Fine Homebuilding
April/May 1997 No. 108

Framing Floors With I-Joists

Whether you're building a new house or remodeling an old one, engineered lumber can give you squeak-free floors with fewer callbacks

by Rick Arnold and Mike Guertin

Most people wouldn't think twice about spending a couple hundred dollars on a computer upgrade that might be obsolete shortly. But the same people would labor for weeks deciding whether to spend a like amount upgrading the quality of a new home by using wood I-joists instead of standard lumber for floors.

I-joists are a bit scary the first time you handle them. Short 3-ft. or 4-ft. pieces seem sturdy enough, but 30-footers flop around like *al dente* linguini. I-joists take a little more care to install than dimensional lumber, but when installed properly, they produce a stronger, flatter and stabler floor deck than one framed with the best kiln-dried dimensional lumber.

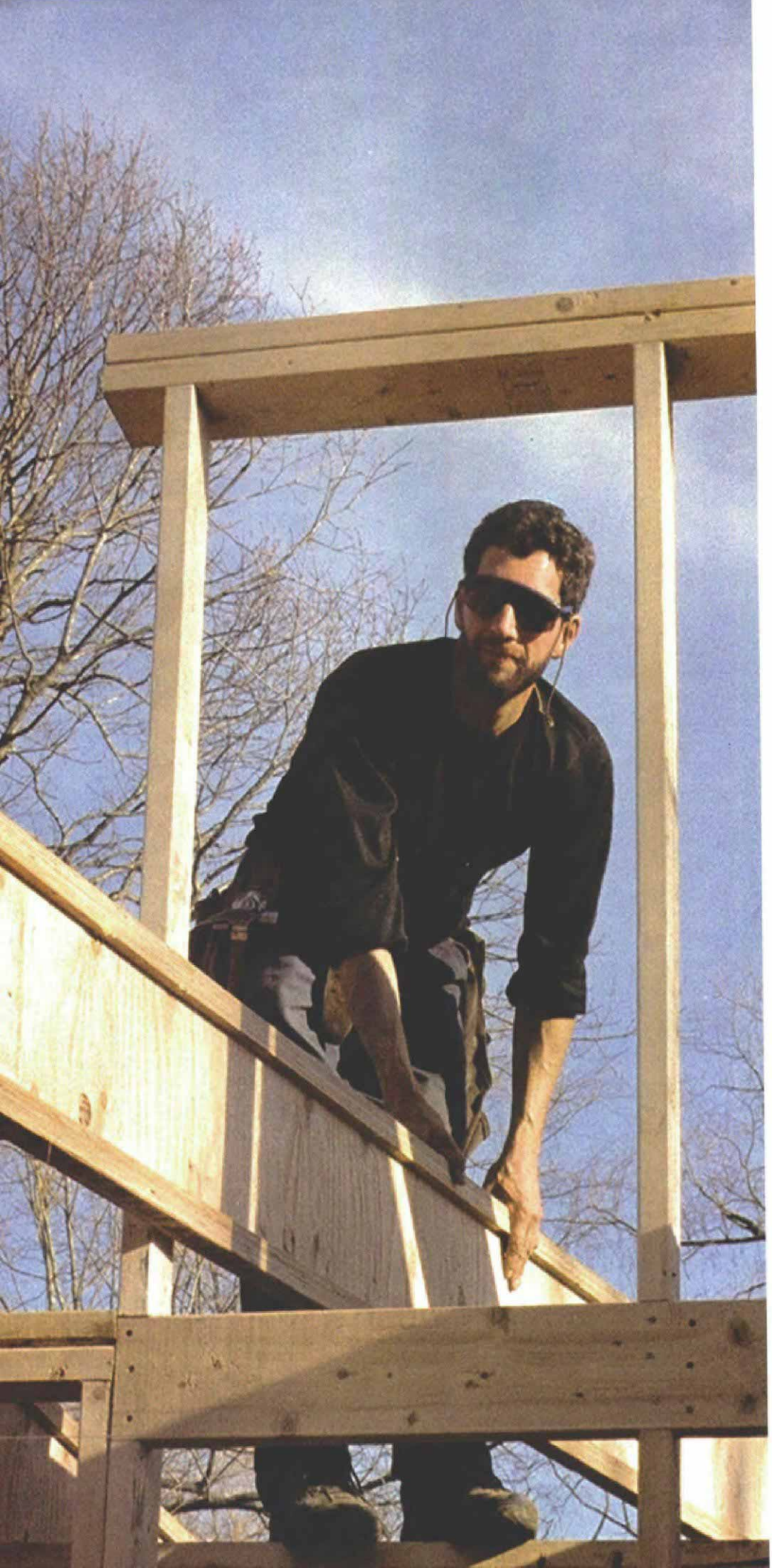
I-joists can be part of an engineered floor system—I-joists are one component of the engineered-wood floor systems manufactured by numerous companies. There are small differences between floor systems from one manufacturer to the next, but we haven't found those differences critical enough to affect either performance or installation.

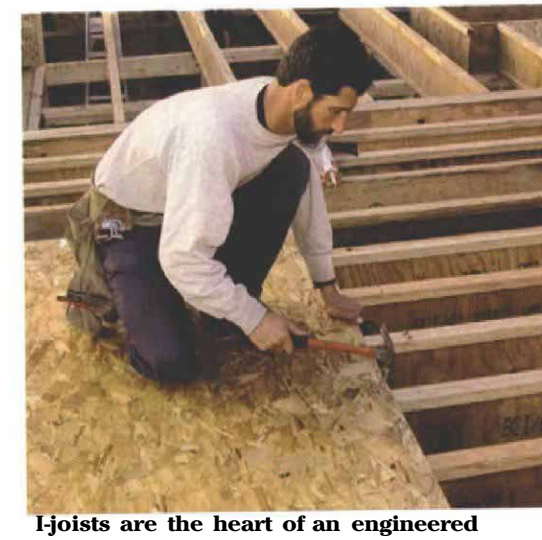
Besides the I-joists, two other components combine to form engineered floor systems. The first is the main beam or girder that carries the joists. In a conventional deck, the main beam usually consists of layers of dimensional lumber such as 2x10s sandwiched together. In an engineered floor system, LVLs (laminated veneer lumber) or PSLs (parallel strand lumber) are used instead. LVLs and PSLs span greater distances and are more stable than beams made with conventional lumber.

I-joists can be installed over dimensional-lumber carrying beams, although manufacturers of engineered floor systems caution against it. If, however, the center beam is installed in-floor or in the same plane as the I-joists, with the I-joists hung from the sides of the beam, a PSL or LVL beam is a must.

The other element of an engineered floor system is tongue-and-groove plywood or OSB structural panel—with the APA Sturd-I-Floor rating—that goes over the joists (top photo, facing page). Here again, conventional structural panels can be used over I-joists, but it goes against manufacturers' recommendations. Also, putting Sturd-I-Floor sheathing down using construction adhesive and the proper nailing schedule actually increases the allowable span of the joists.

As the name implies, I-joists are shaped like the letter "I." The vertical sections are called webs, and the horizontals are the flanges. I-joists

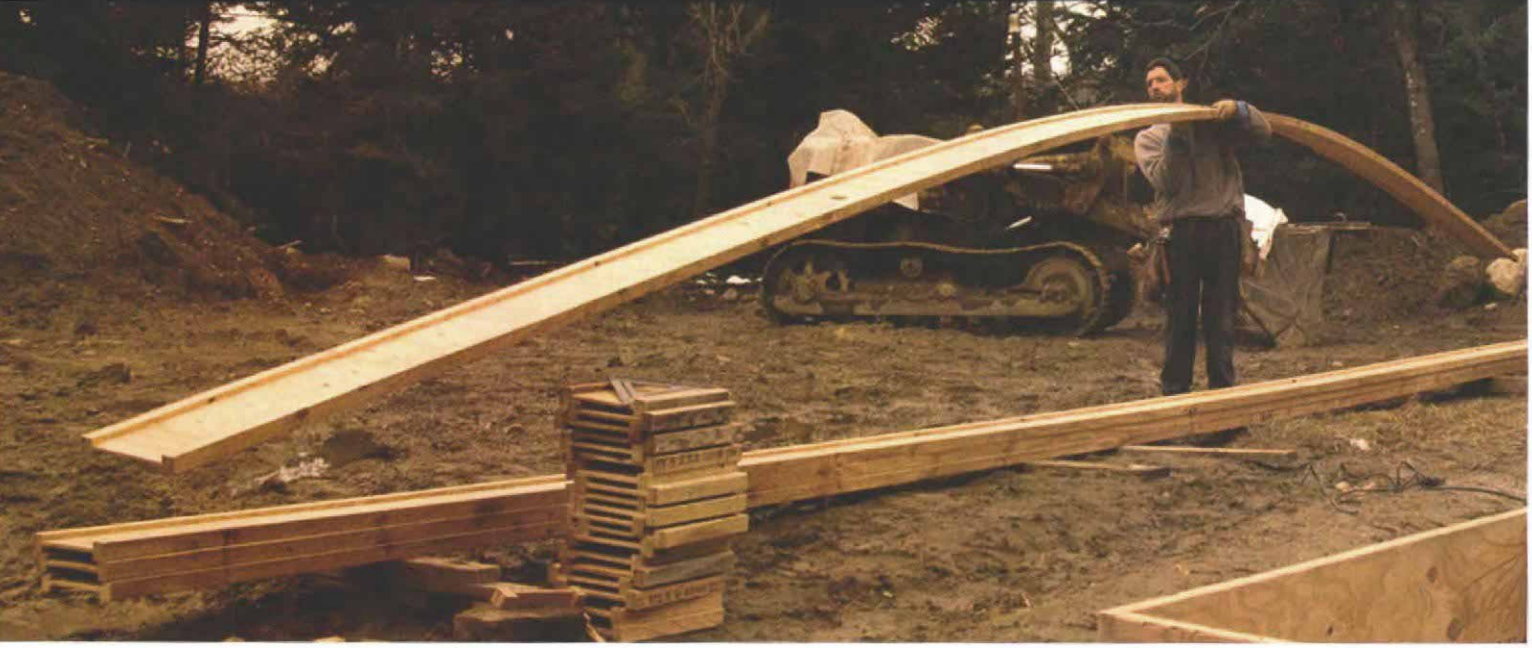




I-joists are the heart of an engineered floor system. Plywood or OSB sheathing is nailed and glued to I-joists for a strong, stable and squeak-free floor system.

Larger I-joists span greater distances. I-joists come in a variety of sizes, and the larger the webs and flanges, the more load they can carry and the greater distance they can span.

Factory-made rim stock is load bearing. Instead of nonstructural ripped-down sheathing, 1-in. thick manufactured stock the same height as the I-joists creates a load-bearing rim.



Lighter and stronger. A 40-ft. I-joist can be lifted easily by a single person. To avoid damage, though, I-joists over 24 ft. should be handled by two people.

Handle with care. I-joists are more fragile than regular lumber and should be handled with care. Damage such as a split flange renders the I-joist unusable.

Stacked I-joists lock together. When stored at the job site, I-joists should be blocked up off the ground at least every 10 ft. to prevent sagging.

come in a variety of sizes, and those with larger webs and flanges can carry larger loads and span greater distances (center photo, p. 51). Manufacturers assign a series number to each size indicating the strength and spanning capabilities of the joist. But be careful when comparing companies' I-joists. Series numbers are not standard from one manufacturer to another.

An engineer can help to size up your I-joist needs—When converting conventional floor framing to I-joists, the manufacturers or distributors provide an engineer free of charge to help with the conversion. If we are drawing the plans ourselves, we bring the engineer in during the design phase. It's a lot easier to integrate I-joists into a house at the design stage, and I-joists offer more design freedom because of their longer clear spans.

We can usually lay out and size the I-joists for most floor systems just by following the literature and charts provided by the manufacturer. Knowing that the lowest series of any I-joist is an upgrade from any common framing-lumber species of the same height, it's usually just a matter of replacing dimensional lumber with the similar-height engineered member (a 2x10 floor joist would be replaced with a 9½-in. I-joist). But because defects don't exist in I-joists, we don't have to order extra stock to replace boards with bad crowns, giant knots or splits.

We install the floor systems ourselves, so we try to design them as simply as possible. Here, the engineer's input is invaluable. Adding an extra beam, a joist or a hanger can save labor in the long run. An engineer also helps us to eliminate unnecessary components. We've found that the more complicated the house, the easier it is to frame the floors with engineered lumber.

Until recently, we had to use ripped pieces of ¾-in. plywood, oriented strand board (OSB) or an I-joist for the rim joists that run perpendicular to the floor framing. But now stock rim-joist material is available for I-joist floor systems (bottom photo, p. 51). Rim stock is made from 1-in. or 1¼-in. material similar to OSB and manufactured to the same height as the I-joists. Manufactured rim stock has a high load capacity and in most instances eliminates the need for squash blocks, or solid blocking between the ends of the joists that help to transfer the outside wall loads to the sills. Manufactured rim stock is available in 12-ft. to 16-ft. lengths that are straight and strong.

I-joists weigh less than conventional lumber—Wood I-joist systems have a number of advantages over dimensional lumber. The first and most obvious is that they weigh about half as much as kiln-dried lumber. A worker can easily carry a 12-in. high 40-ft. joist (top photo), although for safety's sake—and to keep from damaging the I-joists—we try to have two crew members handle long joists. The I-joist height tolerance is within 1/16 in. We feel lucky if our kiln-dried joists vary less than ¼ in.; ⅜ in. is more the norm.

Another advantage to I-joists is their dimensional stability. Even the best kiln-dried lumber shrinks or swells after installation, which can cause a wide variety of problems from squeaking floors to cracks and nail pops in drywall. I-joists don't suffer from these size fluctuations.

I-joists are perfectly straight with no crowns, so there is no need to eyeball every member as we have to do before installing regular lumber. Also, unlike dimensional lumber, I-joists don't check, split, warp or twist. Electricians and plumbers like I-joists because holes for pipes and wires can be larger, and it's easier to cut

Photos top, center: Rick Arnold and Mike Guertin

through I-joist webs than through solid lumber. The biggest drawback to I-joists is that they cost more than dimensional lumber. We got quotes for the house in the photos from several wood I-joist dealers who carry national name brands as well as the regional varieties. Then we priced the floor made out conventional materials. The price for engineered lumber averaged about 15% higher, but your decision on using I-joists shouldn't be based solely on price.

One factor that can give perspective to the price difference is that longer lengths of dimensional lumber cost more per foot than shorter lengths. But because I-joists are a manufactured product, lengths over 40 ft. are available at no additional cost per foot. And then there's the intangible cost factor of all the technical and engineering support as well as performance guarantees that come with I-joists, something that doesn't come with a lift of 2x12s.

I-joist manufacturers claim that the higher cost for their product is offset by the labor savings realized during comparable installations and the callbacks that are avoided using dimensionally stable I-joists. We agree that I-joists make a superior floor deck with fewer callbacks, but we haven't found any appreciable labor savings in the installation of I-joists compared with conventional lumber.

I-joists should be handled with care—Handling I-joists on a job site is the biggest concern for us. They are much more prone to damage than solid lumber. We never let the delivery driver dump a load of I-joists. The flanges can be damaged if the I-joists are dropped onto a rough or rocky job-site surface (center photo, facing page). A ½-in. chip out of a 2x12 won't affect its performance, but a similar chip could be disastrous for an I-joist.

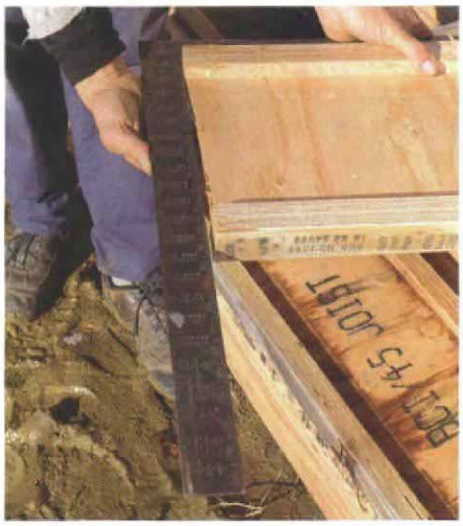
We've seen flanges pop off the webs when they're dumped from a delivery truck. Don't try to reattach an I-joist flange. The repaired joist will fail eventually. The best, most careful way to unload I-joists is by hand or with a boom truck.

After the joists are unloaded, stack them on a flat surface or block them up to keep them from sagging (bottom photo, facing page). If left in a twisted position on the ground for too long, they may take on an undesirable shape. The integrity of the joist probably won't be affected, but it will be much harder to handle and set in place. Stacked flat, I-joists sort of lock into each other for a strong and compact pile (bottom photo, facing page).

I-joists also need to be carefully supported for cutting. Joists longer than 24 ft. should be handled by two workers to avoid damage. We stack the joists on blocks set flat on the ground or on sawhorses spaced no more that 10 ft. apart. Although I-joists are rigid in an upright position, I-joists set on their sides will sag if they're not supported, which makes measuring lengths more difficult. Also, be careful not to saw through the flanges of the next I-joist in the pile when you're cutting that top joist. A sawcut in a flange ruins the I-joist.

I-joists have to be cut to length—When laying out the sills for I-joists, we have to make adjustments to keep the joists centered on the layout because the I-joist flanges are usually wider than 2x joists. The plan we receive from the manufacturer or distributor notes any special items or conditions that we have to pay attention to, such as squash blocks, web stiffeners, backer blocking and hanger locations. We transfer any of these special notes to the plates or beams in red crayon so that the joist installers won't miss important structural details.

After the joist layout is complete, we toenail the rim-joist stock to the sills just as we would with a conventionally framed deck. When laying out I-joists and setting rims, we pay close attention to the minimum bearing surface required by the wide flange I-joists in the joist plan. Some I-joists may need more bearing surface on the sills or wall plates than is left once the rims are set. If this situation is the case, we



All ends should be checked for square. I-joist ends should be checked and cut square before they are cut to length. Out-of-square ends are a common occurrence.

Squash blocks help to transfer point loads. Two-by-four blocks cut slightly longer than the height of the joist transfer point loads directly to the sill.

A site-built jig speeds up the cutting. Because of I-joists' irregular shape, accurate and straight cuts require a jig. A square scrap piece of sheathing that fits between the flanges supports the saw table that rides along a guide screwed to one side of the scrap.

Photo top right: Rick Arnold and Mike Guertin

Web stiffeners add strength to the I-joist web. When I-joists are asked to carry extra loads in specific places, web stiffeners are added. Sheathing the same thickness as the flange overhang is nailed to both sides of the web to supply additional support.

Backer blocks protect the I-joist web. Plywood blocks on both sides of the I-joist keep the web from being damaged when the I-joists are being nailed to framing.

can install wider sills or increase the thickness of the wall, but usually we just skip the rim joist for the time being and run the joists all the way to the outside edge of the sill plate or beam. We'll go back later and block between the joists with rim material.

After the rims are installed, we carefully measure and cut each joist to length. Don't trust the factory ends of I-joists. They rarely come through square (photo top left, p. 53). Cutting I-joists is easy and accurate with a simple jig that can be made on site (bottom photo, p. 53). We write the measurements on the plate and keep the cut I-joists in order so that they can be dropped into place without confusion.

Long I-joists should be carried by two people to make sure they're not damaged from flopping around. It is critical to position the I-joists directly on their layout marks on center beams or bearing walls before nailing the ends. Long I-joists can sometimes vibrate off their intermediate layout points several inches while being handled. We always drive 6d nails beside the flange into the beam on both sides of each I-joist to keep the joist properly positioned until the ends are nailed. I-joists are fastened to the sill with 8d nails driven through the flanges.

I-joist floors require special framing details—Concentrated load points in I-joist floors require details not usually found in conventionally framed floors. These areas are indicated on the plans from the manufacturer or distributor. Also, every I-joist package comes with a floor-framing-detail guide that depicts nearly every framing peculiarity you may encounter.

One detail called for in almost every I-joist floor is squash blocking, which helps to transfer the weight from load-bearing walls directly to mudsills, center beams or wall plates (photo top right, p. 53). I-joist manufacturers specify that squash blocks be cut 1/16 in. higher than I-joists to ensure that the squash blocks take most of the load. Squash blocks are made from 2x stock usually mounted flat against the top and bottom flanges of the I-joist.

Typical locations for squash blocking are beneath jack studs that carry large headers for sliders or French doors or beneath beam-carrying posts. Sometimes they're called for on top of the center beam alongside the I-joists to support a center bearing wall. Squash blocks are also used beneath exterior walls where non-load-bearing stock has been used to close in the rim.

Among other details specific to I-joists are web stiffeners, which are pieces of OSB or plywood thick enough to fill in the width of the flange beyond the web (top photo). The framing guide says that web stiffeners should be cut about 1/8 in. less than the distance between top and bottom flanges, probably so that they can be inserted without driving the web from the flange. They are called for in areas of concentrated load to strengthen the web and to strengthen the webs of some of the taller I-joists. Also, if an I-joist is going into a hanger that isn't tall enough to catch the top flange, web stiffeners are added to keep the I-joist stationary in the hanger. Manufacturers don't give exact dimensions, but web stiffeners are usually only as long as the width of the 2x load they're helping to transfer. Web stiffeners are applied in tandem and clinch-nailed through the web and opposite stiffener.

I-joist headers and doubled I-joists that carry headers are built a little differently than solid-lumber headers. I-joist headers need a 2x filler block between the webs of the mated joists running the length of the header. On I-joists that are doubled for carrying headers, filler blocks are installed between the webs at the locations of all intersecting joist hangers. In these locations the filler blocks usually extend a couple of feet to both sides of the hanger location.

We select the stock size of the 2x filler block to match closely the width between the top and bottom flanges of the I-joists. You don't need to rip the blocks, just use stock with the closest nominal width. Nails fastening two I-joists together should be driven through both webs, through the blocks between and then clinched over. We never nail the I-joists together through the flanges. Nails can split LVL layers in the flange and cause the I-joists to fail.

Use only specially designed joist hangers—Backer blocks are yet another framing detail used in I-joist floors. These blocks are made of OSB or plywood and look a lot like web stiffeners, only they are usually much longer. Although web stiffeners help to increase the compressive strength of the I-joist, backer blocks are used to back up joist-hanger locations or to back up the web in areas where the I-joist has to be nailed to a framing member (bottom photo).

When hangers are called for, we use only hangers specifically designed for I-joists. Most I-joist hangers are top-flange hangers, which means that the top of the hanger has a horizontal tab that attaches to the top of the I-joist flange or beam (photo top right, facing page). Occasionally, U-shaped hangers without the top flange are specified, but these also are designed especially for I-joists with wider seats to accommodate the flange.

Regardless of type, all hangers hung on I-joists need to be installed with backer blocks that extend 9 in. to 12 in. on both sides of the hanger. Top-flange hangers require backer blocks under the top flange on both sides of the joist to support the flange and to keep it from rotating under load. Backer blocks for U-shaped hangers should rest against the bottom flange

and be high enough to accommodate the entire hanger. Never use the bottom flange of an I-joist to support a load. Loading the bottom flange may make it separate from the web.

As we do with web stiffeners, we make our backer blocks out of stock the same thickness as the width of the flanges beyond the web of the I-joist. Backer blocks should always be installed on both sides of the web and clinch-nailed the same as web stiffeners. We also run backer blocking to fill the web spaces that are left exposed at stair openings and in open foyers to make the drywaller's job easier.

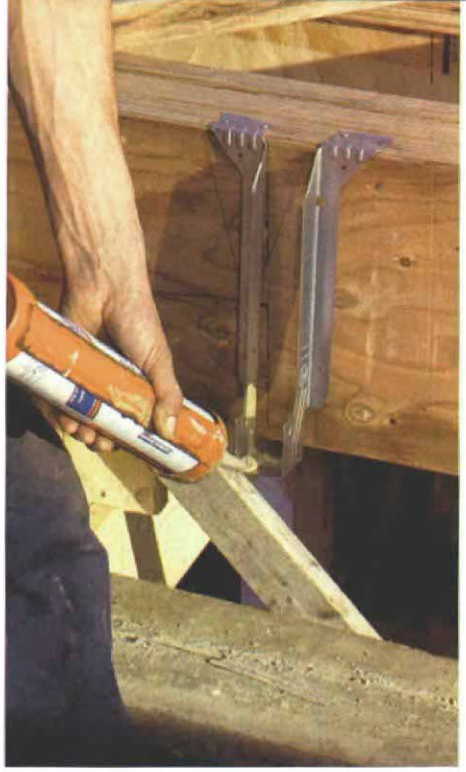
We've found that if these so-called squeak-proof floor systems are going to squeak, they're most likely to do it around joist hangers. To help ward off these annoying noises, we make sure all I-joist hangers are nailed off properly. Then, for added insurance, we squirt a little construction adhesive into the hanger seat before dropping the joists into place (photo top left).

Structural panels complete the floor— We've developed one detail that makes it easy to attach the top plates of walls running parallel to I-joists overhead (bottom photo). Before we install the floor sheathing, we locate the joist bays that fall above parallel nonbearing walls. We rip scrap pieces of sheathing to fit between the webs of adjacent I-joists, and then we tack them down to the top side of the bottom flanges every 16 in. to 24 in. with 6d nails. We always air-drive these nails as opposed to pounding them in with a hammer, which could weaken the web-to-flange connection. Two-by blocks are then attached to the sheathing blocks for a great nailing surface to secure top plates.

As mentioned earlier, wood I-joists are designed to be just part of an engineered floor system working together with the subfloor structural panels to complete the system. After the I-joist installation is complete, we apply a layer of ¾-in. tongue-and-groove subfloor that is glued to the tops of the I-joists with construction adhesive. We also put adhesive between the tongues and grooves of the sheets themselves. Ring-shank nails are used to attach the subfloor.

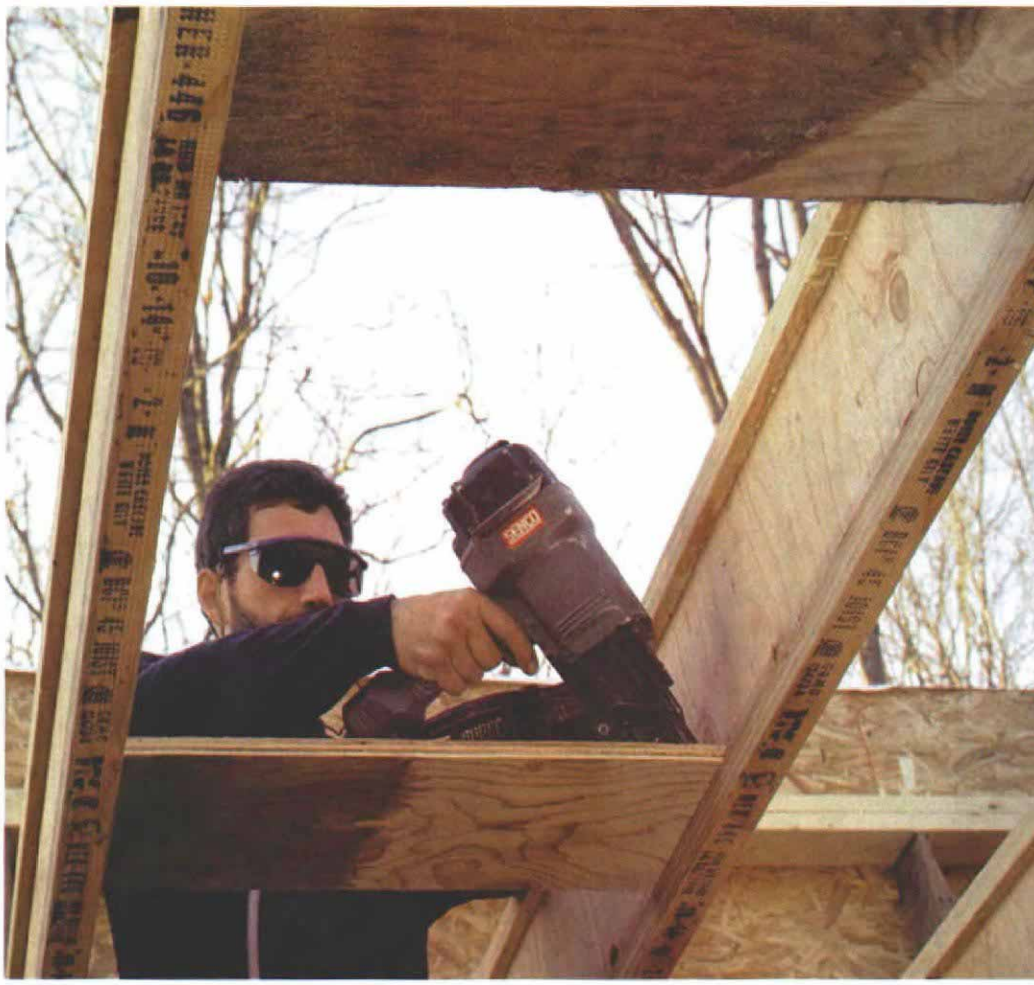
As you begin to frame with I-joists, you'll likely encounter many unusual framing details. We were once faced with something that can be described only as an outside loaded flying cantilever. We sketched the problem and fired off a fax to the distributor's engineers. After phone conversations and faxes back and forth, we came up with a detail we could use. □

Rick Arnold and Mike Guertin are contributing editors to Fine Homebuilding. *They are also partners in U. S. Building Concepts, a construction consulting business in East Greenwich, R. I. Photos by Roe A. Osborn, except where noted.*



A bit of insurance will bring silent floors. A squirt of construction adhesive in the bottom of the joist hanger helps to prevent floor squeaks.

Special joist hangers are used for I-joists. Top-flange joist hangers have horizontal tabs that wrap over the flanges of adjoining I-joists or LVL beams.



Plywood blocking for anchoring interior walls. Lengths of plywood are tacked to adjacent I-joists to attach nonbearing interior partitions that run parallel to the joists.