TECHNICAL SOURCE GUIDE

UNSUPPORTED CURVED STAIRCASE

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In the mainstage production of “Twelfth Night” in the Barber Theatre at Northwestern University, the scenic designer requested an unsupported curved staircase with a 4 ft. by 4 ft. cantilevered landing on the upper end as its only support. Because the Barber Theater is a three-quarter thrust space, the need for an unsupported staircase was crucial to the success of the design. Although I considered using a broader range of materials, such as steel tube, the proper equipment to create curved carriages was not available.

In my experience of building scenery for the film industry, I had become very familiar with the many uses of bending lauan and thought that laminating enough layers of 3/8-inch “bendy board” (sometimes called "wiggle board") might give not only the thickness the designer wanted but also the rigidity needed for the carriages of the curved staircase. Although this appeared to be the best solution to this structural problem, a question of structural integrity of the bending lauan still remained.

My research led me to the American Plywood Association (APA), a member of the Engineered Wood Association. Because bendy board is not an American-made product, the Association was unable to completely answer my question; however, Tom Kozitsky of AM was able to provide minimum bending radii for regular plywood panels. According to this information, the minimum bending radius, parallel to the grain, for 1/4 inch plywood is 5 feet. Because the radius of the inside curve of the stairs was 4 feet, bendy board appeared to be the best solution. Although the structural information regarding load capacities was not available for bendy board, our desired finished thickness of 11/2 inches (six laminated layers of 3/8-inch bendy board) for each carriage appeared to be strong enough to both support the treads and minimize any flexing that might occur.

The dimensions required by the designer for the finished staircase were 11 treads with an 8-inch rise, curving 90 degrees to the left from the stage floor to a landing at +96 inches from its base. Tread width at the top step was 4 feet. Tread width at the floor was 5 feet. For the top five steps, the inside radius was 4 feet and the outside radius was 8 feet. Over the next six steps going downward, each side of each tread flared out about 3 inches, so the radii changed with each step. Because many aspects of this curved staircase were similar to those of a wooden boat, many boat construction techniques were used. The cold molding process used in creating a hull was used in the carriage lamination process. Another technique used in laying out the various ribs of the hull was the bendable batten. In this process,1/4-inch thick strips which had been ripped from the edge of 1 by 4's were used to create easily bendable battens. When bent, such battens will assume a "fair" curve (one that appears smooth and pleasing to the eye).

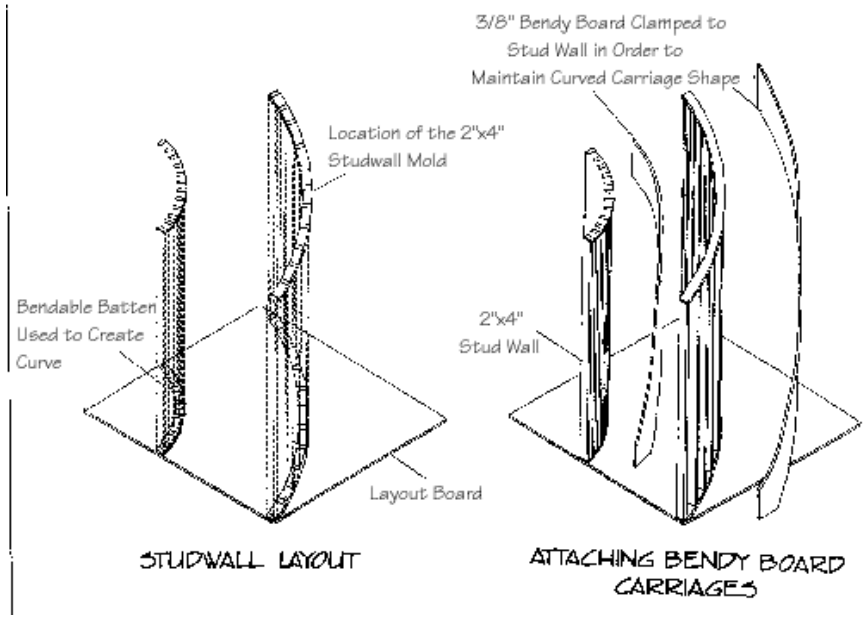
Before points could be plotted that the bendable batten would intersect with, center points for the more consistent radii of the upper portion of the staircase needed to be located. Using the same center point for both inside and outside curves, a line was drawn for the top five steps. On the layout board, the inside radius was actually 3 feet 6 inches, and the outside radius was

actually 8 feet 6 inches. These locations were marked on the edge of the layout board as well as the location of all of the treads. Tacking 4d common nails into the layout board at the intersections of the treads with the inside and outside radii made it possible to form the bendable battens around the nails and bring them to the desired points at the floor line. This created a fairly smooth curve to the carriages.

Subtracting for the l/2-inch carriage wall thickness, a 2 by 4 stud wall for the inside and outside curves was constructed which was used as a form on which to mold and secure the bendy board during the lamination process. These 2 by 4 walls also ensured that successive layers of laminated bendy board would be plumb and square to themselves and the other carriage. Because bendy board is designed to bend in only one direction (parallel to the 8-foot length or parallel to the 4-foot length), carriages had to be cut diagonally out of the 4 ft.by 8 ft. sheets equal to the height of the stair walls. Lamination of the carriages was done one layer at a time, allowing enough time for the yellow carpenter's glue (aliphatic resin) to dry. In each case, clamps were used to hold the bendy board layers to the stud wall frame until the glue had set up.

To construct the treads, frames were created out of l/2-inch square tube steel for each tread. Quarter-inch plywood and Masonite were then attached to the steel frames to create the actual treads. Working from the bottom up, each tread was bolted to the carriages. In order to ensure that the staircase remained level and plumb, the stud wall was disassembled one stud at a time as treads were attached.

The finished curved staircase fit the look the designer wanted, and although one hidden steel tube support was inserted to reduce minor flexing, the staircase was structurally sound.



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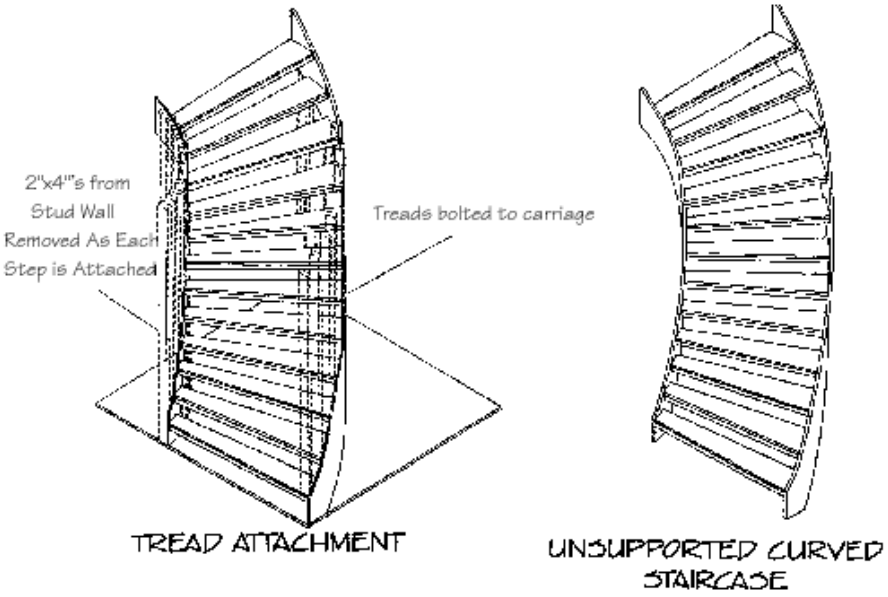

Bendy board is available through Columbia Forest Products for $40.00 to $50.00 each. For further information on Columbia Forest Products, contact Tom Daniel, East Regional Sales Office, Greensboro, North Carolina at 1-800-637-1609

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