# Metal Connectors for Wood Framing

## Galvanized steel folded into sturdy, time-saving devices

by Bruce R. Berg

A swallowtail scarf joint is an elegant way to make a tension tie between adjoining beams, and a housed dovetail will anchor a floor joist to a girder for the life of a structure. But not many construction budgets have an allowance for the extensive and meticulous cutting and fitting that it takes to achieve these time-honored joints. These days, most structural connections in wood-frame buildings are made with steel connectors because they are affordable and easy to install. Also, their structural values have been carefully tested and documented. Consequently, steel connectors are widely accepted by codes and building officials.

The companies that make metal connectors (see the sidebar on p. 49 for sources of supply) offer their products in a remarkable number of configurations. Their catalogs include not only illustrations of the connectors, but also tables that list specifications such as the dimensions of the lumber and the appropriate connectors, their design loads, and the number and size of nails it takes to achieve that rating.

Joist hangers are probably the most common type of metal connector on a construction site, but if you need them you can get connectors to anchor a scissors truss to a bearing wall, adjustable post bases or metal clips that allow you to install outdoor decking without visible nails. This article takes a look at the principal types of steel connectors. Within these categories there are many variations that you can use to solve specific construction problems.

**Concrete-to-wood connectors—**If you have ever struggled to lift a framed wall onto a protruding row of anchor bolts, you are familiar with a potential source of frustration. Despite everyone's best intentions, the holes in the sill plate sometimes don't line up with the bolts, and the plate has to be redrilled. Or a stud lands on an anchor bolt, requiring a nasty-looking notch in the bottom of the stud.

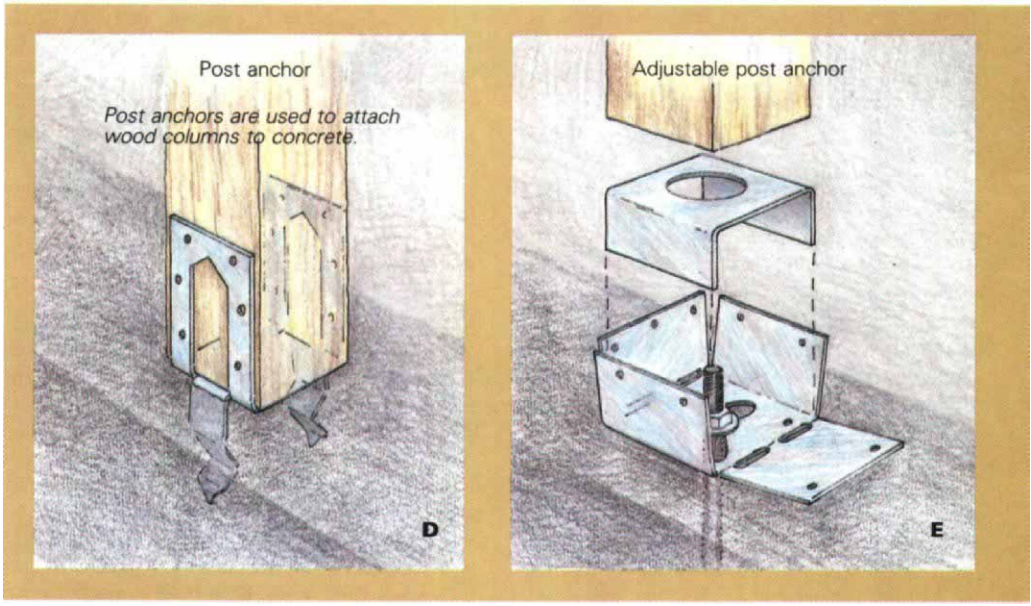
One alternative to anchor bolts that circumvents these problems is the MAS galvanized steel anchor from Simpson (drawing A, facing page). It resembles a Y with a ladle-like cup on the bottom leg that gets embedded in concrete. The branches of the Y are wrapped around the mudsill or up the side of a stud and secured with nails. Prior to the pour, these anchors can be positioned by tacking them to the formwork. And because they emerge from the concrete at the edge of the footing, you don't have to hand-trowel around a bunch of anchor bolts.

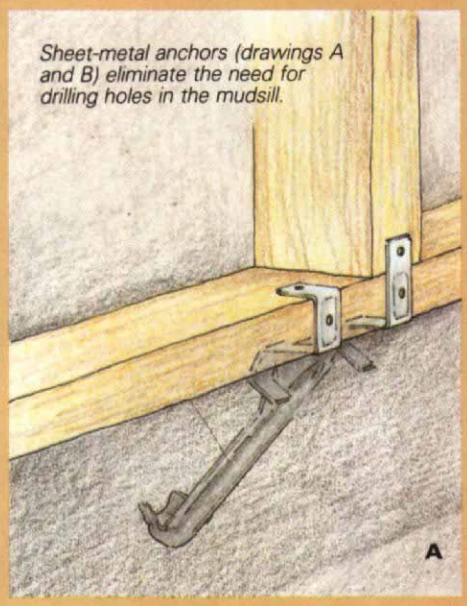
Another sheet-metal anchor from Simpson (called the MA) can be attached to the mudsill before you pour your foundations (drawing B). The anchor's pointy, arrowhead shape allows it to slip easily into the screeded wet concrete.

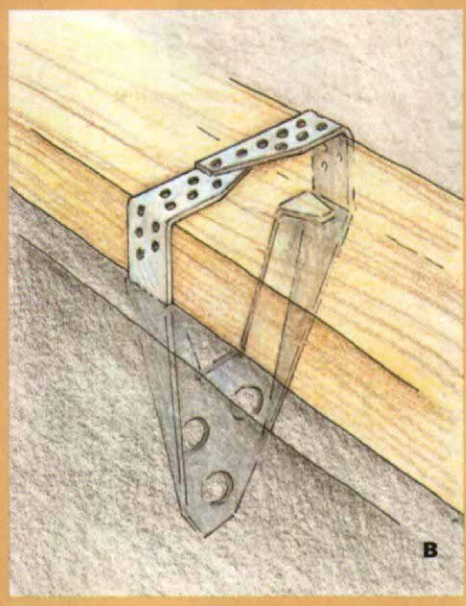
Seismic anchors (sometimes called hold-downs or tie-downs) are frequently specified by architects and engineers when part of a structure needs lateral bracing and there is only a narrow wall section in which to provide it. The narrow wall is stiffened with plywood for shear

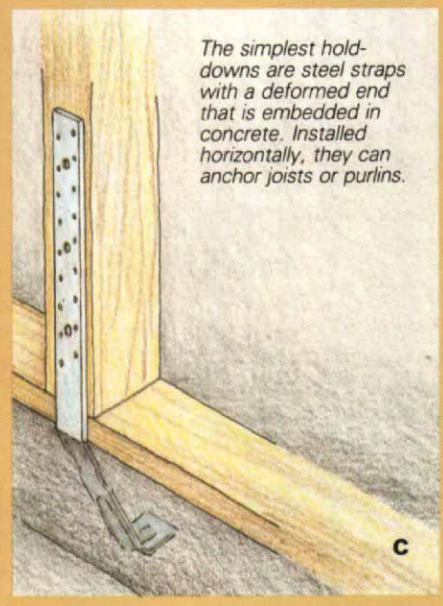
**Wood-to-concrete connections**

**Hold-downs are tension ties between the foundation and the framing. The distance of the bolts from the ends of the studs must be at least seven times the diameter of the bolt. Often engineers will specify greater distances.**






strength, but when a horizontal load is applied to the top of a stiff panel, it wants to lift away from one of its corners. A hold-down provides resistance to this uplift.

Hold-downs come in two basic varieties. The first is a deformed strap that is set into the wet concrete at the location of a post or stud (drawing C). It is then nailed or bolted to the post, sometimes with as many as 24 nails.

The other variety uses a foundation bolt that rises through the plate and through the bottom of a gussetted, welded heavy angle to which it is fastened (photo facing page). The angle is then bolted to the stud or post at the perimeter of the plywood panel. Because of the seismic activity here on the West Coast, builders frequently use pairs of these hold-downs linked by a threaded rod to create a tension tie between two floors.

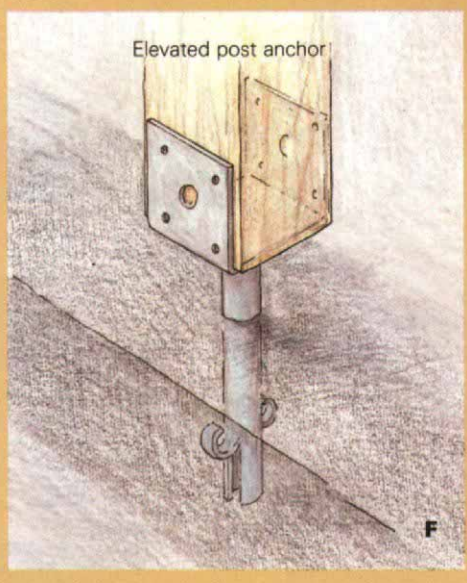
Very similar to the deformed-strap hold-down are purlin and joist anchors. They are embedded horizontally into the concrete or masonry wall, aligned with the top of each framing level. When nailed off to the joists or purlins, they allow the horizontal diaphragm to work together with the wall structure, and prevent the walls from leaning outward.

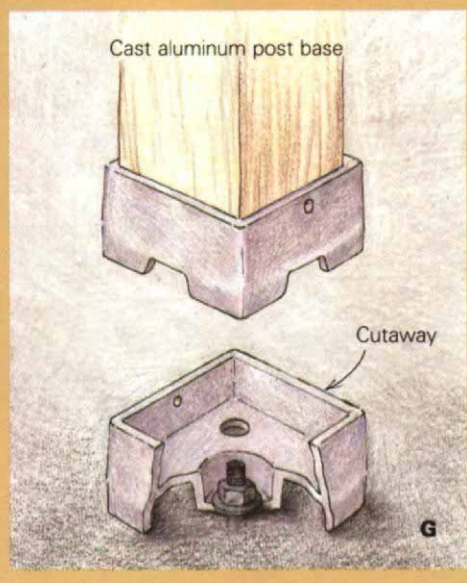
A peek under many backyard decks will reveal row upon row of concrete pier blocks supporting a forest of 4x4 posts. To distribute their loads evenly, the blocks are typically set into a bed of wet concrete. A chunk of pressure-treated pine or redwood is attached to the top of the block for toenailed connections. Pier blocks are easy to work with, but they have their limitations. The wood blocks sometimes detach from the concrete, and they are so small that they often split when you drive nails into them. Also, they provide little resistance to lateral or uplift loads, and can't be replaced if required. A far better way to anchor posts, such as those used to support decks, is the post or column base.

Post anchors are made in several configurations—each for a particular application. One kind is designed to be placed into wet concrete (drawing D, facing page), and its positioning must be precise. Another type uses an anchor bolt to secure it to concrete, and it has a slotted adjustment plate (drawing E) that allows you to tinker with its alignment in the event of a slightly misplaced bolt. You can also use this type of post base on a cured concrete slab or footing by tying it down with an expansion bolt, concrete nails or powder-actuated fasteners.

Some post anchors have a standoff plate that elevates the post about 1 in. above the concrete, which prolongs the life of the post in moist areas. Under really wet conditions, you can use an elevated post anchor (drawing F) to get the wood several inches above the concrete.

Cleveland Steel makes a dressy post base out of cast aluminum that lends a sturdy appearance to a column, and elevates the wood above the concrete (drawing G). The base is secured with




**Heavy-duty post bases are excellent foundations for fences. The steel pad under the post is raised slightly above the concrete to keep the post dry. Grout between the steel pad and the concrete ensures good bearing.**

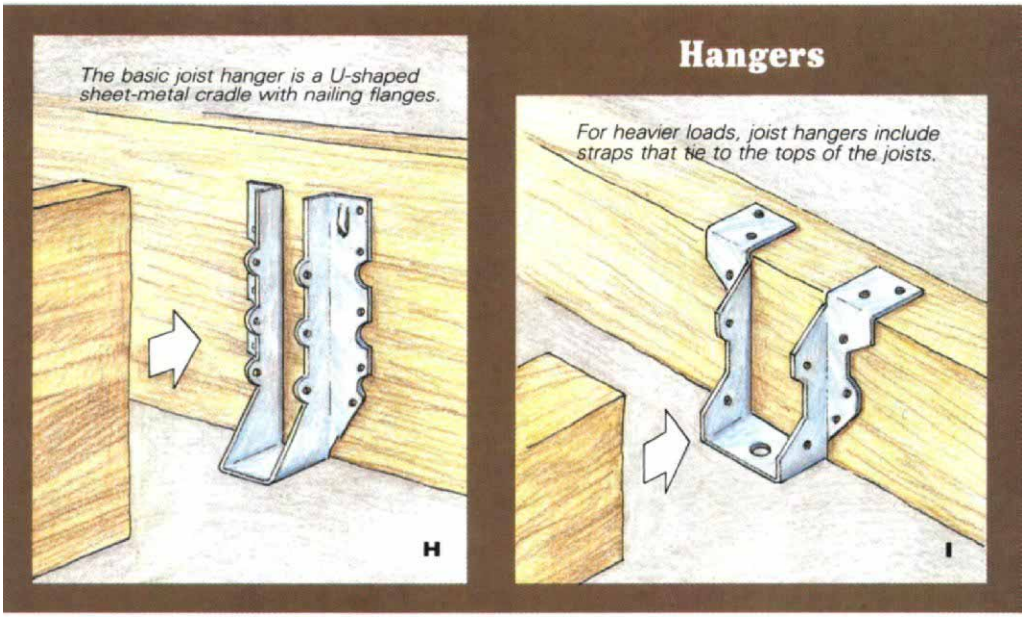
Drawings: Christopher Clapp

a single anchor bolt, and weep holes allow an escape route for rainwater.

Since most post bases allow little room for adjustment once they've been installed, you've got to be scrupulously accurate as you embed them in the wet concrete. Use a string line or a transit to align rows of post bases as they are set in the concrete. Lumber-crayon marks on the formwork can ensure the accuracy of your spacing in the other direction.

Sometimes builders use post bases to support beams, as on a low deck. In this situation you can first prepare the forms, then place the beam in its final position on top of falsework with the post bases attached to the beam. Pour your concrete, take out the falsework and your beam is ready to carry its load without the aid of a wooden column.

Post bases also come in heavy-duty versions. These are made of thicker steel than the standard bases, and have longer straps that extend up the sides of the post. One good application of the heavy-duty post base is to anchor fence posts (photo previous page). Excavate your post hole and use a short section of Sonotube to bring the level of the concrete about 6 in. above grade. As you fill the hole with concrete, insert a #4 rebar in the center of the hole before you embed the heavy-duty post base. Bolted to this kind of a base, your fence posts won't rot off at grade in ten to twenty years.




**Hangers**—The basic hanger is a galvanized strip of 14-ga. to 18-ga. steel folded into a U-shape (drawing H). Hangers are made in various sizes to accommodate typical framing lumber. At the bottom of the U, the metal widens to form a seat for the joist or purlin. Properly installed, the member rests snugly against the seat of the hanger. Flanges on the legs of the U turn outward, and nails driven through holes in the flanges secure the hanger to the beam; other holes allow fastening to the joist.

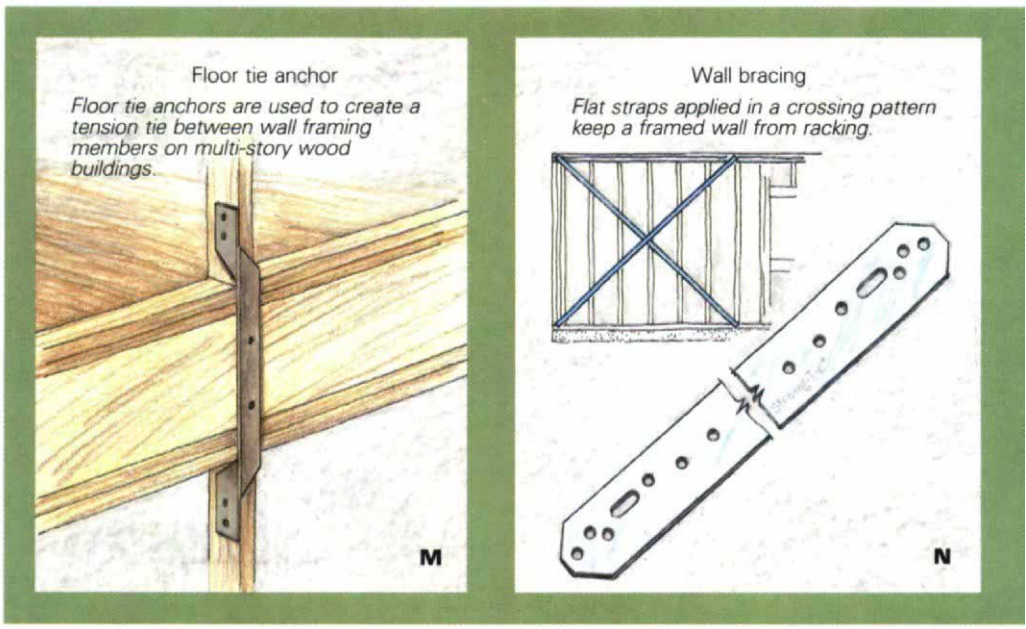
Representatives of the companies that make steel connectors say that the most common mistake made in installing their products is inadequate nailing. Because the shear strength of the nails is the limiting factor in the strength of the connection, it's critical that you install the connectors with the nails specified by the manufacturer. Commonly available wire nails in the correct diameter are often longer than the thickness of the framing member, so you have to use "joist-hanger nails," which are simply short versions of common nails. Also, nails that are used in outdoor locations or driven into treated wood should be galvanized.

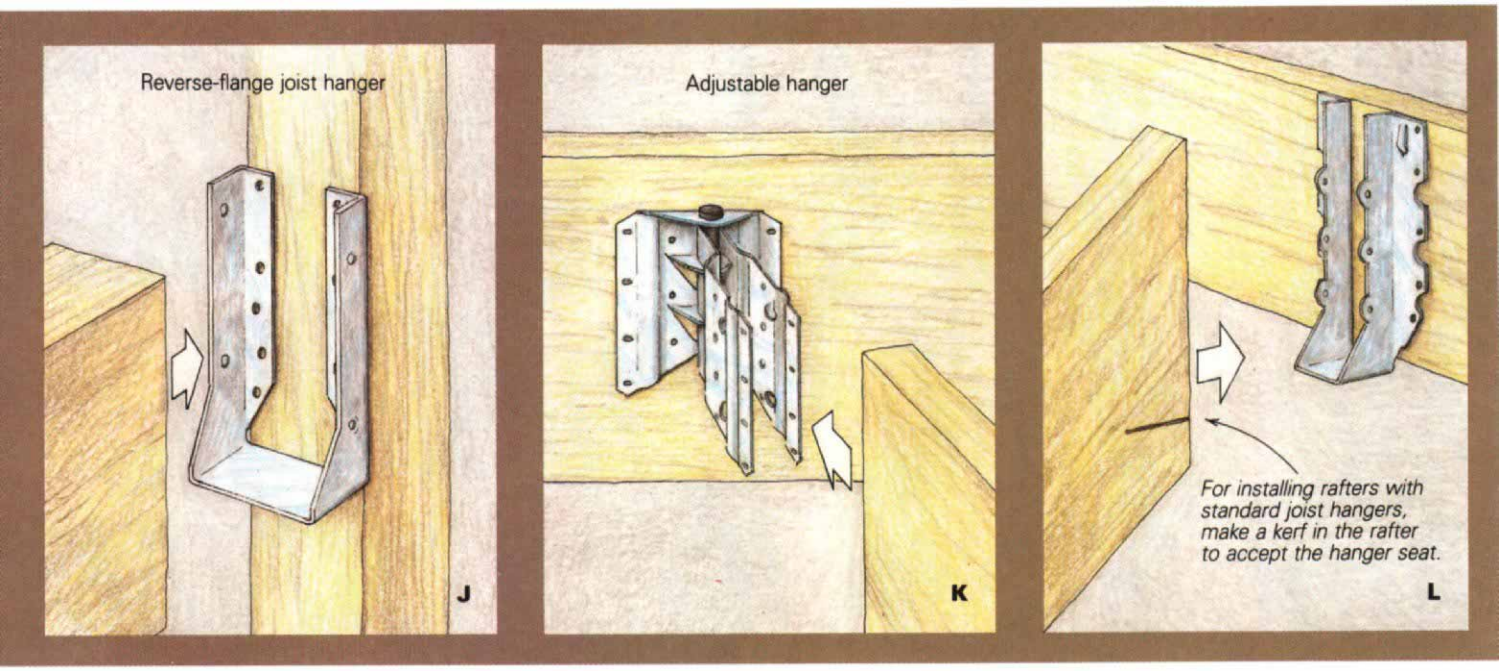
Another typical mistake is to cut the joists too short. The gap between the beam and the end of the joist should be no more than 3/16 in., and closer is better.

When you are installing joist hangers on a beam that is deeper than the joists, you have to snap a chalkline on the beam to align the bottoms of the hangers. Because joist material

## Straps and bracing

**Steel straps are useful tension ties throughout wood-frame buildings. Here a steel strap is used to resist the uplift load on a beam.**






sometimes varies slightly in depth, position your hangers to accommodate the deepest joists in the lumber pile. Then add shims to the hanger seats to bring the shallower joists flush with the top of the beam.

To hang joists that carry heavier than normal loads, use hangers with a top flange (drawing I). When you nail down the subfloor, don't worry about the thickness of the metal draped over the joists—a few hammer blows will compress the wood fibers enough to make the floor lie flat.

On most hangers the flanges turn outward, but you can also get them with reverse flanges (drawing J). Reverse-flange hangers can be useful in tight spots, such as a window retrofit when you have to add a header and there isn't room for trimmers to carry its load, or when two perpendicular beams meet at one post.

Not all hangers are designed to carry members perpendicular to a beam. Most companies make 45° hangers as standard items, and some manufacturers, such as Panel Clip and Cleveland Steel, are set up to make "specials" to fit unusual framing needs. They can make hangers that are sloped to carry rafters, skewed at angles other than 45°, or a combination of the two. Simpson makes a hinged hanger that will skew to 60° and slope up to 30° (drawing K).

Another way to handle a rafter with a conventional hanger is to cut a kerf in the end of the rafter that is the same depth as the hanger seat and perpendicular to the plumb cut (drawing L). The hanger seat tucks into the kerf.

**Straps and bracing**—Sometimes called tension ties, steel straps are applied to wood-frame construction in numerous ways. For example, if the plumber cuts through the top plate in a wall, a steel strap can restore the structural integrity of the plate without adding much bulk to the framing. Other common uses of the steel strap are to tie opposing rafters together across a ridge, and to resist the uplift of a cantilevered beam (photo facing page).

One of the simplest yet most useful connectors I have used is the twist strap. A typical one is made of 16-ga., 1¼-in. wide galvanized steel bent so that the faces of the two ends are 90° to each other. They are often used in pairs on framing members that cross one another to prevent the wood from twisting. I've also used them as hangers to suspend old ceiling joists from new beams during remodel work.

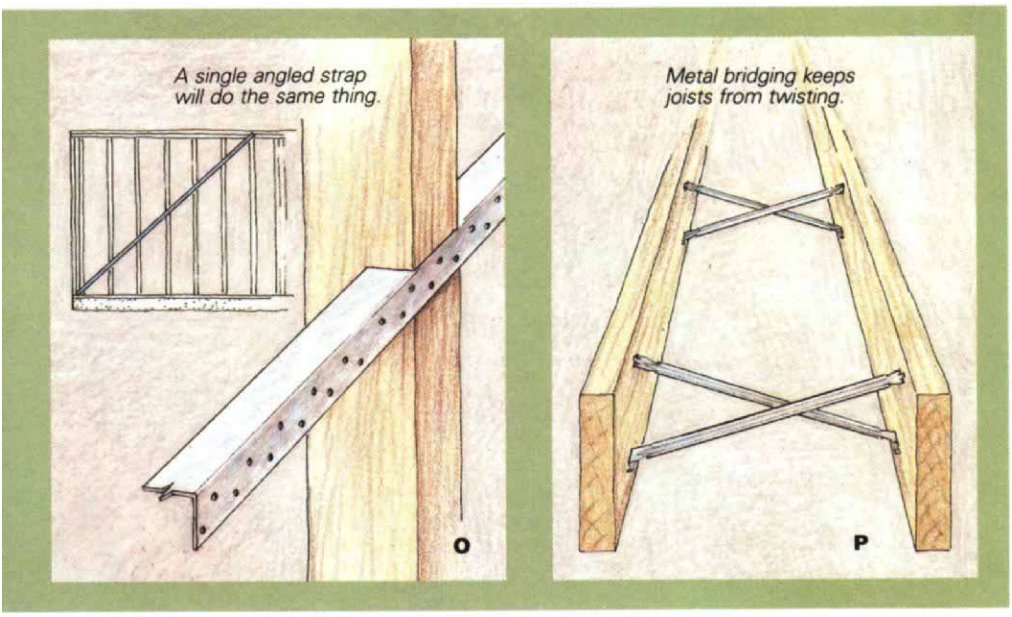
Another version of the twist strap is the floor tie anchor (drawing M). A 90° degree twist at each end of this strap allows it to be attached to the framing on multi-story buildings to make a tension tie between floors. It does the same thing as a pair of hold-downs, for less money.

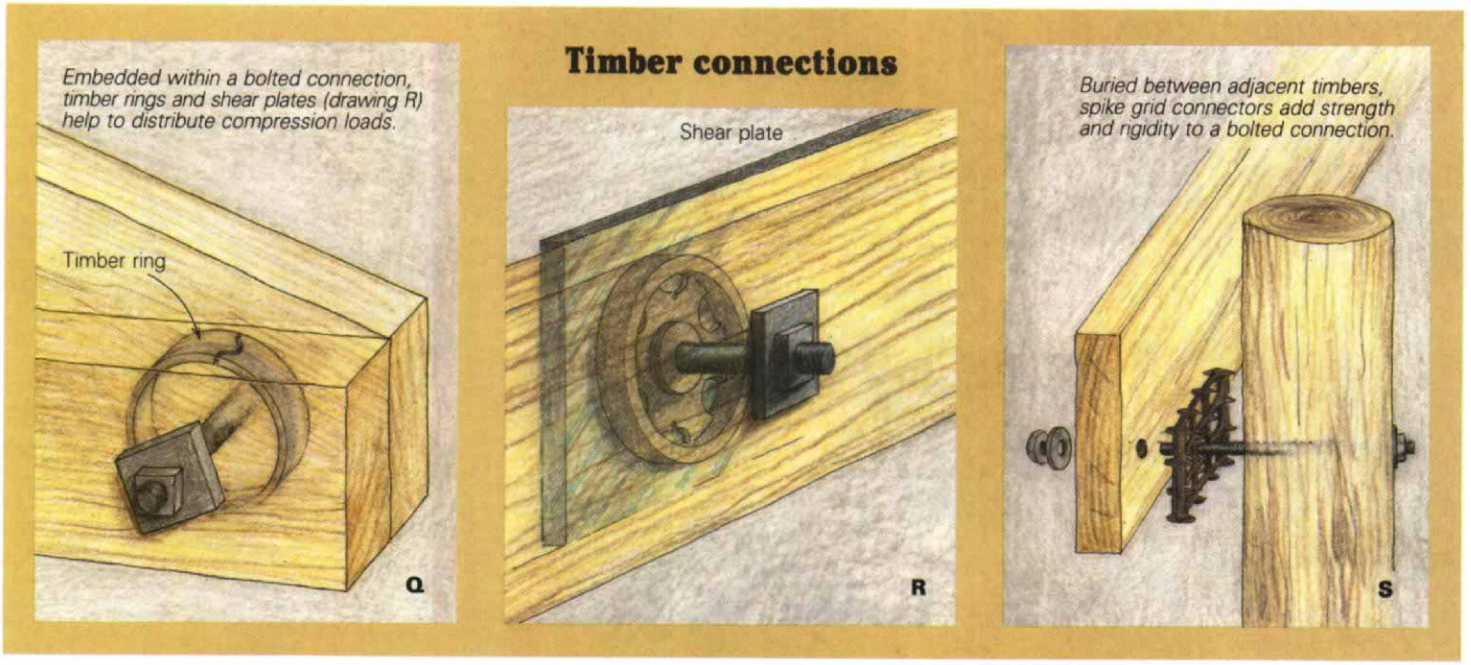
Metal wall bracing (drawing N) is another form of strap tie that can speed things up on a job site. While not nearly as strong as a well-nailed plywood diaphragm, it is at least as strong as 1x4 let-in bracing, and you don't have to cut notches to install it. To prevent racking, the flat variety needs to be applied in pairs to form an X or a V.

Whenever I'm remodeling older homes that have diagonal blocking, I enhance the shear strength of the wall by adding a flat wall brace to the line of blocks. I nail it securely to each block and each stud. If I'm working on an interior wall, I use a power plane to cut a shallow groove for the brace across the studs so it won't telegraph through the finished wall.

Another type of steel wall bracing comes in a T or L section (drawing O). It is let into a kerf cut across the studs in a straight line, providing the framed wall with both compression and tension bracing in a single strip.

Metal bridging (drawing P) is so much faster to install than wood bridging that it is an ideal example of how steel connectors have added to the efficiency of wood-frame construction. Prongs on the ends of the bridging eliminate the need for nails. You drive one end into a joist about 1 in. from its top edge, then the other end






into the adjacent joist 1 in. from its bottom edge. Because they require no nails, they don't develop nail squeaks. But don't let the pairs of bridging touch one another or they will make noise. Keep them 1 in. apart, and remember that on spans over 16 ft., you need to use two sets of bridging to conform to most building codes.

**Timber connections**—Timbers are typically bolted together, and because they are usually supporting substantial loads, a lot of pressure is concentrated on the bolted connections. Timber rings, also called split rings, and shear plates are two metal connectors that are used in concert with bolts to spread out compression loads and shear forces, reducing the potential for crushed wood fibers around the bolts.

Timber rings (drawing Q) are steel rings that ride in matching grooves cut into adjacent timbers. A grooving tool that resembles a hole saw is used to cut the grooves for the rings, and at the same time it bores a hole for the bolt that runs through the center of the rings. When installed, the rings are hidden from view, captured by the pair of timbers.

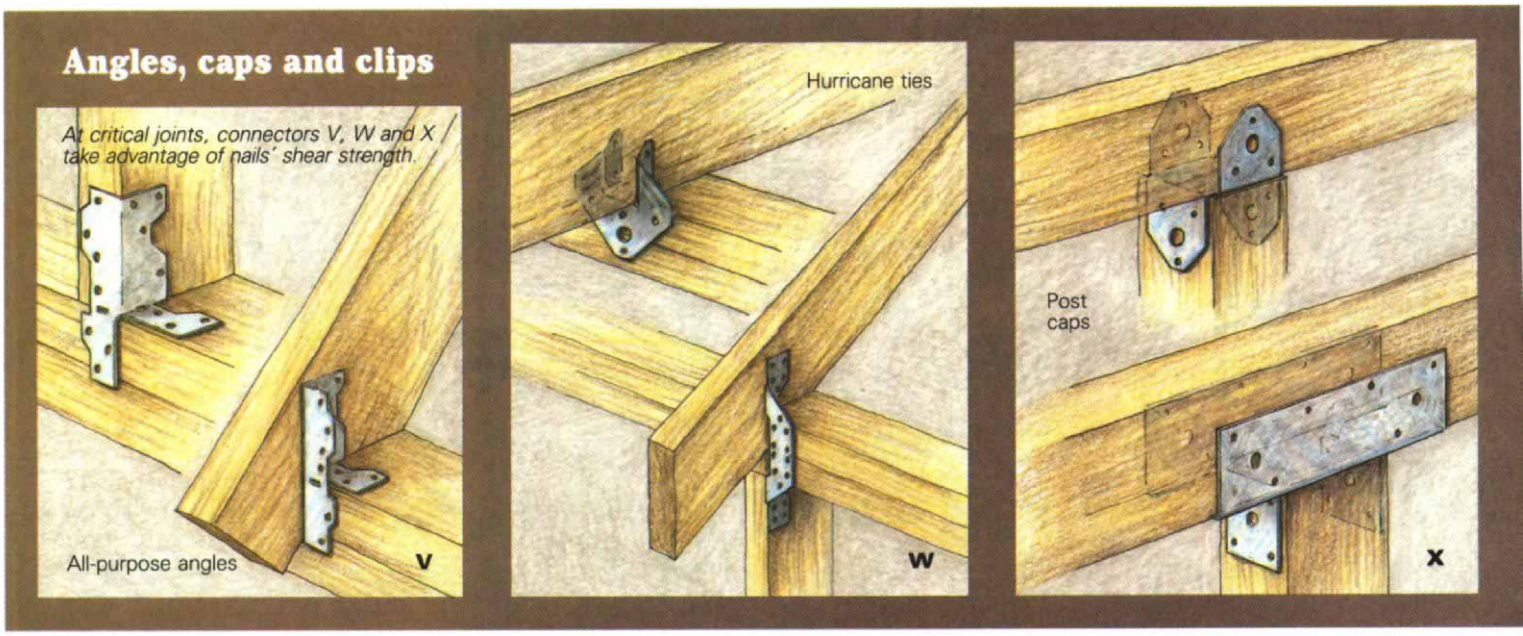
Shear plates (drawing R) are similar to timber rings, but they are used to make metal-to-timber and concrete-to-timber connections. Both Cleveland Steel and TECO are suppliers of timber rings, shear plates and the grooving tools necessary to install them.

TECO also makes spike grid connectors, which are used to add strength and rigidity to the joints between heavy timbers. Resembling medieval instruments of torture (drawing S), the grids consist of rows of spikes protruding from a malleable iron matrix. They fit between two timbers at a bolted connection, and a threaded compression tool is used to apply enough pressure to the timbers to embed the spikes. For securing a pole to a timber, TECO makes a spike grid that is curved on one side and flat on the other.

**Truss clips**—If you install nonbearing partitions in a building with trusses overhead, you must not create a rigid connection between the truss and the top plate of the wall. The bottom chord of a truss moves up and down as the loads on it change, and if you don't take its vertical movement into account, the truss can become overloaded.

Steel angles called truss clips can be used to attach a partition wall to a truss while still allowing the truss to move (drawing T, facing page). A slot in the vertical leg of the angle accepts a nail into the lower chord of the truss, anchoring the top of the partition while allowing the chord to move up and down.

Cleveland Steel makes a connector plate, shown in drawing U, that uses the same slot principle to anchor a scissors truss to a wall plate. In this application, the truss wants to move in a horizontal direction, and the slots allow a full inch of movement.



**Angles, caps and clips**—All the companies that manufacture steel connectors make multi-purpose devices that are known as angles, angle clips or reinforcing angles. Their function is to connect butt-joined framing members without toenailing. The more elaborate versions are partially slotted at the fold and have bend lines that allow them to fit a variety of intersections (drawing V, facing page).

Hurricane ties and seismic anchors are another way to avoid toenailing at critical connections. They are folded to wrap around rafters and top plates (drawing W), where they are secured with nails that are working in shear.

Post caps too are designed to get the nails or bolts to work in shear where a post and its beam come together (drawing X). Most are made of 16-ga. galvanized steel, but heavy-duty versions made of 3-ga. painted steel are a standard item from Simpson. Post caps resemble post bases, and in fact some are made to accept a piece of rebar so they can be partially embedded in concrete to become post bases.

By using plywood clips (drawing Y) you can avoid having to use blocking under all the edges of the plywood. The clips will keep the edges of the plywood from seriously deflecting under heavy loads. I use two plywood clips for 16-in. rafter spacing and three for 24-in. rafter spacing. But I don't use them for hot-mopped roofs, because the potential for a little deflection is still there. Instead I'll block under all edges or I'll use T&G plywood.

A slick clip that lets you build a deck without exposed fasteners is made by Philips Manufacturing. It is a galvanized steel angle with prongs on one side that grab the decking on its edge (drawing Z), eliminating rusty nailheads and indented moons from misplaced hammer blows. And since a portion of the clip is sandwiched between adjacent pieces of decking, the clip also acts as a spacer to ensure good drainage.

**Specials**—Sometimes no commercially available connector can solve a given problem. If I can find something close to what I need in one of my catalogs, I give the manufacturer a call and ask about modifications. Frequently the company is more than willing to customize a connector for me, and the price has not seemed out of line. (Of course, be sure to ask what the delivery time will be.) To ensure accurate results, supply your fabricator with a full-scale drawing of the special connector that specifies the material to be used, all dimensions, angles and nail or bolt placement.

If you need a truly unusual steel connector, I recommend going to a local sheet-metal or welding shop. A good drawing of the connector is essential, If you are unsure about the loads that the custom connector may have to carry or resist, see if the welding shop can figure them out. Failing that, seek out an architect or an engineer for assistance. □

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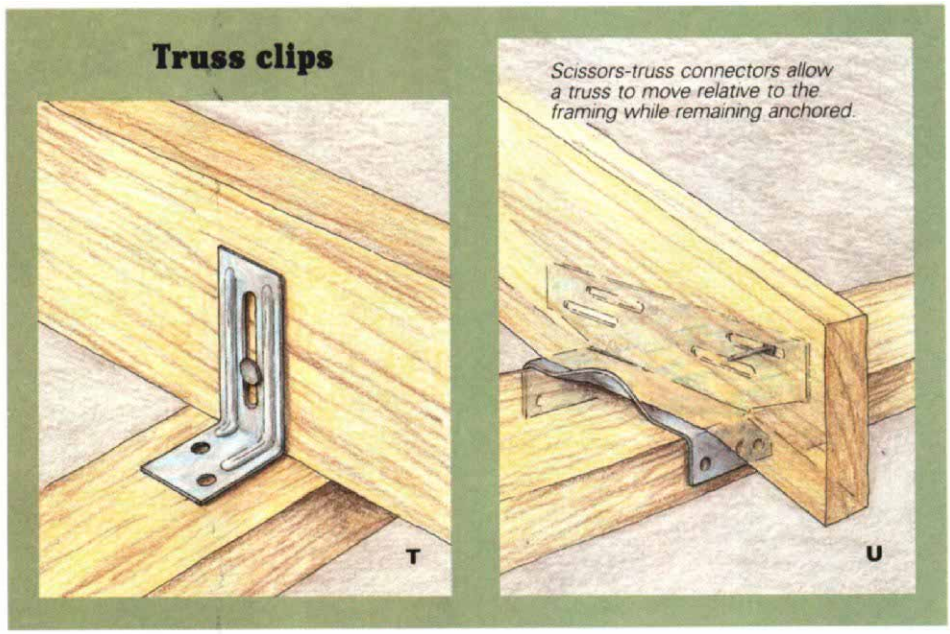


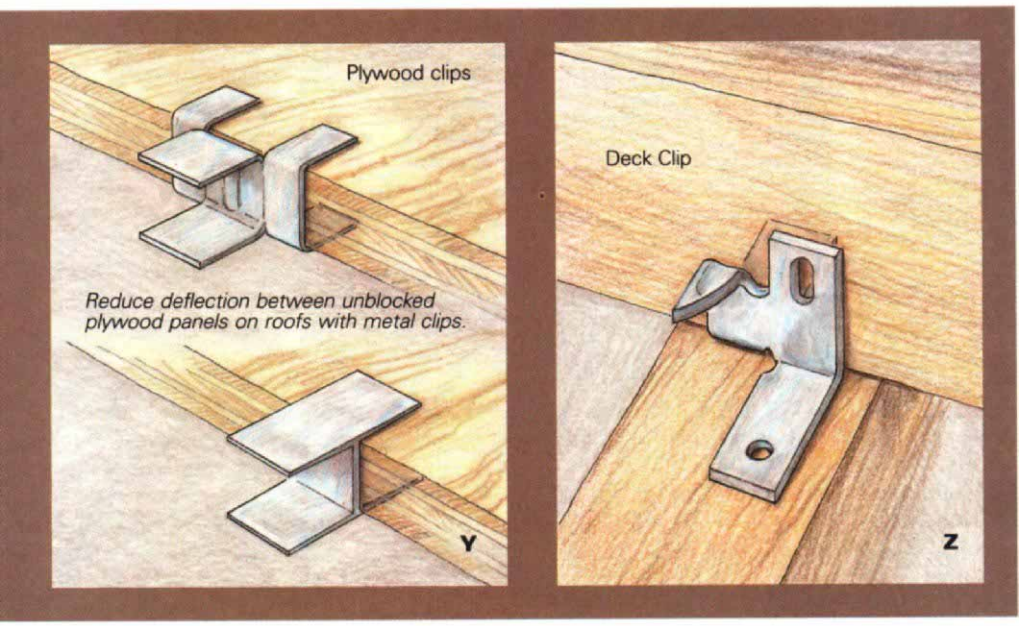


## *Sources of supply*

***Cleveland Steel Specialty Co.***
**14400 South Industrial Ave.**
**Cleveland, Ohio 44137**
**(800) 251-8351**

***Dec-Klip***
**Philips Manufacturing**
**460 2nd St.**
**Lebanon, Ore. 97355**
**(800) 544-0124**

***Harlen Metal Products***
**300 West Carob St.**
**Compton, Calif. 90220**
**(213) 774-8383**

***Heckmann Building Products Inc.***
**4015 W. Carroll Ave.**
**Chicago, Ill. 60624-1899**
**(800) 621-4140**

***Panel Clip***
**4203 Shoreline Drive**
**Earth City, Mo. 63045**
**(800) 521-9335**

***Silver Metal Products Inc.***
**2150 Kitty Hawk Rd.**
**Livermore, Calif. 94550-9611**
**(415) 449-4100**

***Simpson***
**1450 Doolittle Dr.**
**P.O. Box 1568**
**San Leandro, Calif. 94577**
**(415) 562-7775**

***TECO***
**5530 Wisconsin Ave.**
**Chevy Chase, Md. 20815**
**(800) 638-8989**