SOUTHERN FORESTS PRODUCT ASSN.

Framing With Floor Trusses

Ask any builder who has used parallel-chord floor trusses how he likes them and you're likely to get an enthusiastic answer. No wonder. As building components go, they have a lot going for them. A floor truss can span 38 feet with no intermediate support. It does this not with massive timbers, but with a series of cleverly arranged 2x4s. The use of smaller-dimension lumber to shoulder large loads means that a trussed floor makes more efficient use of wood than a floor framed with 2x8s or 2x10s.

A truss makes better use of labor, too. There's no cutting, so the framing goes faster; duct runs can be built into the webs, speeding up hvac installation; and pipes and wires can be quickly routed through any part of the open webs, saving the contractor from worrying about a plumber boring holes in the beam's midspan.

A 3 1/2-inch-thick truss also has more lateral stability than a 1 1/2-inch-thick joist and presents a wider nailing surface for decking. As engineered components, trusses are more predictable than dimensional lumber. They rarely warp, and they're generally stiff enough that if you glue and nail your subflooring, you'll never have to worry about squeaks.

Of course trusses aren't right for every project. Like any material, they have their drawbacks and limitations. Knowing when to use them and how to use them correctly demands some knowledge of how they carry a load.

Truss Types

Structurally, a floor truss resembles an I-beam in that it puts most of its material along its top and bottom edges, where the stresses are greatest. But instead of having a solid web, a truss uses a series of rigid triangles, usually wood but sometimes metal. Because triangles are an inherently stable shape, the truss effectively transfers all loads to the bearing points with little deflection. Additional vertical members are installed wherever a truss encounters a shear force, such as where the truss rests on a wall.

Trusses are broadly classified by what their webs are made of and whether they bear on their top or bottom chords (see Figure 1, next page). A *bottom-chord bearing* truss sits directly atop a wall plate or foundation sill, just like a standard joist. A *top-chord bearing* truss hangs from the bottom of its top chord and can rest either directly on a bearing surface or on a raised setting block (the setting block can be built into the truss). This flexibility gives the designer control over floor and ceiling heights.

Truss web members can be made from lengths of 2x4 held in place with metal connector plates, from tubular steel that's bolted through the chords, or from 20-gauge steel that's formed with the connector plates integral to the webs.

Metal-web trusses have the advantage of being lighter and easier to carry than their wood-web counterparts. And though most metal-web trusses are sized to match conventional 2x10s and 2x12s, 18-inch-deep trusses are available for very long spans. Some fabricators even make 18-inch-deep metal-web "stock" trusses that range in length from 24 to 28 feet. They're bottom-chord bearing, can be cantilevered up to 2 feet at one end, and are designed to shoulder live loads of 40 or 50 pounds per square foot. They're marketed to builders of standard ranch and Cape-style homes and are competitive in

Parallel-chord trusses let you bridge long spans and speed your floor framing

BY CHARLES WARDELL

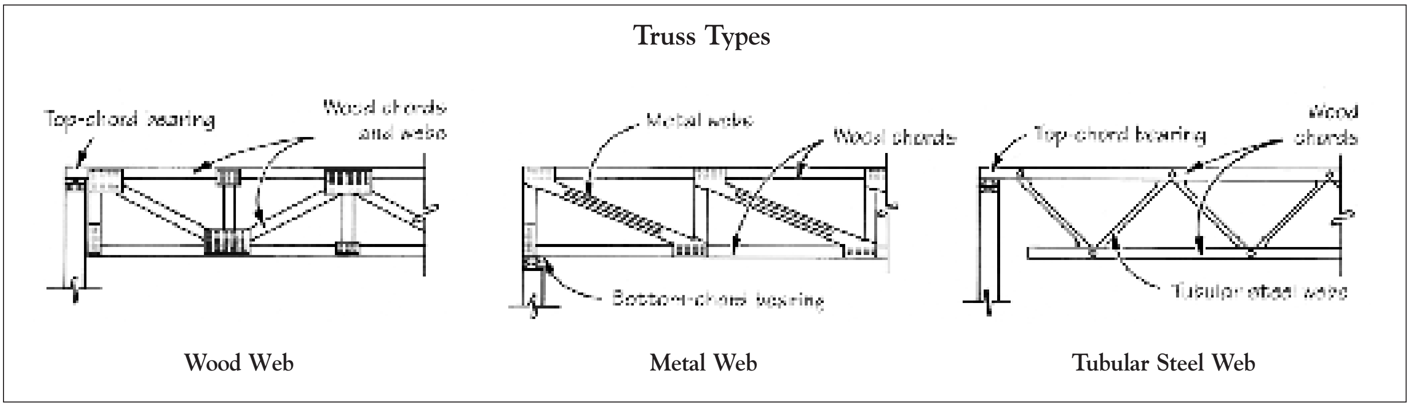


Figure 1. *Trusses are classified by their web material and whether they bear on their top or bottom chords.*

price with stick-framed floors.

Wood-web trusses. Unlike metal-web trusses, which come in just a few sizes and standard designs, almost every wood-web truss is a custom product. Not only can it be made in almost any configuration, but its performance depends on variables such as the strength of its members, and the location, size, and strength of each connector plate. Because of this, fabricators claim that wood trusses are somewhat over-engineered to give them a greater margin of structural safety than their metal-web counterparts.

In fact, the strongest residential trusses — girder trusses — are usually made completely of wood. A pair of girder trusses is often used to flank an opening such as a stairwell and to support the weight of a header that in turn carries several standard floor trusses.

Design and Planning

Some builders believe that they get better engineering with trusses than with other floor systems, such as wood I-joists. Most trusses are custom-made for a particular job which means that the fabricator must take a close look at the plans. But it means that the builder must spend extra time with the plans, too. A trussed floor requires more forethought than one framed with I-joists or solid lumber. Before ordering a set of trusses, for instance, you should know the location of all ductwork and plumbing. Space for these is figured into the truss design and, once in place, the trusses can't be altered without being reengineered.

These constraints may be unacceptable on some custom building jobs, where midstream design changes are the rule. As one custom builder put it, "We've never built a home where we didn't end up moving the walls around." Even small changes like moving a tub or toilet can spell big headaches on a trussed floor — especially if the drain lands over a top chord.

Remember also that deep trusses change the normal height calculations between successive floors. If you're used to framing with 2x8s and switch to 16-inch trusses for instance, you'll have to either lower your ceilings or add an extra tread and riser to any stairways. And if you make the stairway longer, you'll have to do the same to the stairwell, for headroom. Include the extra space in the floor plan.

Also, be aware that most floor trusses are designed to support typical residential live loads; the standard truss won't carry structural dead loads at midspan, which are part of many conventional framing systems.

In general, structural loads should land on the exterior walls, not on the truss. Potential problems include attic kneewalls that help support a set of rafters, or a load-bearing partition that supports ceiling joists. While these loads are unlikely to break a truss, they could make it deflect enough to crack the interior wall finish. Fabricators *can* engineer a truss that will carry structural loads, but they'll charge more for it than for a standard truss. They may also ask you to hire your own structural engineer to approve the design or to do the load calculations.

Ordering Trusses

The lead time for ordering floor trusses can run up to two weeks, but just to be sure, order them earlier than you think you have to (you'll probably need them before backfilling the foundation). You can order them through a lumberyard or directly from the fabricator. But regardless of where you place the order, choose your fabricator carefully. As with most things, the best reference is the fabricator's reputation among other builders in your area.

One key thing to look for is good technical support, especially if you've never used trusses before. The fabricator should have a technical representative available to meet on site with the contractor, architect, or engineer. A good tech rep will search for the most economical way to truss a building. For most residential jobs, the next step is for the fabricator's design staff to review your plans and alert you to any possible problems. For complex designs, the fabricator may want you to hire your own engineer.

For complicated orders you can also have the fabricator send you a set of shop drawings for approval before the trusses are made. Although one fabricator estimates that this happens in less than a quarter of all residential work, it's a worthwhile step if you want to make sure that the trusses are the right length or that hvac runs and special structural elements like bearing blocks (the extra vertical web members needed over support points) are in their proper places.

As soon as you receive a shipment of trusses, inspect them for handling damage. Look for tight joints that are fully covered by connector plates, and make sure that the plates themselves are centered over the joint and firmly embedded in the wood. (By the way, never try to refasten a loose plate: You can't restore the bond once it's been broken).

Reject any trusses with excessive splits, with loose knots next to the metal plates, or with loose or deformed plates. Also reject any that show evidence of having been damaged and repaired. And beware of warped or wet lumber, which can cause dangerous stresses as it shrinks and dries.

Working With Trusses

The most typical comment from builders who have used trusses is how simple they are to install. One reason is that they're usually spaced 24 inches on-center, instead of 16 inches, meaning fewer to install. Another reason is that trusses don't have to be cut or measured; they fit

Figure 2. *The job foreman on this multi-family building estimated that the floor framing took half as long with trusses as it would have with standard dimensional lumber.*

Figure 3. *Floor trusses are usually lifted into place by hand (left), though fork lifts and cranes can speed the process (right).*

Setting Floor Trusses: Three Men and a Crane

by Richard Dempster

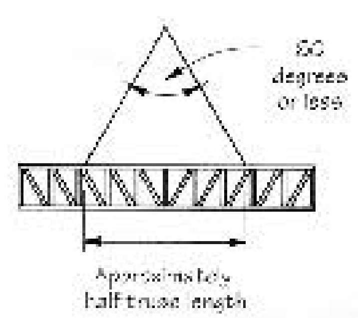
I've set second-floor trusses both by hand and with a crane, and I'm convinced that the crane is the only way to go. On the last job where I put them up by hand, we installed about twenty 2x4 wood-web trusses. They were 28 feet long and 22 inches deep, and weighed about 150 pounds each. Someone had to stand underneath one end and hand it up to the carpenter on the wall. This is stressful work, and if the person on the top plate pulls too hard, the truss can slip off the opposite plate — possibly while someone is standing beneath it. If I had followed my instinct and had a crane do the lifting, a job that took three men most of a day would have taken only an hour. Plus I wouldn't have had an aching back for the next three days.

By comparison, while building a 5,000-square-foot custom home a few years ago, it took three of us two hours to set 45 second-floor trusses — with the help of a crane. These were all bottom-chord bearing 2x4 trusses, 22 inches deep, and ranging in length from 24 to 32 feet. The job site had a large flat area with nothing in the way of positioning the crane or swinging the trusses once they were picked up. We placed them about 40 feet from the house, so the crane would have a clear swing.

We put one man, Bill, by the trusses, and John and me at the front and rear walls of the house. Bill separated out three trusses at a time, and slipped cable loops around them at two points (see illustration.) He then signaled the operator to take up the slack and lift the bundle enough to see if it was in balance. If it rode level, the operator hoisted it up above the wall and swung it into place, taking care to keep the bundle from rotating.

John and I paid close attention while the bundle came down to the plate, catching the ends and steering them to the middle layout mark, making sure we had good bearing at each end. One of us would then release the loop and send it back. While Bill was getting the next bundle ready, John and I moved the trusses to their layout marks, flushed them up to the outside of the walls, and nailed them off. It was easy to set three trusses in about five minutes, just in time to receive the next bundle. Before the crane operator left, we braced across the top chords and had him lift the 3/4-inch plywood for the subfloor in two stacks. What could have been an hour of heavy, miserable work dissolved into ten minutes of focus and handwaving.

Two-Point Lift



Use a two-point lift for trusses up to 30 feet long. One-point lifting can damage the truss.

COURTESY OF TRUSSPLATE INST.

Next, we plumbed, squared, and braced the first truss in the layout. We then attached the band brace, which we had marked with the same layout as the top plate. We aligned the ends of the trusses with the layout on the brace and nailed them off. Before the day was out we had finished laying the double plywood subfloor.

Like everything else in building, using a crane requires good planning. Give careful thought to how and where you'll store your materials before the crane gets there. Some sites, especially in remodeling, may present difficult or insurmountable obstacles, like utility wires, trees, or other buildings, and will have to be handled in some other fashion (one option is a fork lift). Make sure the crane operator, his safety engineer, or an independent safety engineer looks at a difficult site beforehand — it'll save you a lot of time, money, and anxiety.

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together like a puzzle. In most cases, they're simply hauled up to the plates and toenailed down.

The four-unit condominium pictured in Figure 2, page 20, is a good example. The building was framed with lightweight metal web trusses 20 feet long and 13 inches deep. The 15 or so trusses for each unit were hand-lifted to the plates, rolled into place, and fastened in about an hour. The job foreman estimated that the floor would have taken twice as long to frame with standard joists. This job was typical. It's rare to see trusses craned into place on a residential job (though a long, wood-web girder truss can be quite heavy). With a little sweat, most can be set by hand (see Figure 3, page 20). If you're lucky enough to have a crane however, be sure not to lift the truss sideways: The excess bouncing and flexing can loosen the connector plates, setting up an eventual failure. (For more on using a crane to lift floor trusses, see "Setting Floor Trusses," previous page).

Watch for tags. Most trusses come with tags or labels that tell the builder how to install them. For instance, every truss should have a tag that shows which way is up (see Figure 4). *Never* ignore it. Each web member is designed to be in compression or tension, but not both. Installing a truss upside down defeats the design and will lead to failure.

When necessary, trusses should also include labels that say where to fasten lateral braces or that alert the builder to any special structural conditions. These include the locations of concentrated loads, cantilevers, and interior bearing points. One example is a bottom-chord bearing truss that crosses a girder or bearing wall and that's designed to function as two simple beams. A note attached to the truss will tell the builder to cut the top chord after installation (see Figure 5). If this cut isn't made, then a load applied to one end of the truss will cause uplift on the other, making the truss act like a seesaw.

Stairwells. Stairwells are usually headed off with solid lumber or with laminated-veneer or parallel-strand headers. Figure 6 shows three methods of doing this. One way is simply to place a column below either end of the header. If columns are unacceptable, an alternative is to flank the opening with a pair of doubled girder trusses. If the length of the stairway must remain flexible, then the space between the girder trusses can be filled in with a 2x6 or 2x8 "ladder frame." If you know the size of your stairwell opening, however, a better method is to order girder trusses with built-in beam pockets to catch the ends of the header.

Firestopping and draftstopping. Firestopping slows the spread of fire by preventing a structure from acting as a duct system for smoke,

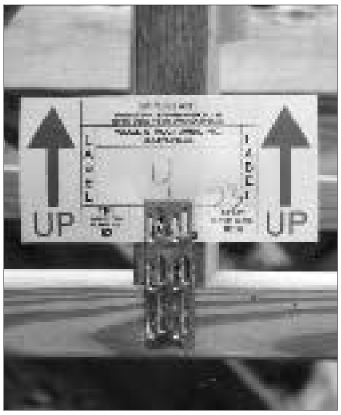


Figure 4. *In order to work properly, a floor truss must be installed right-side-up, as labeled. An upside-down truss is a recipe for failure.*

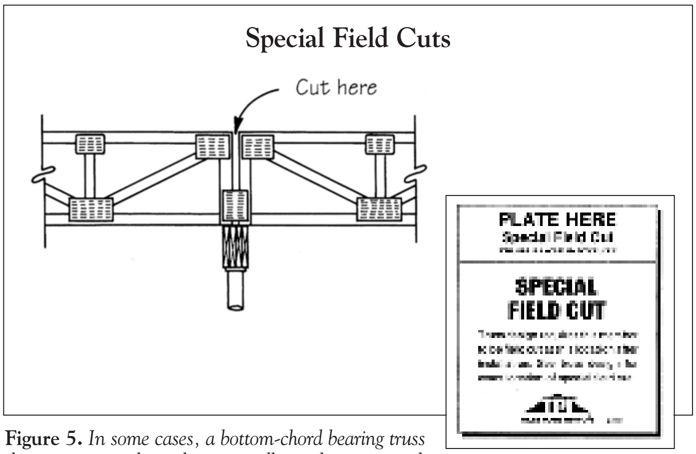
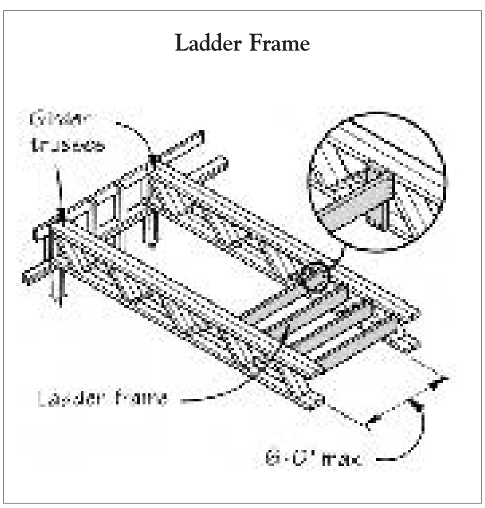


Figure 5. *In some cases, a bottom-chord bearing truss that crosses a girder or bearing wall may be engineered as two simple beams. The tag will instruct the builder to cut through the top chord after installation so that the truss does not see-saw across the girder (inset).*

Stairwell Details

C



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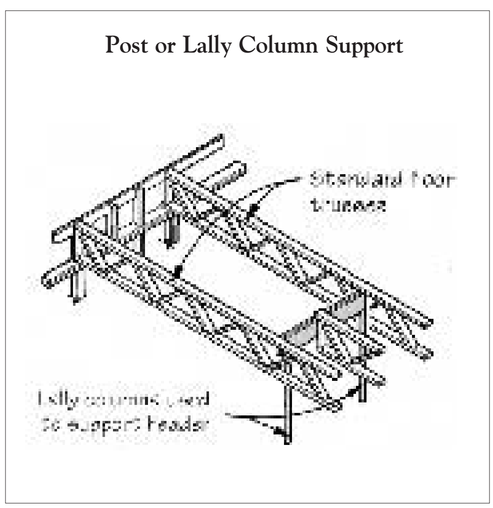

Figure 6. *In engineered floor truss systems, stairwells are usually flanked by girder trusses designed to support solid or engineered lumber headers. The header slips into a beam pocket (A) in the girder truss, and is shimmed tight to the underside of the girder's top chord. The header, in turn, carries the top chords of several floor trusses (B). Combining top-chord bearing trusses with a girder that bears on its bottom chord keeps the framing flush.*

Where design flexibility is needed, you can ladder-frame the floor area between the two girder trusses, which allows you to adjust the width or length of the stair opening (C). Or you can forego girder trusses altogether and support the staircase header with lally columns (D).

Firestopping

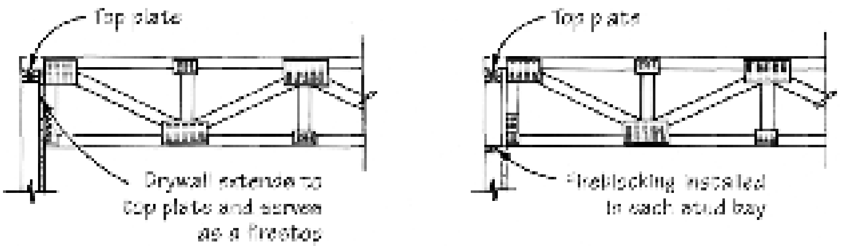

Figure 7. *Many codes require firestopping at the intersection of enclosed vertical and horizontal cavities. With bottom-chord bearing trusses, this means extending the drywall past the truss to the top plate (left) or installing a 2x4 firestop inside each stud bay just below the truss's bottom chord (right).*

Bracing Bottom-Chord Bearing Trusses

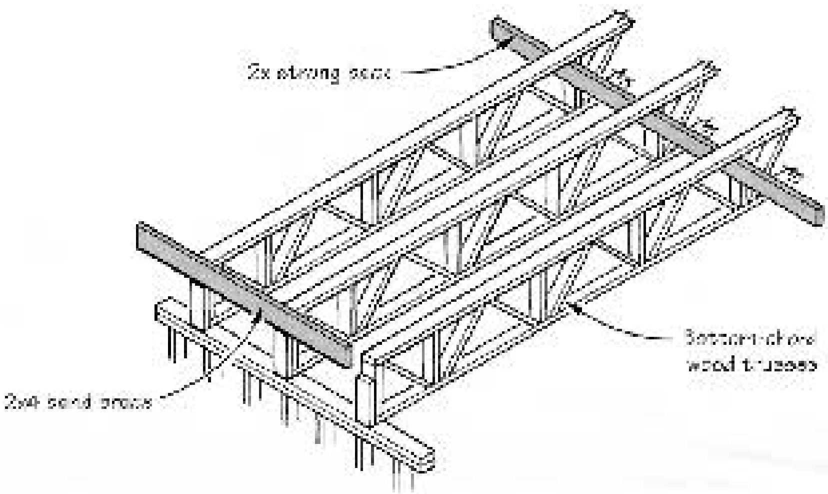

Figure 8. *The ends of bottom chord bearing trusses are tied together with a 2x4 band brace. Horizontal strongbacks at 10-foot intervals distribute loads and prevent twisting, which can loosen truss plates.*

flame, and hot gases. On platform-framed buildings, the top and bottom wall plates double as fire stops. But a top-chord bearing truss short-circuits the top plate. Common solutions are to extend the drywall past the truss to the top plate or to insert a separate 2x4 firestop inside each stud bay just below the truss's bottom chord (see Figure 7). Check with your local code official for firestopping requirements in your area, as they vary from place to place.

Draftstopping slows down the spread of fire through a large concealed open space like a truss-framed floor by dividing it into two or more smaller spaces. The BOCA National Building Code limits horizontal areas to 1,000 square feet; anything larger must be partitioned off. The code requires the use of $1/2$-inch thick drywall or $3/8$-inch thick plywood for draftstopping. The Uniform Building Code has the same requirements and also requires that any draftstopping divide the space in question into approximately equal halves. Installing draftstopping is just a matter of fastening the drywall or plywood to one side of a truss, although pipes and ducts in the floor cavity will slow the process.

Bracing and spacing. A bracing system must keep a set of trusses from bending, twisting, or otherwise deforming. On bottom-chord bearing trusses, the ends are tied together with a 2x4 band brace that doubles as a nailing base for the perimeter of the plywood deck (see Figure 8). Underneath, a horizontal strongback — a 2x6 or 2x8 laid on edge — should run continuously through all the truss webs at 10-foot intervals. The strongback also serves the same purpose as bridging in a standard floor, distributing concentrated loads over a wider area.

The 24-inch spacing of most floor trusses can also lead to problems in the finished floor if you don't compensate for it. When placed over that span, a $3/4$-inch-thick plywood subfloor can deflect enough to cause waves in vinyl flooring and cracks in ceramic tile. Some builders tackle the problem by installing two layers of subflooring or using $1^5/_8$-inch-thick Sturdi-Floor panels (be sure to use a nailing pattern that's designed for 24-inch on-center framing). You'll also be better off with flexible grouts and smaller tiles, whose joints more readily absorb slight deflections.

Finally, you may have to approach the insulation a bit differently when using trusses. It can be tough to properly insulate the $3^1/_2$-inch-thick open webs with fiberglass batts. If you need a tight insulation job, consider using a blown-in product. ■

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For More Information

A 100-page technical manual, *Handling, Installing & Bracing Metal Plate Connected Wood Trusses* (Publication No. HIB-91), is available from the Truss Plate Institute, 583 D'Onofrio Dr., Suite 200, Madison, WI 53719; 608/833-5900 ($7 postpaid). Although the book focuses on roof trusses, it also includes some useful information about floor truss systems.