Deck Support: Making the Crucial Connections

by Christopher DeBlois, P.E.

"It looked like a battlefield," shouted the headline of the *Atlanta Journal and Constitution* for April 9, 1995. There was no field of combat involved, however. The scene of this eye-catching story was the backyard of a prominent Atlanta citizen in a well-to-do neighborhood: His deck had collapsed during a party, with 63 people on top.

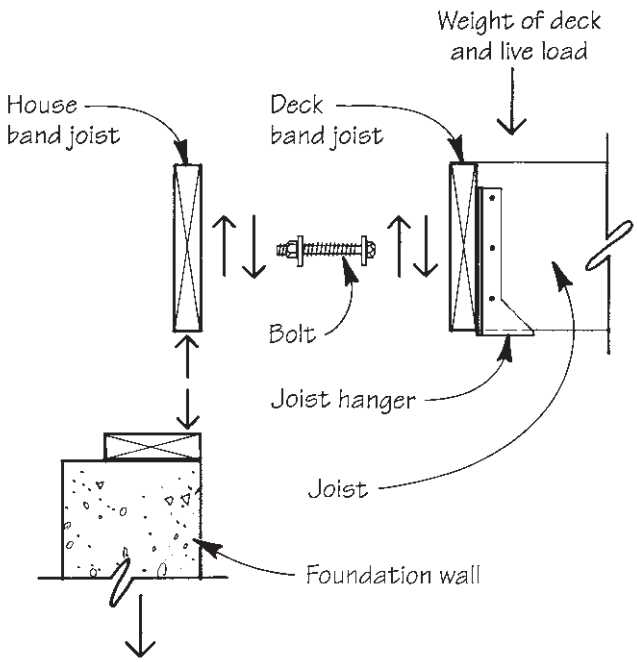
Sixty-three people may seem like a lot, but some easy calculations show that the load on the deck was no more than the building codes say a deck should safely support. The collapsed structure was 25 feet long and extended 12 feet out from the house: 300 square feet of deck.

The codes typically require that decks be able to support the same live load as the rooms to which they connect. In the case of a residence, that's no more than 40 pounds per square foot (psf). For a 300-square-foot deck, that's a total of 12,000 pounds. Dividing by 63 people, that comes to an average of a whopping 190 pounds per person. I'm willing to bet that even throwing in the weight of the tables, chairs, and food that had been set out, the total live load (in addition to the weight of the deck itself) was less than 12,000 pounds.

So if the deck wasn't overloaded, what went wrong? I didn't inspect the failed deck, but I do know that the failure occurred at the connection between the deck and the house. The front photo shows the outer end of the deck still propped up on its wood posts, with the deck surface almost vertical and the joists hanging down to the ground. The deck appears to have torn away from the band at the house.

I don't know what size or spacing of bolts had been used, and now that that particular deck has failed, it's no longer a crucial question. What I am sure of, though, is that almost all the decks that I do inspect don't have enough bolts connecting the deck band joist to the house. Let's take a look at what is really required.

Forces at a Deck Band Connection



The attachment of a deck band joist to the band joist at the house is a "single shear" connection: two members side by side transferring a vertical load. Bolts (with washers) are the best way to carry this load.

How Many Bolts Are Required?

When a bolt (or nail, screw, staple, or other mechanical fastener) is being pushed down on one side by one piece of wood and is being held up on the other side by a second, it's what engineers call a *single shear* condition (see illustration, below). To calculate capacities for a bolt in single shear, there are a few variables you need to know: What is the bolt diameter? What is the density (which you know if you know the species) and thickness of the wood? Is the load applied parallel or perpendicular to the grain of the wood? What is the duration of the load? Armed with this information, an engineer can look up capacities for single shear in the *National Design Specification for Wood Construction (NDS)* published by the American Forest and Paper Association (202/463-2700).

Take, for example, a 2-by Southern Pine side member, such as the deck band joist attached to the house framing. With a 1/2-inch-diameter bolt and single shear applied perpendicular to the grain for "normal" duration (a factor that includes full live loading but not high wind or earthquake forces), the allowable shear load in the bolt is 330 pounds. Of course, the bolt itself could handle many times that load, but what will fail first is the wood: That's what limits the capacity to 330 pounds.

For a deck with joists spanning 14 feet with 2x10s 16 inches on-center and 2x6 decking, the weight of the deck itself is approximately 7.3 psf. Add this to our design live load of 40 psf, and the total load is 47.3 psf. One-half of this load must be supported at the band at the house. Simple multiplication (14 ft. x 47.3 psf x 1/2) gives a load along the band of 331 pounds per foot. Therefore, to transfer this load from the deck band to the house, 1/2-inch bolts spaced 12 inches on-center are required. That may seem like a lot of bolts. It's certainly more than I'm used to seeing on the decks I inspect. On the other

Bolting Schedule for Deck Bands

Joist Span	6'	7'	8'	9'	10'	11'	12'	13'	14'	15'	16'
Bolt Size	1/2"	1/2"	1/2" 5/8"	1/2" 5/8"	1/2" 5/8"	1/2" 5/8"	1/2" 5/8"	1/2"	1/2" 3/4"	5/8"	5/8"
Bolt Spacing	24"	24"	18" 24"	18" 21"	16" 18"	12" 18"	12" 16"	12"	12" 16"	12"	12"
16d Nail Spacing	9"	8"	7"	6"	5"	5"	4"	4"	4"	3"	3"

Note: *This table assumes a deck design load of 50 psf (40 psf live load, 10 psf dead load), and Southern Pine 2-by dimension lumber. As an example, for a deck spanning 8 feet, you can use 1/2-inch bolts on 18-inch centers or 5/8-inch bolts on 24-inch centers.*

hand, it's cheap insurance if 63 people ever happen to be eating barbecue on that deck.

I have developed a table (see above) that gives the code-required bolt spacing for the conditions described above: 1 1/2-inch-thick Southern Pine bands loaded across the grain. It gives an acceptable bolt size and spacing for spans from 6 to 16 feet. If you have more load than the standard 40 psf, or if you frame with a less dense wood (Spruce-Pine-Fir, for example, is less than 80% as dense as Southern Pine), then you can have your engineer develop a similar table.

Leg screws and nails. The table also gives a schedule for 16-penny nails, for builders who so choose. I prefer bolts because they're easier to inspect and easier to take out if you ever have to remove the deck. Where you can't get access for a through-bolt, lag screws are my second choice; substitute the same diameter as the bolt required. Either lag screws or bolts are obviously much beefier than nails, so will resist long-term corrosion better than nails.

Nailed Ledgers Inadequate

There are two more important points to make. First, if 1/2-inch bolts 12 inches on-center are required for a 14-foot deck span, how many nails do you suppose are required to properly transfer the load from joists to band through that 2x2 ledger strip you may have used in the past to support deck joists? Trust me, it's more than you want to put through that skinny, split-prone member. Please use joist hangers in this situation; they're far more reliable.

Also, the bolt capacities given by the *NDS* assume that you're dealing with good sound material. Rot and termites can reduce those numbers to zero in a hurry. Like the decking and joists, the deck band is always pressure-treated. Buy yourself a little more cheap insurance and install a pressure-treated band at the house wherever a deck (or screened porch or similar space) will be bolted to it. It won't do much good if the deck band is sound but the one at the house rots out.

Ounce of Prevention

I'll admit this column is a little preachy. Unfortunately, CABO and other residential codes aren't explicit enough about proper deck support for my tastes. Even so, most decks with less bolting than is really required by code are still standing. But that may only be because there are safety factors built into the design values and because, more significantly, not everyone hosts a 63-person picnic.

Fortunately, no one in Atlanta died from the collapse of that deck. But proper bolting in the first place might have avoided the trouble altogether. ■

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