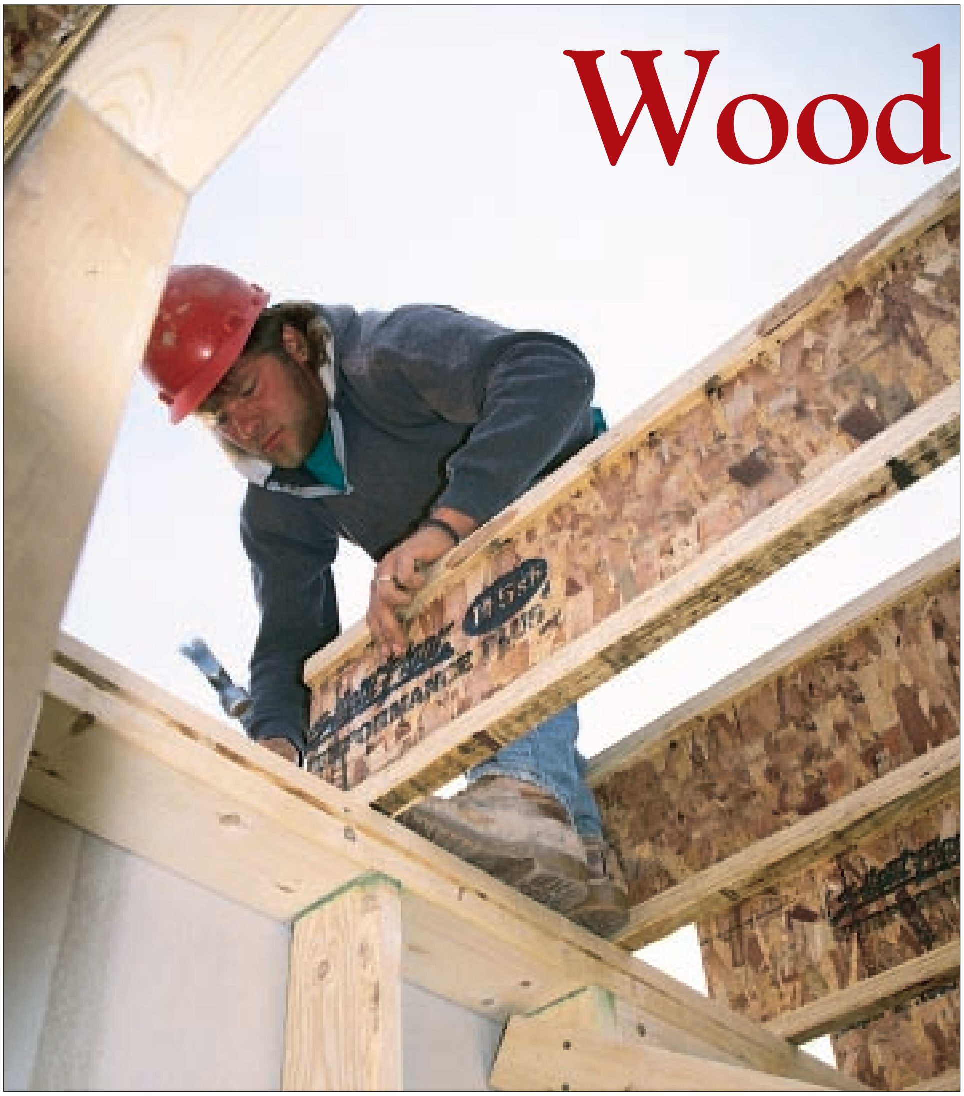

CAROLYN BATES

Wood I-Joist Do's and Don'ts

by Curtis Eck

To banish squeaks, sags, and splits, steer clear of these common mistakes

As a technical representative for a major wood I-joist manufacturer, I work with architects, designers, engineers, and builders to help them to correctly use my company's engineered wood products. Much of my time is spent on job sites looking at installations that range in quality from exceptional to bad to alarming. Builders who have used solid-wood 2x10s for 15 years know what they can and can't do; when they switch to wood I-joists, however, they're confronted with a relatively new product that has somewhat different structural characteristics. I often see the product misapplied even by experienced builders.

Some of these errors are caused by poor design, while others are the work of subcontractors who alter the joists after they've been installed. Most of these mistakes could lead to squeaky or bouncy floors — problems that glue-nailed I-joist floors were specifically designed to solve. Other mistakes can cause more serious problems.

Despite industry efforts to educate architects, builders, and dealers, mistakes still happen. What follows are the most common problems I've encountered and ways to avoid them.

Misplaced Holes

The most common problem I see is misplaced and improperly sized holes in the web of the I-joist. With my company's I-joists, for example, you can cut holes up to $1\frac{1}{2}$ inches in diameter anywhere in the web, including right over a bearing point. Anything bigger than that risks compromising the web's shear capacity: The bigger the hole the bigger the problem, and the farther away from a bearing point it has to be.

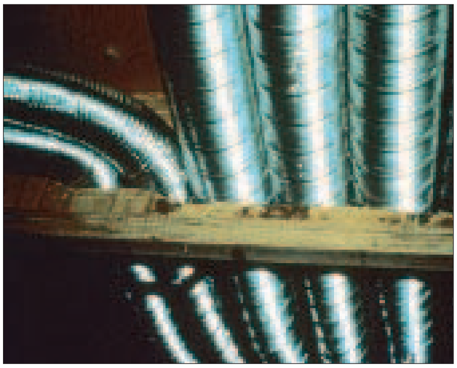

Figure 1. *Routing five ducts through this I-joist meant removing the web, which effectively destroyed the joist.*

Figure 2. *These large holes are too close to the end bearing point, so they compromise the strength of the joists. Follow the I-joist manufacturer's hole charts to avoid problems.*

Figure 3. *Because this joist hanger isn't tall enough to catch the I-joist's top flange, the joist may roll in the hanger. Note also that the builder has chiseled away the bottom flange to make it fit in the hanger, weakening the joist.*

Sometimes the problem is obvious. For instance, the hole cut for the ducts in Figure 1 has completely destroyed the web, and with it the joist. (By the way, the problem was fixed by sliding a new I-joist next to the old and rerouting the ductwork.) Less obvious are properly sized holes drilled too close to the bearing point (Figure 2), which also compromises the strength of the joist. There's no need to guess about the location of holes in I-joists: Manufacturers supply hole charts with their I-joists. If you follow the chart, you'll avoid problems.

Hanger Problems

The next most common error is the improper use of joist hangers. The hanger in Figure 3 isn't tall enough to catch the I-joist's top flange. This leaves the top flange without lateral support, making it more likely to roll in the hanger. A worse problem is that the bottom flange had to be chiseled away to make it fit the seat of the hanger. This reduces the strength of the joist.

Sometimes I see hangers used that are wider than the joist flange. In this case, the carpenter has to nail across the gap between the hanger and the flange. If the joist ever moves at the bearing point, the nail will rub against the hanger and cause a squeak. Filling the space in the hanger with plywood blocking may stop the squeak, but hanger manufacturers say that this increases the stress on the hanger by loading it unevenly. The resulting deflection at the seat of the hanger could leave a void in the decking above and make a bulge in any drywall ceiling below. The bottom line is to use properly sized hangers.

Other common problems with I-joist hangers include:

- ***No nails into joists.*** I see plenty of hangers nailed to the supporting girder but not to the joist. The I-joist can then rub against the metal hanger and cause a squeak.
- ***Too few nails into girder.*** Face-mounted hangers need a nail in every hole, but sometimes installers leave some nails out. This greatly reduces the hanger's load-carrying capacity.
- ***Wrong-size nails.*** Hangers are typically nailed to I-joists by angling a nail down into the bottom flange. Though we recommend $1^1/_2$-inch-long, 10d nails for this, some installers use $2^1/_2$-inch-long nails, which go all the way through the flange, hit the bottom of hanger, and curl under the joist. This can lift the joists slightly and cause a squeak.
- ***Unnailed tabs.*** Simpson hangers have tabs that bend over the top of the bottom flange to lock the joist to the hanger. It's very common for the nails to be left out of these; again, the penalty is a squeak.

The Two-By Rim

One of the main functions of a rim joist is to transfer loads from the wall above to the wall or foundation below. To accomplish this, the rim joist must be the same depth as the floor joists. A typical 2x10 is only $9^1/_4$ inches deep, so it doesn't match up well with a $9^1/_2$-inch I-joist. Using the 2-by as a rim joist leaves a gap at either the top or bottom (Figure 4). Some manufacturers make $9^1/_4$-inch I-joists, but even here a "matching" 2x10 won't do. The 2-by

Figure 4. *A 2-by rim joist is usually shallower than the I-joists; even if it's not, it will eventually shrink and leave a gap. This concentrates the structural load on the narrow joist webs, which aren't designed to support concentrated loads. Acceptable rim materials include I-joists, plywood strips, or an engineered rim material.*

Figure 5. *Avoid breaking an I-joist at midspan over a girder, as the builder did here. Crossing the girder with a continuous-span I-joist will yield a stiffer floor, and will not require full-depth blocking to resist rotation where the joists end on the girder. Note also the nail splitting the bottom flange, which reduces the joist's carrying capacity.*

Figure 6. *Beveling a joist beyond the inside of a bearing wall reduces its resistance to shear forces, which are greatest at the bearing. In this photo, the problem is made worse by the wall at the left, which rests on the joists with no bearing wall below.*

Figure 7. *Notching the flange of an I-joist seriously weakens it; the closer the notch is to the middle of the span, the worse the problem. You can fix a notched joist by putting an additional joist next to it, or by removing the notched portion and supporting it with headers that span between the two adjacent joists.*

Figure 8. *Where two or more I-joists serve as a girder, the web area should be filled in with blocking. The absence of blocking between the double joists in the photo means that the load at the joist hanger will be carried entirely by the I-joist it's attached to, instead of by the girder as a whole. The most likely result is a squeak or sag in the floor.*

will shrink and the I-joists won't, so you'll still end up with a gap.

The trouble with this gap is that it puts all the loads on the joists themselves; in fact, it concentrates the load at the points where the thin I-joist webs meet the flanges. Depending on the web and flange materials, this concentrated force may either crush the web or cause it to knife through the flange. The same bearing problem occurs where the I-joists cross a girder and support a bearing wall; in this situation, the blocking between the I-joists must be full depth.

The solution, of course, is to use a full-depth rim joist. This can be another I-joist, ripped strips of 3/4-inch plywood, or an engineered rim joist. I usually recommend using engineered products because you can lag ledger boards for decks and porches into them without installing special blocking — something you can't easily do with I-joists or plywood. The two products I know of are Timberstrand LSL RimBoard (Trus Joist MacMillan, 200 E. Mallard Dr., Boise, ID 83706; 800/628-3997), which is made from glued-up aspen chips, and Versa-Rim (Boise Cascade, One Jefferson Sq., P.O. Box 50, Boise, ID 87328; 800/232-0788), which is basically a 1-inch-thick LVL.

Joists Interrupted at Girder

Most I-joist systems are designed to run the entire width of the building, regardless of whether they cross an intermediate support. The main reason is performance: A 30-foot I-joist running continuously over an intermediate girder provides a stiffer floor than two 15-footers that break at the girder. This means that the floor in Figure 5 will be bouncier than it should be.

Ease of installation is also important: It takes less time to put up one set of 30-foot joists (a "continuous" span) than two sets of 15-foot joists (two "simple" spans). Using a single, continuous-span I-joist may also eliminate the blocking required where two simple-span I-joists meet above a bearing wall. (This blocking prevents the joist ends from rotating). Where there is a bearing wall above, however, full-depth blocking is always required to transfer the load to the girder.

An additional problem with Figure 5 is the nail in the I-joist's bottom flange. Because it was driven too close to the end of the flange, the nail caused a split. Splitting the flange reduces the allowable bearing stress because the web doesn't have as much flange to bear on; you need a minimum 1 3/4-inch bearing surface under I-joists. Nails should be no closer than 1 1/2 inches from the end.

Figure 9. *Notching a rafter over the inside edge of a wall leaves it bearing not on the heel, where it should, but on the toe. These rafters will split up the middle when loaded.*

Shear Destruction

Where I-joists meet rafters at an exterior wall, it's not uncommon for the joist bevels to be cut beyond the inside face of the bearing surface (Figure 6). Even with solid joists this isn't a good idea, because it reduces their effective depth.

Small loads and short spans are less worrisome than heavy loads and long spans, but other factors may contribute to the problem. Note, for example, the load-bearing wall on the left in Figure 6 — the exterior wall of a shed dormer. This wall raises the load on the already

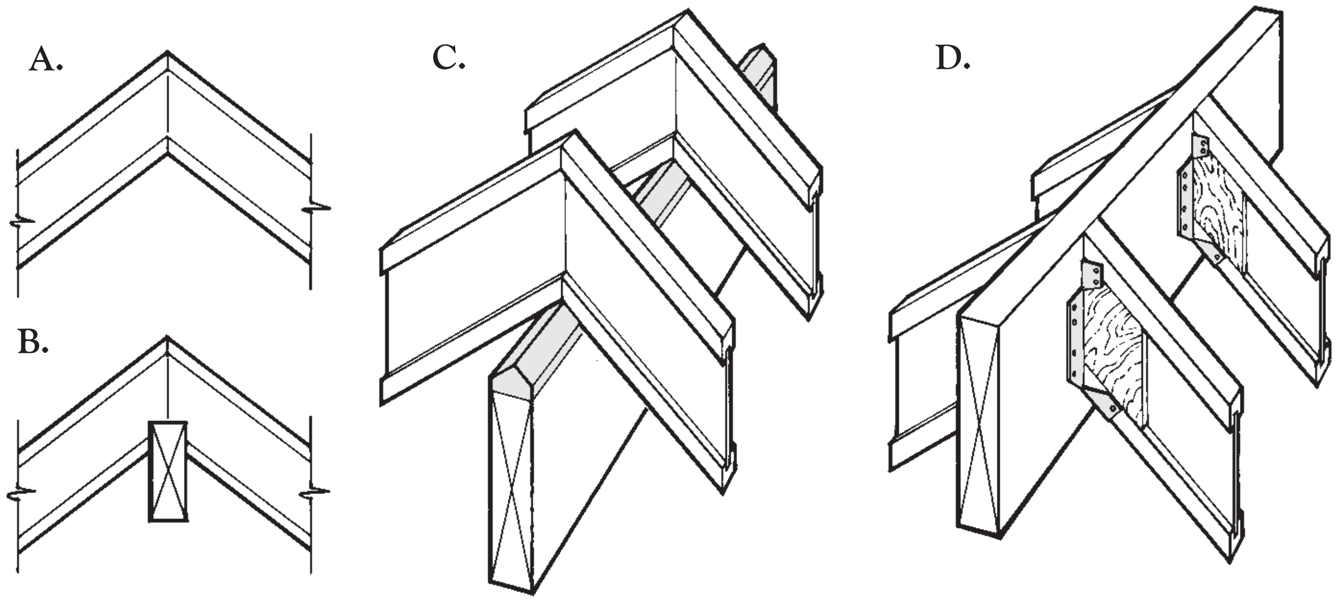

Figure 10. *I-joist rafters can't be rested against each other at the ridge like 2-by rafters (A). Birdsmouths aren't permitted, either (B). Instead, use a structural ridge and either rest the joists on a beveled plate (C) or hang them from the beam (D).*

weakened joists, perhaps leading to a failure.

Our engineers fixed this problem by having the builder add plywood gussets to the webs. How far back these need to go depends on the situation and must be worked out by an engineer. It's better to avoid the problem altogether by designing the structure so that the rafter line is as high as possible, ensuring a small bevel cut on the joists.

Notched Flanges

It's not unusual for a plumber or hvac installer to notch part of a joist when installing pipes or heating ducts. With an I-joist, this might mean cutting the flange (Figure 7). I-joists have their highest-strength material in the top and bottom flanges. Cutting a flange seriously compromises the joist capacity and should be avoided at all costs.

The problem was fixed by cutting out the notched section and running a pair of headers between the two adjacent joists. Whether this would work in other cases depends on whether the two adjacent joists can handle the load. To find out, you'll need to go back to your designer or supplier so they can look at the original design. The best solution, of course, is to route mechanicals so as to avoid notching the joist in the first place.

Hollow Girder

Two I-joists that are doubled to serve as a header must be joined together with blocking at joist hanger locations. Without this blocking, one joist will have to support a load that should have been distributed between two (Figure 8). You could end up with a squeaky floor, or even with a lump in the floor. Where several I-joists are joined to form a girder, blocking between the members is even more important.

Attaching Sheathing

Most I-joist floors are covered with glue-nailed sheathing, and are designed to perform as a system. A bad sheathing job can cause squeaks and other problems. Common mistakes include the following:

- ***Missed nails.*** Often a nail will miss the joist and end up lying tightly against the side of the flange. When the sheathing moves up and down at that point, the nail rubs against the wood, causing a squeak.
- ***Glue sets too soon.*** Sheathing should be attached right after the glue is spread. Otherwise, the glue will set and the sheathing will not be properly attached. The problem here is not just squeaking. Most span charts assume that a floor is properly glued and nailed. If it's not, it will have more bounce than it should.

Weakened Rafters

Toe-bearing is a common mistake with 2-by rafters (see "Common Roof Framing Errors," 8/95), and I-joists are no exception. Never notch an I-joist rafter beyond the inside edge of the bearing wall: You risk splitting the web section of the rafter up its centerline (Figure 9).

Some roof framing problems are unique to I-joists (Figure 10). An I-joist roof is like an I-joist floor in that it requires bearing at both ends. This means that you can't just bring the rafters together at the peak of the roof and expect them to hold each other up. To keep them from failing or sagging, you need to support the peak with a structural beam. You can't cut birdsmouths at the top of I-joist rafters, because this means cutting the bearing flanges. Instead, you'll need to either hang them off the face of the beam with joist hangers or cap the beam with a beveled plate and lay the rafters on top of this. ■

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