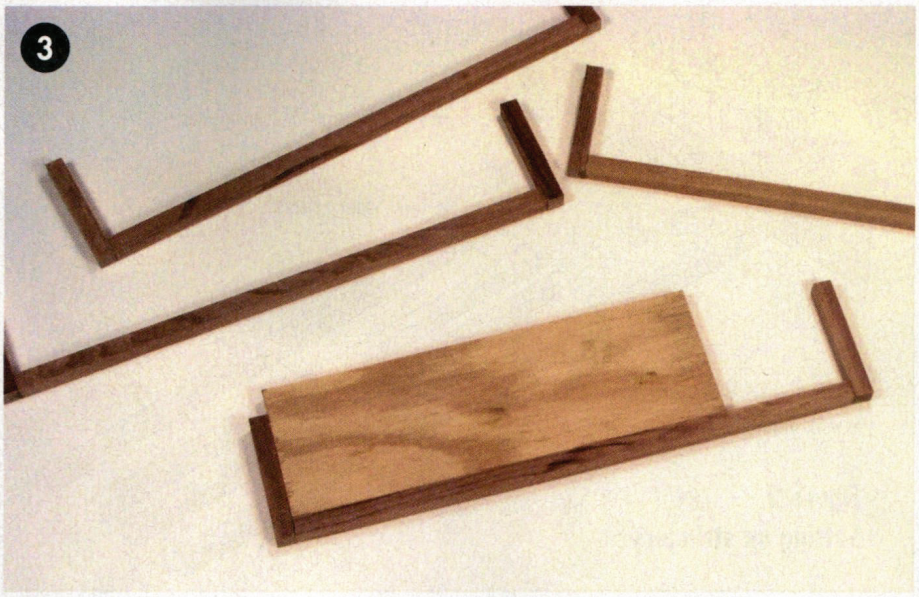
To assemble your bridge, I suggest a good, waterproof glue, like Titebond II. Glue alone—even waterproof glue—will often not hold small pieces in place over the long run, where mechanical fasteners, like brads or screws, will. However, most of our bridge will be easy to repair, if necessary. When constructing the frame, though, use the glue in combination with mechanical fasteners. Brads (small headless nails), available in ½" or ⅝" lengths at hardware stores, work fine.

When gluing pieces together, use the glue sparingly and clamp parts in place when you can. A clamped joint is a strong joint. If you intend to stain your bridge, be extra careful with the glue, as the stain won't penetrate the glue and sloppy gluing will show. If you are planning to paint your bridge, this is not as important. If you are like me, though, the glue seems to go everywhere. Just do the best you can and clean up any places where the glue seeps out.

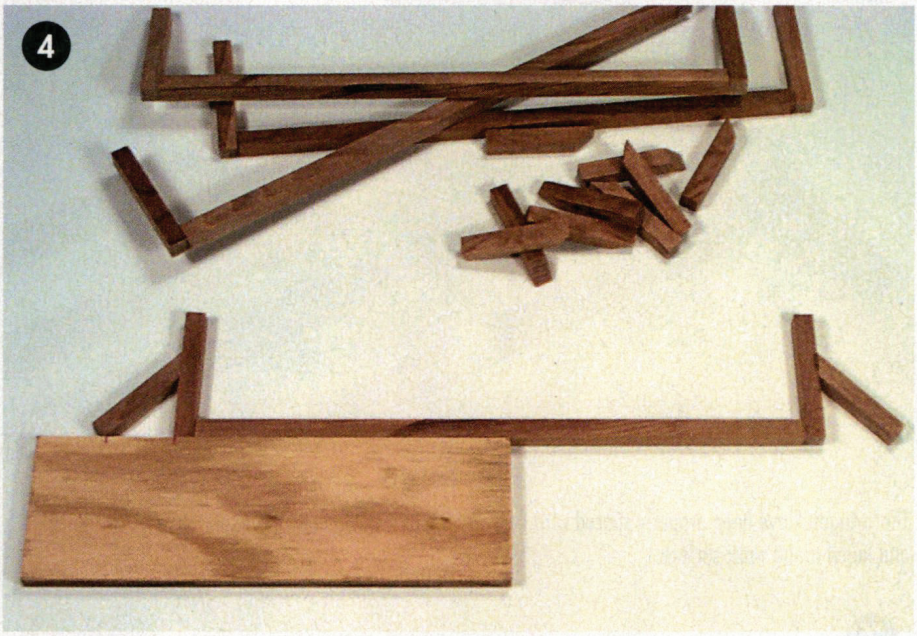
Cross-beam assemblies

Let's start by making the cross-beam assemblies. There are 10 of these, each made up of one cross beam (part D), two posts (part E), two braces (part F), and four side supports (part J).

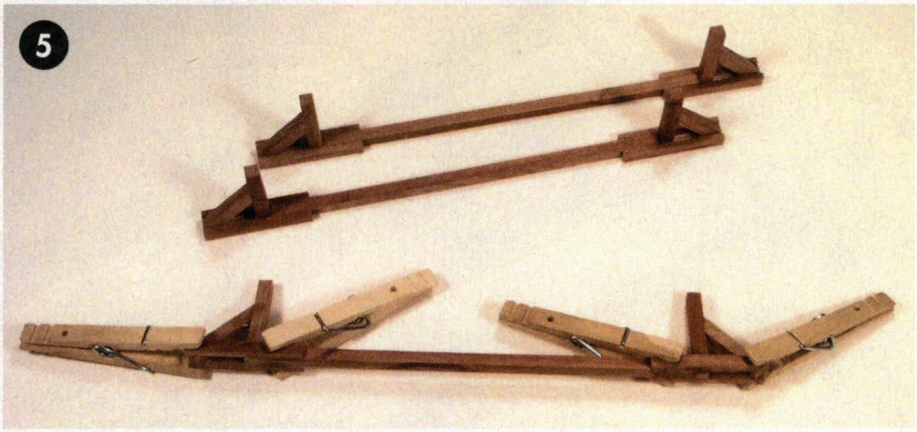
Start by gluing a post to each end of the cross beam. Apply a drop of glue to the cross-beam end and push the post into place, making sure it is vertical. Use a square (X-acto makes an inexpensive one) or a square bit of scrap to ensure squareness, as shown in **photo 3**. Do this to all the cross beams. By the time you've finished the last one, the first will be solid enough to work on. Using a scrap of wood for alignment along the bottom of the cross beam, glue a brace (part F) against the post, with the 45° angle contacting the post (**photo 4**). The other end of the brace will rest on the scrap for now (see the picture). Repeat the process on the other end. When all the cross beams have



A square piece of scrap wood helps ensure squareness when gluing the posts to the cross beams.



A scrap with a smooth edge is used as a guide for gluing the braces to the posts.



Clamp the side supports in place with clothespins until the glue has set.

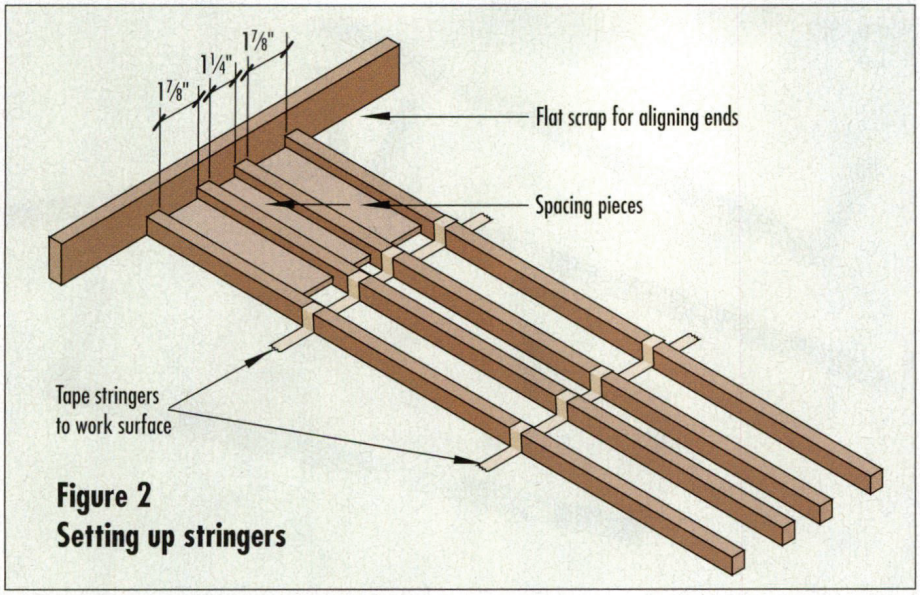
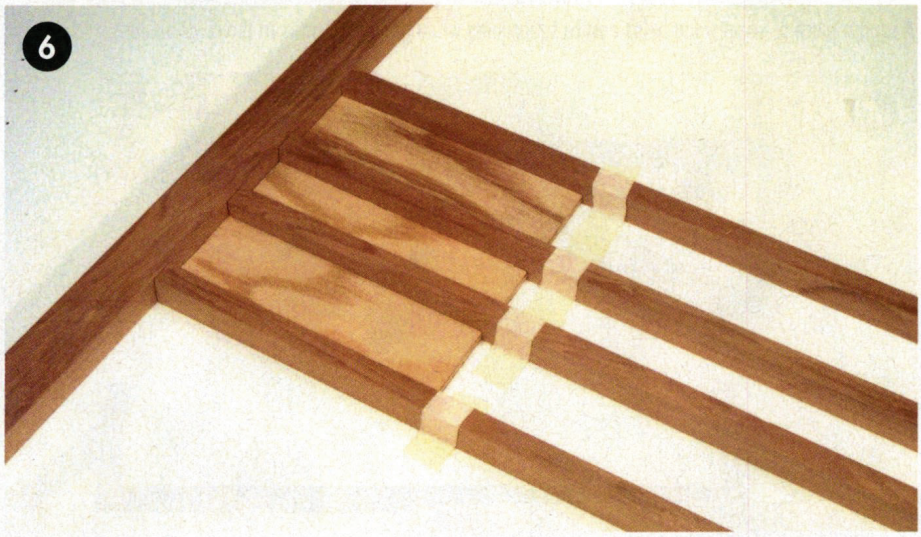
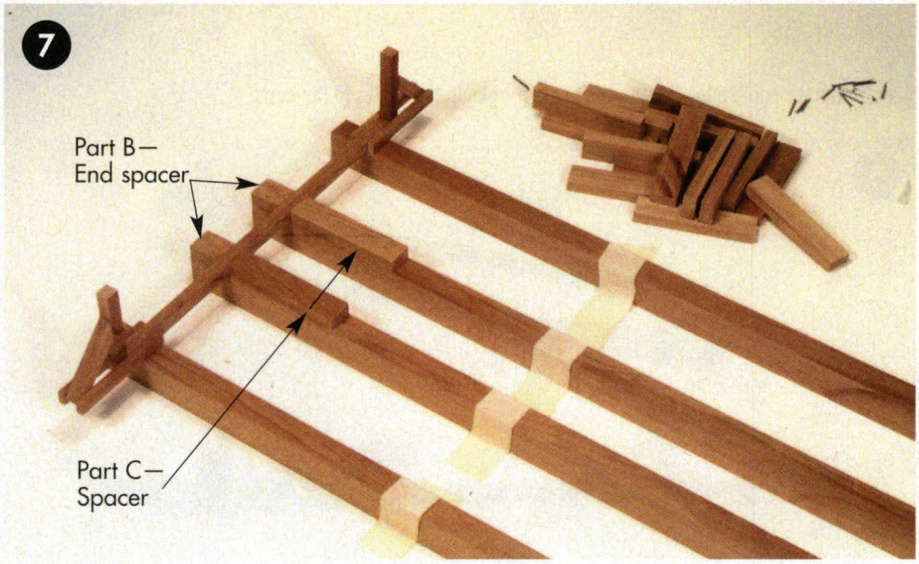


Figure 2
Setting up stringers



The stringers have been properly spaced with the spacing pieces, aligned with the piece of wood on the end, and taped to the work surface.



The end spacers, first cross beam, and first set of spacers have been glued and nailed in place.

had their braces fitted, carefully glue and clamp a side support (part J) to either side of the cross beam and brace at both ends, making the ends flush with the corner of the brace (**photo 5**). Then do the same with all the remaining cross beams. This completes the cross beam assemblies.

The frame

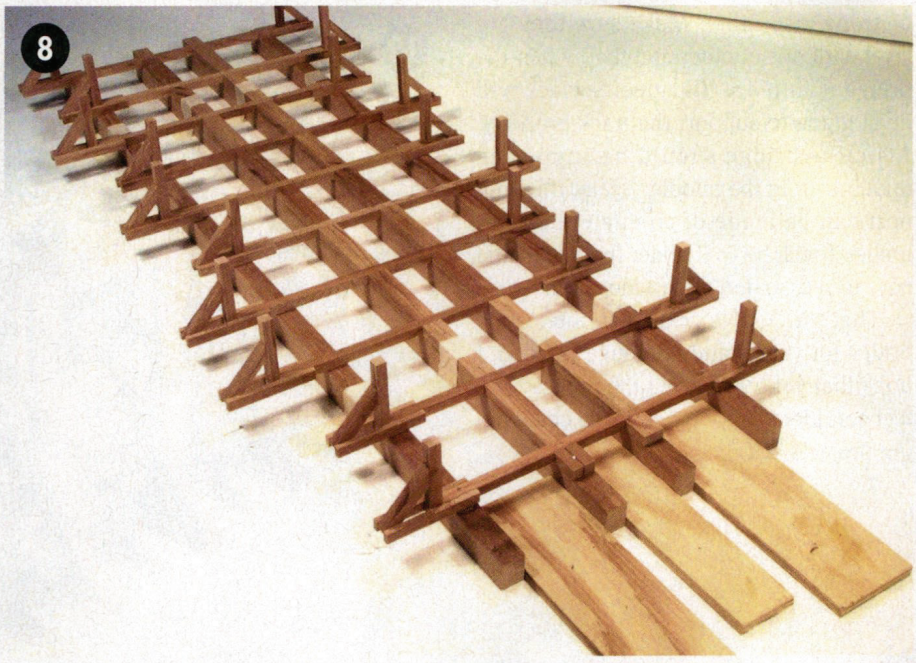
Cut some spacing pieces from scrap plywood. You'll need one 1¼" wide and two 1⅞" wide. Make them 4"-6" long. Take the stringers (part A) and arrange them, with the spacing pieces sandwiched in, as per figure 2 and **photo 6**. Use a straight-edge along one end to maintain squareness. Tape the stringers to your work surface to hold them in place, then remove the spacing pieces.

Glue and nail end spacers (part B) to the tops of the two middle stringers at one end. When these have set up, glue and nail a cross-beam assembly to the tops of all the stringers, next to the end spacers, taking great care that an equal amount overhangs each side (**photo 7**). Now glue a spacer (part C) next to the cross beam on top of the two middle stringers and put the next cross beam in place, *but don't glue it in* (even accidentally). Don't worry about correct overhang at this point. We'll deal with it later. Continue this process until the last cross beam has been placed (**photo 8**). If the tape gets in the way, reposition or remove it. Then glue on the end spacers. Trim the stringers to length with a razor saw.

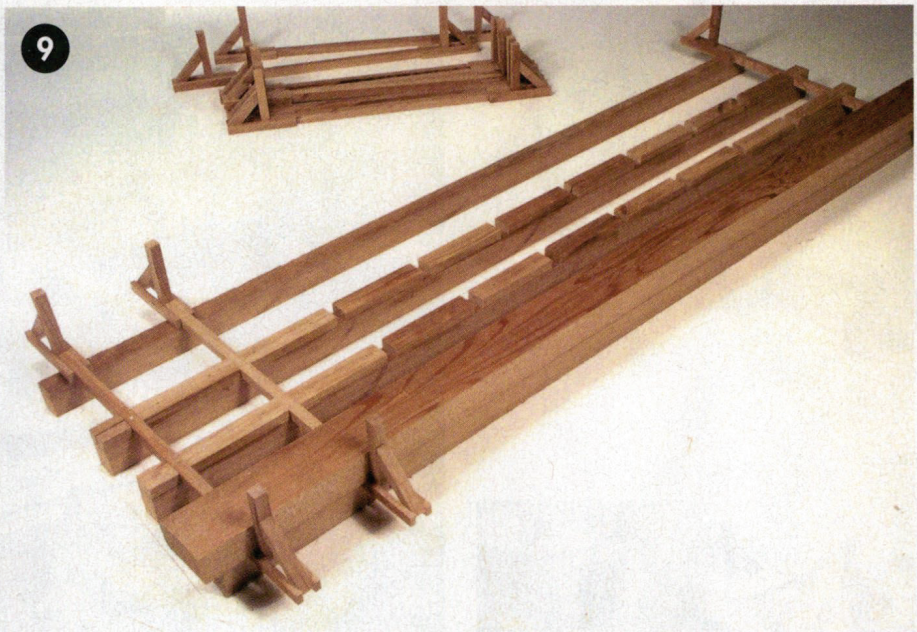
Now glue and nail the last cross beam in place, making sure the overhangs are equal. When this has set, glue the other cross beams in place, using a straight stick laid across the the cross beams (**photo 9**), flush against the posts on one side, to ensure that all the assemblies are accurately placed and that all the posts are in line. The finished frame appears in **photo 10**.

Deck and railings

Glue a deck piece (part G) to each of the cross beams, hard up against the posts, and with an equal amount overhanging each end. Now do the same on the other side of the bridge. Add two more planks to each side in the same way (**photo 11**), butting the edges of one up against the other. Now lay (but don't glue) the remaining planks in place and drop a piece of



All the spacers have been glued and nailed in. Only the first and last cross beam assemblies have been permanently fixed at this point. The tape was repositioned as I went along.



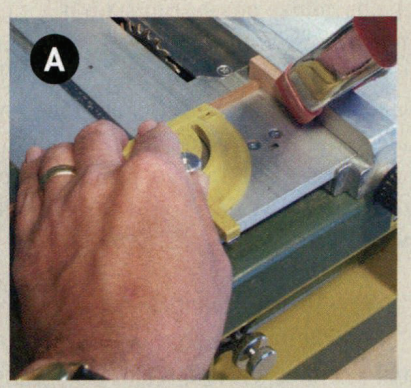
Using a straight piece of wood against the inside of the first and last post, the remaining cross-beam assemblies can be accurately placed, glued, and nailed.

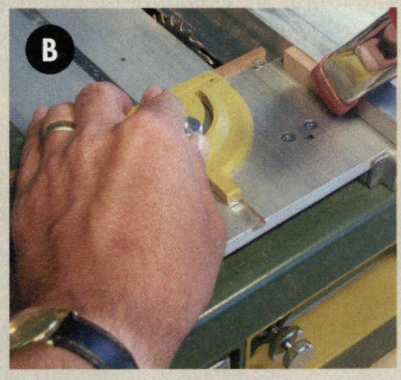
track into the space. It should just fit, or be a little sloppy. If the track does not fit, the last two boards will have to be trimmed slightly until it does. When you are happy with the fit, glue the remaining deck boards in place.

Take one of the rails (part H) and glue it to the inside surfaces of the posts, flush with the tops of the posts, and with an equal amount overhanging each end. Clamp the rail to the post with clothespins until the glue has set (**photo 12**). Do the same on the other side. Glue the second rail in place, allowing about ¼" of space between this and the top rail. Finish off the bridge by gluing the top rail (part J) in place. Carefully glue it to the posts and the edge of the rail below it.

Finishing

Your bridge is now complete (**photo 13**). You can install it as is and let nature





Cross-cutting multiple pieces to the same length

In this project, there are lots of pieces that must be cut to the same length. There is a simple and safe way to do this very accurately on your table saw. First, clamp a small block of wood to your table-saw's fence, near the blade. Then carefully measure the length of the desired cut from the blade to the edge of the block, not the fence. Lock the fence in place, then move the block toward the front edge of the saw, well clear of the fence. This will become your cutting guide.

When cutting, support the work to be cross cut in the miter gauge and run it up against the block (**photo A**). As you advance the work toward the blade, it should clear the block before it gets to the blade (**photo B**). If you hold each piece securely against the miter gauge, you'll end up with all the pieces cut precisely to the same length.

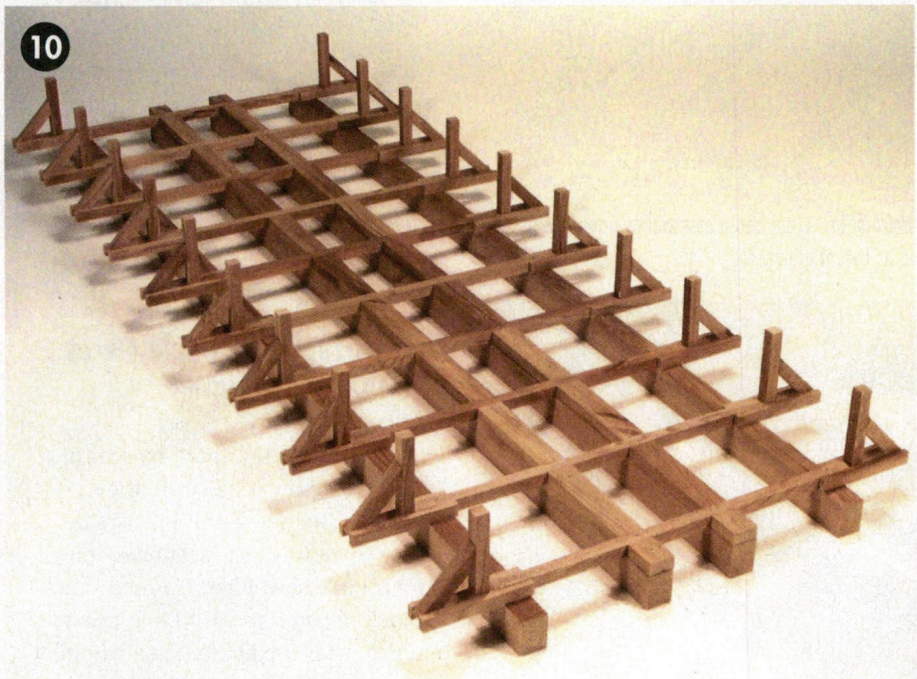
Also, you can tape several pieces together and cut them simultaneously. Cutting right through the tape will also give you a cleaner cut on the wood.

take its course or you can stain it a dark brown, or even paint it if you wish. One method that works well for naturally weathering the wood is to mix some iron filings with some white vinegar. After this mix has aged a day or two, paint the wood with it. The wood should turn a nice, weathered gray.

Installation

To install your bridge, you'll need to prepare some abutments. These are merely surfaces at either end for the bridge to sit on. They can be cast concrete, pieces of stone, or timber. Make sure they are level with one another and that, when the bridge is in place, its upper surface will be at grade to support the track properly. Also, the bridge should be supported underneath in the middle. Again, this support can be made of concrete, rock, or timber. It will be well under the bridge and hard to see, so don't go to too much effort.

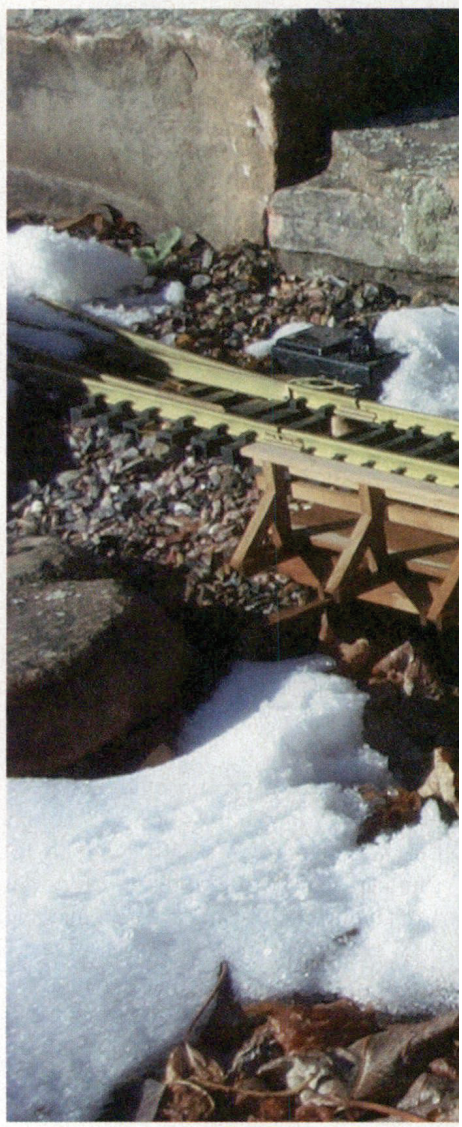
That's it. You've created an interesting bridge for your standard-gauge railroad. I hope that you've enjoyed the process and feel confident to try other, more challenging projects. II



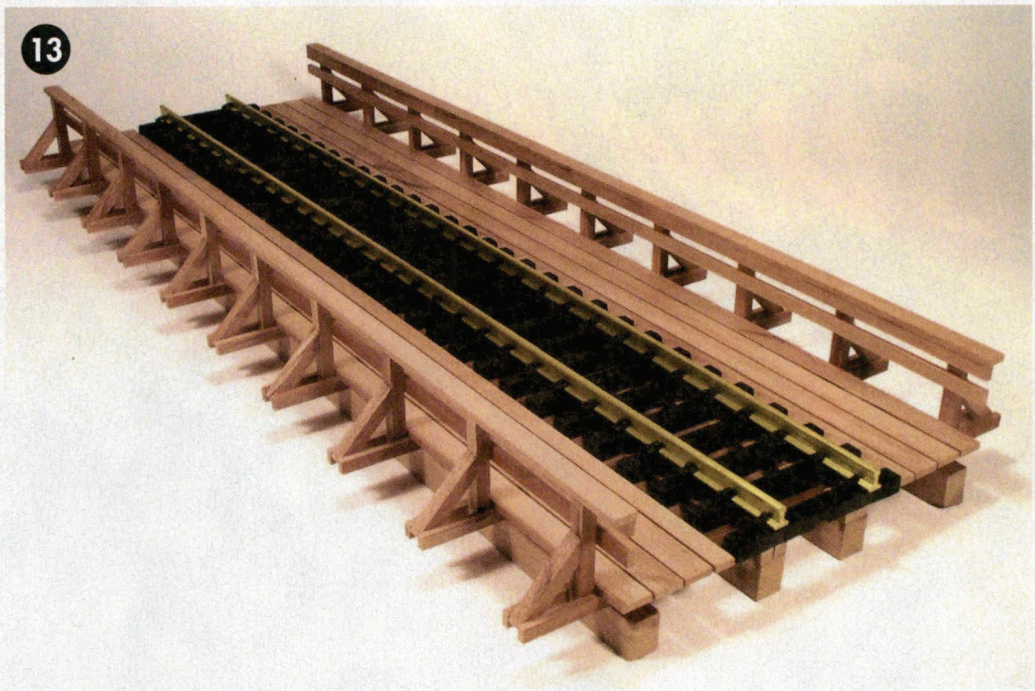
The finished frame. The posts form a perfectly straight row.

The decking is glued in place with the aid of clothespins. I put a little space between the pieces for looks.

Top rails have been glued and clamped. The inside decki



e trimmed to accommodate the track.



The finished bridge, ready to be installed on the railway.