Wall Bracing

Wood, metal and plywood can all be used to keep walls from racking

by Larry Haun

I was born and raised in rural Nebraska, where the one constant is the wind. Many of the farm buildings I remember from my childhood leaned to one side. I was fascinated by these buildings. I used to think that was the way people built them. It took a while to figure out that those buildings leaned because the wind was always pushing on their poorly braced walls.

The first house I helped build was in 1947, back in the handsaw days. For wall bracing we mitered the ends of 2x4 blocks, then we nailed the blocks between studs along a diagonal line—good braces to prevent racking but time-consuming to build.

I now live and work on the West Coast, where houses must be built to withstand not only the wind but also earthquakes. I've braced many a wall, and here I'll talk about the best ways I've found to keep walls plumb and true through gusts and tremors.

Let-in bracing—Once platform framing became popular, carpenters learned to brace walls by mortising, or letting in, a diagonal 1x4 or 1x6 into the plates and the studs of a wall (photo below). Many building codes call for this type of bracing in almost every wall that has room for it. Braces are required at each end of a long wall, with an additional brace for every 25 ft. of wall space. The codes don't say how long the braces should be; they just say you must have them. Each brace must oppose the other—one slanting one way, the next slanting the opposite way—to guarantee that one member will always be in compression (the force that pushes together or crushes). Let-in wood bracing works best in compression.

I like to use let-in bracing even if the wall will later be sheathed with plywood (another form of bracing). It takes me only two or three minutes to install a brace, and let-in bracing holds the building plumb until the sheathing goes on. Other carpenters sheathe their walls before raising them or hold walls plumb with temporary 2x4 braces after they're up. But sheathing the walls first means squaring them up perfectly on the deck—a tedious job—and when temporary braces get in the way, workers tend to remove them: there go the plumbed and squared walls.

When shear forces go beyond the ordinary, a structural engineer can calculate how to brace a wall to keep it from racking and uplifting. Often, it's a matter of combining panels and seismic anchors (see sidebar on shear walls, p. 57). But where high winds or major earthquakes are uncommon, 1xs are adequate for bracing. For the inexperienced, installing 1x let-in bracing can be dangerous, so the procedure needs to be studied well and executed carefully to avoid injury.

Notching studs and plates—While the wall is still flat on the deck, and with both the bottom

Installing let-in bracing. **Walls are held plumb with let-in bracing: good-quality 1x6s mortised into the studs and the plates. The bottom of the brace is nailed to the bottom plate and the first stud only; the rest of the nailing will be done once the wall is raised and plumbed. Here the author nails the bottom of the brace while his brother notches studs for the next brace.**

and top plates nailed off, I get the wall relatively square by keeping the bottom plate parallel to its layout line and nailing the studs at right angles. It's not important that the wall be precisely square just yet. Then I pick out a good 12-ft. 1x6—#2 grade or better—and place it at about 45° on the wall studs from bottom to top plates. I don't run the brace end right into a corner; I keep it in a stud bay so that I won't hit a nail when I cut the notches.

When you install let-in bracing, keep in mind that the steeper the angle, the less effective the brace, so a 45° angle is better than a 60° angle, for example. On an 8-ft. wall, the 12-ft. 1x6 will cross over at least four studs (on 16-in. centers) and five stud bays.

I cut the end of the brace flush with the bottom plate. If I'm working on a concrete slab, I trim the bottom end of the 1x6 about ½ in. short to keep that succulent end grain away from termites. Next, I set my circular saw to a depth of about 1¾ in. I place one foot on the brace to keep it in position and hold the saw with both hands to avoid kickback. Now, with my saw riding on top of and parallel to the brace, I cut 1-in. deep kerfs in the studs and the plates (top photo, right). I cut on both sides of the brace, then cut the brace ½ in. short of the top of the double top plate. I cut the brace ½ in. short before raising the wall so that I won't have to trim the brace when the wall is plumbed. Cutting the brace short gives me a bit of play when plumbing a raised wall; otherwise, the brace may be long if the wall is not square.

Now the wood between the kerfs must be removed to accommodate the let-in brace. One way to remove the wood is to cut additional kerfs, closely spaced, to a depth of about 1 in. The wood can then be knocked away with a straight-claw hammer. But this method is slow and leaves an unclean notch.

The better way to make the notches requires care and experience to do it correctly and safely. It involves making a plunge cut into the sides of the studs between the two 1-in. deep kerfs. The object is to lower the blade into the stud or plate and cut out the piece between the kerfs so that the brace will fit. Just remember that the cut needs to be at least ¾ in. down from the edge of the stud. When you're making this cut, be sure to keep both hands on the saw. And when you're learning this technique, it's a good idea to brace your elbows against your knees so that you'll be able to stop the saw from kicking back.

Nailing the braces—Now I drop the 1x6 brace into the notches and nail three 8d nails through the brace into the bottom plate and two more 8ds into the first stud. That's it. I start two nails in the brace at each remaining stud and five more at the double top plate. These nails will be driven home when the walls are raised and plumbed (bottom photo, right). You can also start a nail in the top plate and bend it over the brace to keep it in position while raising the wall.

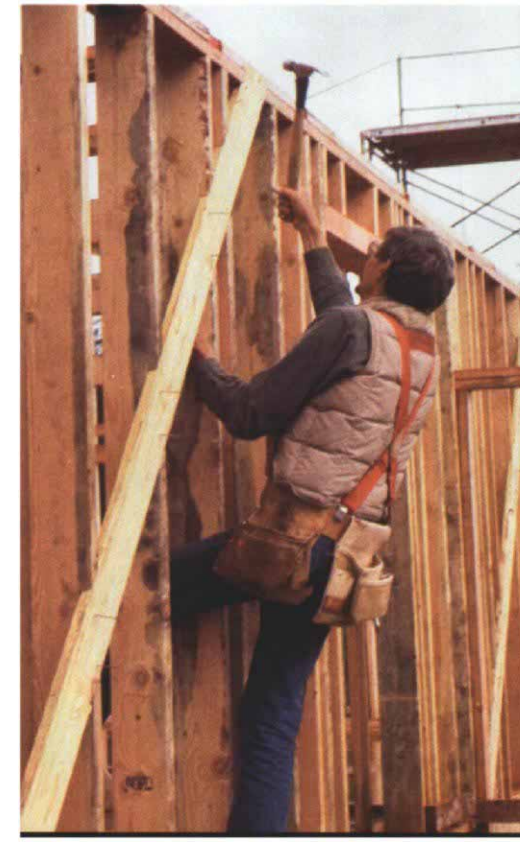
Rake walls and other tall walls can be braced by using a long 1x or two short ones. The short ones will lap in the center, which requires cutting a deeper notch in at least three studs. Even with this deeper notch, I've never had an inspector question the compression strength of the studs. When plumbing the walls, I nail the lapped 1xs into the studs with 16d nails.

Cutting kerfs. **With the 1x6 lying diagonally over the relatively square wall, the brace becomes a template. One-in. deep kerfs are cut into the studs on both sides of the brace. The brace terminates at a stud bay, not at a stud, to avoid the possibility of hitting a nail with the saw.**

Metal-angle braces—Metal-angle framing braces [left drawing, p. 56) are fairly new in the construction industry. They're available at lumberyards, and the angle braces we use (CWB106 and CWB126 from Simpson Strong Tie, 1450 Doolittle Dr., San Leandro, Calif. 94577; 800-999-5099) are 18-ga. metal and come in two sizes: One is about 9½ ft. long and is installed at a 60° angle; the other is over 11 ft. long and is installed at a 45° angle. They offer holding power not only in tension, but because of the metal angle, they hold in compression also. Compared with 1x let-in braces, metal braces are faster, easier and safer to install and will hold the building plumb just as well.

To install a metal angle brace, I lay it across the framed wall diagonally just like a wooden 1x. I make a pencil mark on the plates and the studs along one side of the brace. Then I cut a kerf 1 in. deep along this pencil mark. I slip one flange of the brace into the kerf and nail the brace to the bottom plate with two or three 16d nails, then add one more 16d through the brace and into the first stud. At the double top plate, I start a nail alongside the brace and bend it over to hold the

Walls up; braces nailed. **Let-in braces are nailed off after the walls are plumbed. The nails in the double top plate are driven first, followed by the nails in the rest of the studs.**



brace as the wall is raised. Later, when the building is plumbed, the metal will be nailed permanently to the other studs and plates. The braces come predrilled: One flange has no holes; the other side looks like an incredibly uniform piece of Swiss cheese.

The 18-ga. braces I use are only about 1/16 in. thick, which causes no problem with siding. On taller walls, metal braces can also be lapped at the center. A slightly wider kerf has to be cut in the studs where the two braces overlap. I'll mortise the lapped section into the studs a bit to ensure there will be no lump in the siding.

Bracing an open wall. **Walls with large openings, such as the front wall of a garage, can be braced with a 2x4 let into the double top plate. Once the wall is plumbed, the 2x4 is laid diagonally from the open wall to the sidewall and fastened with 16d nails.**

Walls with large openings—The front wall of a garage, which is almost all opening, can be braced in several ways. One way is to plumb the walls and add a diagonal brace at ceiling height. I lay a 10-ft. or 12-ft. 2x4 diagonally across the double top plate from the wall containing the garage header to the sidewall (photo above). On a detached garage, I put the brace on both front corners. I mark the brace's location on the double top plates, cut out these sections and drop the brace into the notches. Once the wall is plumb and straight, I nail the brace in place with 16d nails and trim it flush with the walls.

A more traditional method of bracing garage walls is to use long or lapped 1x6s, nailed diagonally on the double top plates from corner to corner of the garage, forming a large X at ceiling height. This bracing will hold the garage-door opening stable until rafter ties and ceiling joists are in place. The 1x braces can then be nailed up into the ties or joists for further stabilization.

A third method of bracing a garage wall is to nail a piece of plywood to the small section of wall on either side of the garage-door opening. Although these walls are generally quite narrow, perhaps 1 ft. or so, an 8-ft. high section of plywood will help brace the entire wall, especially if a let-in 2x4 brace has been installed up top.

Bracing walls with sheathing—Most walls are long enough to accommodate a whole sheet of plywood or oriented strand board (OSB) on each end. Nailing one or two 4x8 panels on these walls should be adequate bracing in parts of the country where shear forces aren't much of a concern. Other panels nailed on short walls within a house, such as the backside of a closet or a bathroom, can help stabilize an entire building.

I usually start sheathing a plumb wall at a corner by driving two 16d nails between the bottom plate and the floor sheathing or concrete slab. I let these nails protrude an inch or so to support the panel, square the panel with the corner and tack it in place. A common nailing schedule for plywood or OSB panels is 8d nails at 4-6-12, meaning you drive a nail every 4 in. at the building's perimeter, 6 in. at joints between panels, and 12 in. in the field, or inner part, of the panel.

In colder parts of the country, builders may want to increase the R-value of the walls by sheathing the exterior walls with 1-in. foam insulation (right drawing, below). Wall bracing can be provided by nailing a sheet of ½ in. plywood at each corner and overlaying it with a sheet of ½-in. rigid foam insulation to bring it out flush with the 1-in. foam. □

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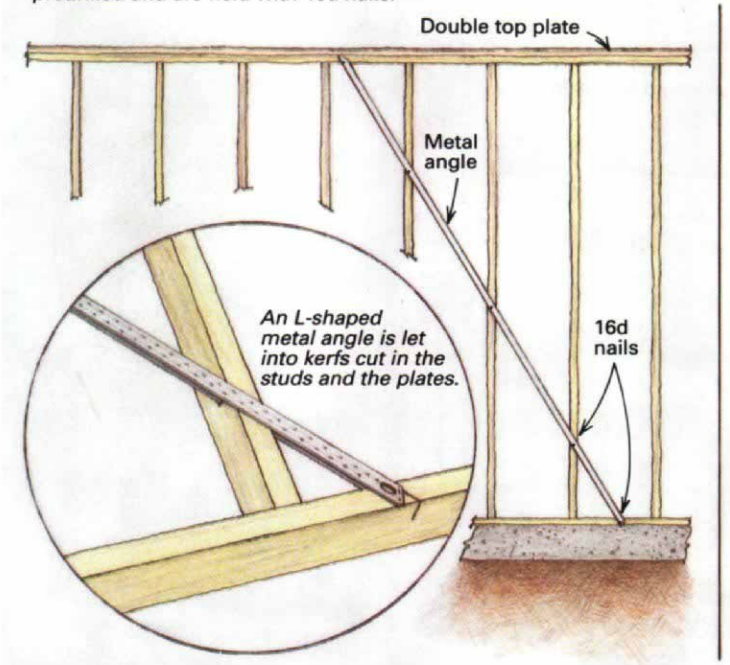
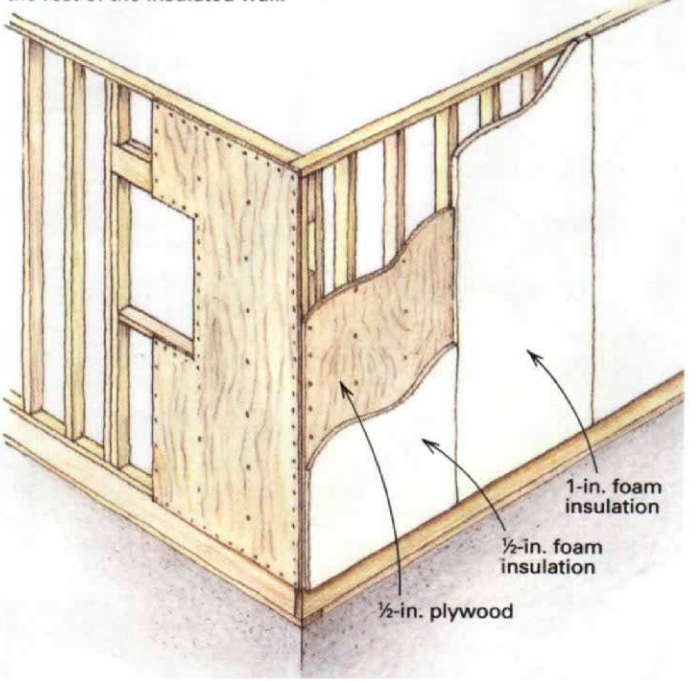
Metal-angle framing braces. *Metal-angle braces are easier and safer to install than wood braces because you only need to cut a kerf in studs and plates and drop the brace in. Metal braces are predrilled and are held with 16d nails.*



Panel bracing and rigid insulation. *When using 1-in. foam insulation, a builder can brace a corner with ½-in. panels and cover them with ½-in. foam to bring the corner out to the depth of the rest of the insulated wall.*



Drawings: Christopher Clapp

Shear walls

Here on the West Coast, many buildings require shear walls, and it takes an engineer to determine what combination of sheathing and metal connectors goes into a shear wall. Unlike sheathed-and-framed walls, a shear wall includes special measures to hold the house frame together at its weakest points—where the foundation meets the frame and where one floor meets another or the roof.

***Seismic anchors*—One common feature of a shear wall is that the framing is more-securely connected to the foundation. Most often this connection begins with anchor bolts. Common anchor bolts are L-shaped threaded rods embedded in the foundation that protrude up through the mudsill. When engineers design shear walls, they determine what type, what size and how many anchor bolts are necessary.**

Some workers just jab anchor bolts into the wet concrete stemwall. Anchor bolts should be connected to the rebar (see *FHB* #64, p. 65, for more on installing anchor bolts).

In a shear wall, anchor bolts can be connected to the wall framing, not just to the mudsill. Seismic anchors, such as Simpson Strong Tie's HDA/HD series (photo above) are what engineers are calling for more and more to make this connection. These welded, heavy-gauge metal hold-downs prevent a building from pulling off its foundation. A seismic anchor fastens to an anchor bolt and is bolted to a post. Usually, the post is a 4x4 nailed in the wall like a stud. Although old-style seismic anchors had to be held up above the mudsill to reduce the chances of the bolt's splitting the post, the newer seismic anchors are redesigned to rest on the mudsill.

The building plans will indicate where a seismic anchor belongs and what kind to use. A shear wall usually has a seismic anchor at each end, whether the wall is 4 ft. long or 40 ft. long to resist uplift from both directions. Seismic anchors may also be required at corners and at each side of openings.

***All about panels*—I'm not an engineer, so I can't tell you everything there is to know about shear panels. Engineers have to consider not only what forces need to be resisted but also the number of openings in a wall, the size and grade of the lumber, the height of the building and many other factors. One thing I know from experience is that shear walls often require a better grade of sheathing than the stuff used on floors. Commonly, plans call for ⅜-in. thick structural I or II (the highest and next-highest grades) plywood on shear walls with studs at 16 in. o. c. and ½-in. structural I or II when the studs are 24 in. o. c. Check your plans and codes to be sure what grade of sheathing is called for.**

A single 8-ft. panel normally will cover the framing from the bottom plate to the double top plate. On taller shear walls, I either nail a row of blocks at 8 ft. to provide a nailing surface for the end joints, or I use longer panels. On multistory houses, I like to nail 4x9 or 4x10 panels from the mudsill to the middle of the second-floor rim joist.

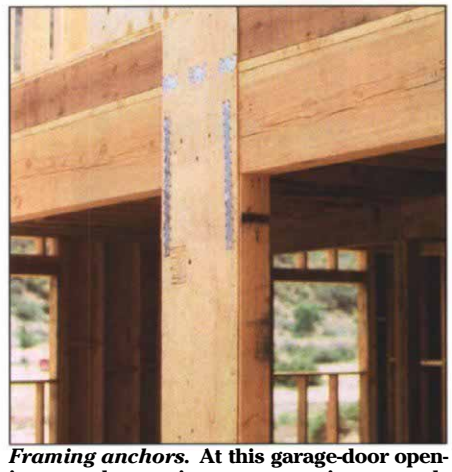
***Connecting foundation and frame.* A seismic anchor is bolted to the foundation and to a 4x4 post; its job is to keep the building on the foundation. The seismic anchor is mounted above the mudsill to keep the through-bolts from splitting the post.**

Panels can be installed horizontally, too. When plywood is nailed up horizontally, the majority of its veneers also run horizontally, making it stiffer under shear stress than vertical plywood. But to take advantage of that stiffness, the edges of horizontal plywood must be nailed to blocking. No matter how I lay up the panels on a shear wall, I always nail the edges to something—studs, rim joists, mudsill or blocking. If a panel doesn't break on the center of a stud, I either rip the panel to fit, or I nail an extra stud in the wall to provide adequate backing.

I try to place panels so that the seams fall somewhere in the middle of window and door openings rather than along an opening's edge. And I often sheathe right over doors and windows. Then, when the whole wall has been sheathed, I go back with a chainsaw or a reciprocating saw and cut out the openings, (see *FHB* #78, pp. 38-43 for more on using chainsaws.) There may be a required ⅛-in. gap for expansion between sheets. I achieve this gap by tacking a couple of 8d nails between sheets.

***It's all in the nailing*—An engineered plan includes the nailing schedule, which indicates the exact type of nail to use—its length, the size of its head and its shank diameter—as well as the spacing between the nails. Panels are nailed to hold-down posts and other framing members with a nailing schedule that can read, for example, 10d commons placed at 2-4-6. In other words, the nails in each panel are 2 in. o. c. along the perimeter of the building, 4 in. o. c. around edges that butt into other panels, and 6 in. o. c. in the inner part, or field, of the panel. That's a lot of nails!**

Pneumatic nailers are great for nailing off shear walls. Just be careful to adjust the air pressure so that the nails are driven flush with the surface of the sheathing. If they break the skin on the panel, they're more likely to rip through the panel when the wall is stressed. Also, don't hold the nailer directly in front of your face. If a nail hits a metal strap, such as a metal brace beneath the sheathing, it could drive the nailer straight back into your face.



***Framing anchors.* At this garage-door opening, metal strapping connects trimmer studs and headers; above it, three clips are nailed to the top plate and the rim joist to transfer shear forces.**

Some building codes will not allow clip-head nails in shear walls, so make sure you're using full-head nails in your pneumatic nailer. And keep shear-wall nails back % in. from the panel's edge to reduce the chances of their splitting out.

Strapping*—The sill can be attached to the rim (or band) joist and the rim joist to the bottom plate with framing anchors (bottom photo, above), such as Simpson's model A-35F. These flat metal clips are often nailed around the perimeter of the building every 16 in. o. c. Metal straps up to several feet long can make a positive connection between different floors. These straps are nailed into hold-down posts, rim joists and second-floor posts. Framing anchors add a lot of labor, but they'll keep your structure on the foundation and in one piece when the big one hits. —*L. H.

Photos this page: Larry Haun