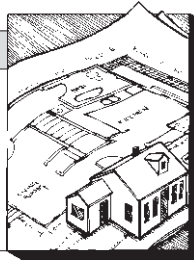


Stiffening Stairway Railings

by Gordon Tully



A house contains nothing potentially more dramatic, playful, and beautiful than a stairway. But a stairway is also a structure, as is a stair railing, and both must support surprisingly heavy loads.

In previous columns I have hammered away at the disparity between the ordinary construction of railings and code requirements. Here I want to extend the discussion to the railings at stairways.

Code Load a Heavy One

The BOCA code, in its Massachusetts version, dictates that "railings and barriers around stairways, stairwells, balconies... and other floor openings, both exterior and interior, shall be designed to resist a concentrated load of at least...300 pounds... and...a uniformly distributed load of...100 pounds per lineal foot applied in any direction at the top of the railing. The...loads need not...act concurrently."

Now, you find me a wooden residential stair railing with balusters that will support a lateral load of 300 pounds or 100 pounds per lineal foot at every point, and I will eat it as a high-fiber breakfast, without salt. These severe provisions are rarely enforced in house construction, and the standards should be reduced. But by how much? I know of one railing—it protects a 30-foot drop in an historic house—that wouldn't hold 5 pounds per lineal foot, yet has withstood 250 years of bumptious oafs and careless children. On the other hand, no one wants to set too low a limit—or build a substandard railing—and then find that someone fell through it.

So what do you do? When will your code official suddenly get nervous and start enforcing the code? And if you decide not to meet code, how safe is safe? Do I dare advise you on how far to back off from the code? (Answer, courtesy of my attorney, is "No way.")

The best I can do is suggest solutions that will preserve some of the dignity and beauty of a staircase without forcing you to break code.

Dealing With a Long, Straight Railing

A long, freestanding railing presents the stair designer's toughest challenge. Consider the lower end of such a stairway. If the railing is at the standard 32 inches above the nosings and is 12 feet long, the code requires that the newel post at the bottom of the stair resist a rotational force of almost 2,000 foot-pounds (half the rail's length multiplied by 100 pounds per foot multiplied by the railing's height).

There are two basic ways to deal with this problem: design the newel post properly; or use some other method for supporting the railing.

Burying the Newel in the Floor Structure

Most construction manuals show a standard detail for securing a newel to the framing below. Unfortunately, these details work only for short runs. For the long run we are considering, try a design that will transfer the load from the newel into the extra thick floor framing as shown in Figure 1.

Supporting the Newel Post on Top of the Floor

The usual solution for anchoring a newel on top of a floor—using a bolted-on steel angle—also works only for short runs. For a 12-foot run, the only solution I can contrive that meets code is to make the newel out of steel! The newel is a vertical 2 1/2-inch-square steel pipe welded at its base onto a long, 4x4-inch steel angle. The angle, hidden behind the first riser, is lag-screwed or bolted securely into the floor structure. Finally, the steel newel post is clad with wood to create what looks like a 4-inch-square wood post.

The moral here is to consult an engineer whenever you run into this condition.

Turning the Stair

One design solution is to brace a long run of railing against another section set at a right angle (Figure 2). This helps you in two ways. First, it gives you a double-height anchorage at the corner, since you can run the newel down into the wall intersection and anchor it to the framing. In addition, the perpendicular section of railing acts as a kind of buttress, bracing the long run. You'll have to leave a free end eventually, but if you make the last section of stair and railing short, any force transferred to the bottom newel post will be small.

Beefing Up the Balusters

Another option is to support the rail all along its length by using oversized balusters and eliminating the newels altogether.

How big must the balusters be? That depends on how strong you assume the wood is. Hardwood has been stress-graded only within the last two years. It turns out that oak is about as strong as Douglas fir, with a graded strength typically between 1,500 and 2,250 pounds per square inch (psi). However, these wood grades are quite conservative, since they assume the wood is flawed. When you actually load-test an un-flawed piece of wood, it fails at three or more times its rated strength. The safety factor is to account for nat-

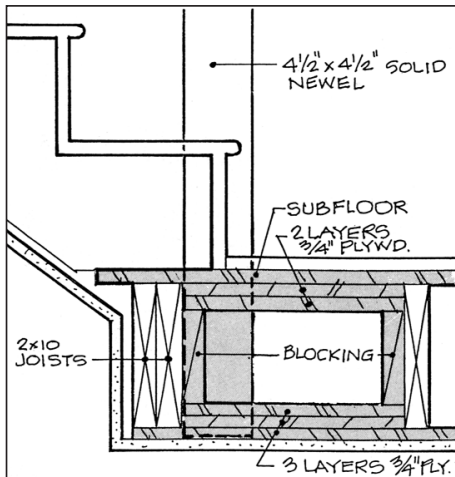


Figure 1. A long free-standing railing can be safely secured by transferring the load from the newel to the floor framing. To anchor the newel, slide the end through tight holes cut in two triple layers of 3/4-inch plywood, as shown. The bottom sheet of ply replaces the ceiling strapping below, while the subfloor serves as the top sheet.

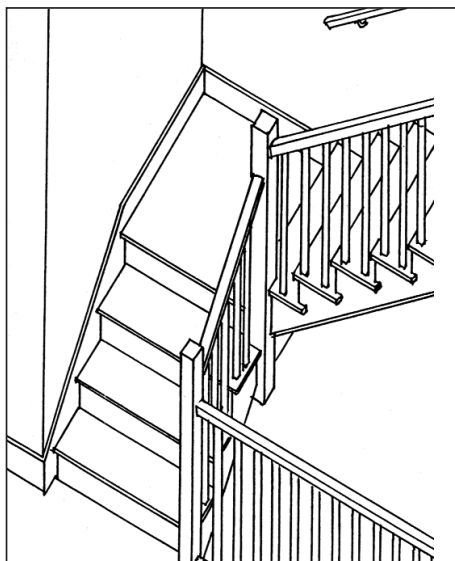


Figure 2. A section of railing like this, with returns at each end, is intrinsically stronger than one on a straight run. To maintain the railing's full strength, do not cut down the newel where it attaches to the framing (despite what you read in construction manuals).

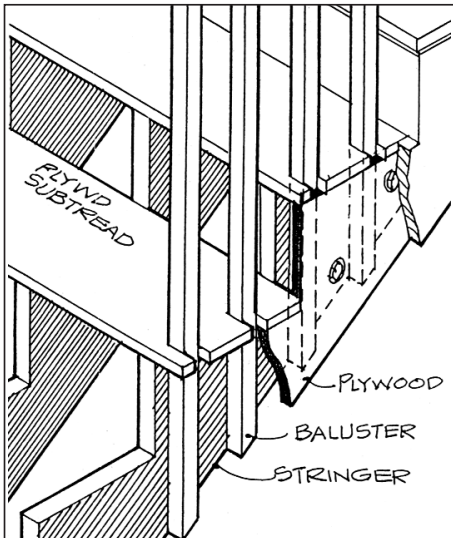


Figure 3. This cut-away shows how structural balusters can be supported with a glue rather than bolts or screws, in order to develop their full strength.

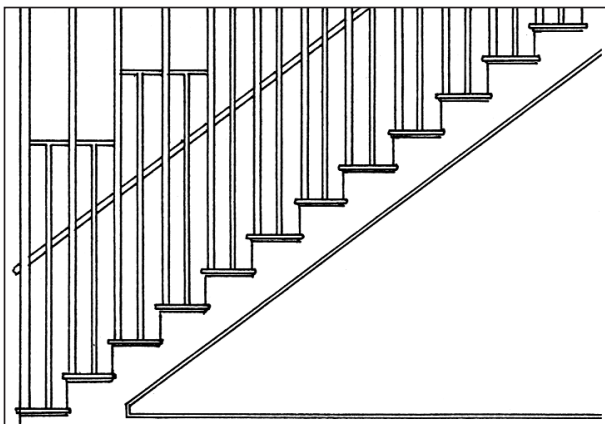


Figure 4. You can embellish a simple full-height balustrade by alternating the thickness of the members. Here, the main members are 1½ inches square, while the secondary ones are 1⅛ inches thick.

ural flaws and for weaknesses introduced during the construction process (for instance, saw cuts, nails, holes, splits, etc.).

The table below will help you make a trade-off between the assumed strength and the size of structural balusters. If you want to keep square balusters down to visually acceptable

sizes, you will have to assume strengths beyond those listed in the grading rules. For example, three 1¾-inch square balusters per tread—required if you assume a strength of 1,500 psi—creates a balustrade that is more than half solid. Put another way, if you want to use two 1¼-inch balusters per tread, you are forced to

assume that the wood has a breaking strength of 6,000 psi.

Assumed Strength (in psi)	One per tread	Two per tread	Three per tread
1,500	2⅜"	1⅞"	1¾"
3,000	1⅞"	1½"	1⅜"
4,500	1⅝"	1⅜"	1¼"
6,000	1½"	1¼"	1⅛"

One way to improve the situation slightly is to make the balusters rectangular, with the long dimension perpendicular to the handrail.

Supporting Structural Balusters

Even when the balusters are of adequate strength, you still face the problem of transferring the load into the supporting structure below. If you can bury the balusters well down into a wall, you have the problem solved. But if you have only a stringer to hang onto because it's an open stairway, the problem needs careful attention.

In the solution shown in Figure 3, the balusters are sandwiched between the main stringer and an outer layer of plywood, essentially creating a glued three-dimensional boxbeam to provide the needed support. Note that this sets the balusters further into the stair than would normally be the case. Most important, the system does not rely on bolting or nailing through the balusters, and thus allows you to assume a higher strength.

Running the Balusters to the Ceiling

The simplest and most elegant way to support a straight railing is to carry the balusters all the way to the ceiling (see Figure 4). If this works in your particular situation, it not only makes a handsome solution, but the structural problems become easy to deal with, just as they do on a deck when the railing supports are carried down to the ground.

Whichever way you choose to solve these vexing problems, may the resisting force be with you. ■

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