



**A crowbar provides leverage and control.** One person moves the wall; the other tells when the wall is straight up and down, or plumb. Here, a crowbar forces a racking brace forward, moving the top of the adjacent wall. A block nailed to the bottom plate provides even more leverage. When the wall's plumb, the brace is nailed to the bottom plate.

# Plumbing, Lining and Bracing Framed Walls

A framing contractor explains his efficient sequence for keeping walls straight and true

by Scot Simpson

**I** have a painting on the wall of my office at home. The painting hangs in a room built in the 1920s or 30's, and the room has 2x4 floor joists and rafters. No matter how hard I try, I can't get the picture to hang straight. My office was probably plumb and straight when it was new, but now it's neither straight nor square nor level. A picture that doesn't hang squarely on a wall might not bug you, but even worse things can go wrong if you build an out-of-square structure.

To avoid these problems, once you've built, stood and nailed walls together, they must be

plumbed and lined. Plumb and line makes walls straight and true. Plumbing is setting a level against the end of a wall to make sure that it stands up straight. Lining is using a tight line attached to the top of a wall to gauge a wall's straightness along its length. You plumb and line walls before installing joists, rafters and sheathing because it's nearly impossible to move walls after these items are nailed in place.

Doing an inaccurate job will slow down every subsequent framing phase. If exterior walls aren't straight, you'll have to measure every rafter or

floor joist before you cut it; otherwise, it won't fit on the crooked wall. And if you have crooked walls, you'll have bowed siding; you'll have to scribe soffits. You'll have a mess.

If you've framed the floor and the walls carefully, it shouldn't take more than a few hours to plumb and line the walls. You can speed the process by approaching the tasks methodically and by eliminating unnecessary steps.

**Start with careful layouts and straight lumber**—When framing walls, you should use the

straightest lumber possible for the top and double-top plates, the corner studs and the end-wall studs. And make sure you cut the bottom and the top plates exactly the same length.

Once walls are stood, be sure all intersecting walls are nailed together tightly and that all double-top plate laps are tight. Intersecting walls must line up in their channels, and corner studs must line up.

Next, bring in your brace lumber—an assortment of 2x4s ranging from 8 ft. to maybe 14 ft., depending on wall height—and distribute the braces throughout the house. These braces help you move walls into position and hold them there until the joists, rafters and sheathing go on.

To plumb and line, you first get exterior corners standing straight up, or plumb. Next, you straighten the top plates so that they're in line with the walls' corners. Then, you plumb and line any interior walls that intersect exterior walls and finish by plumbing and lining remaining interior walls.

**Plumbing exterior corners**—Pick any exterior corner of the building as your starting point to plumb the walls, but work in one direction after that because when you move one wall, you also move any walls attached to it. Take care not to move walls that you've already plumbed.

You'll need two people—one who will move the wall, the other who will check it for plumb (photo, facing page). The person who's checking the wall puts a level against the end of the wall to see which way it's leaning. I use an 8-ft. level or a 4-ft. level attached to a straightedge that reaches from the top plate to the bottom plate.

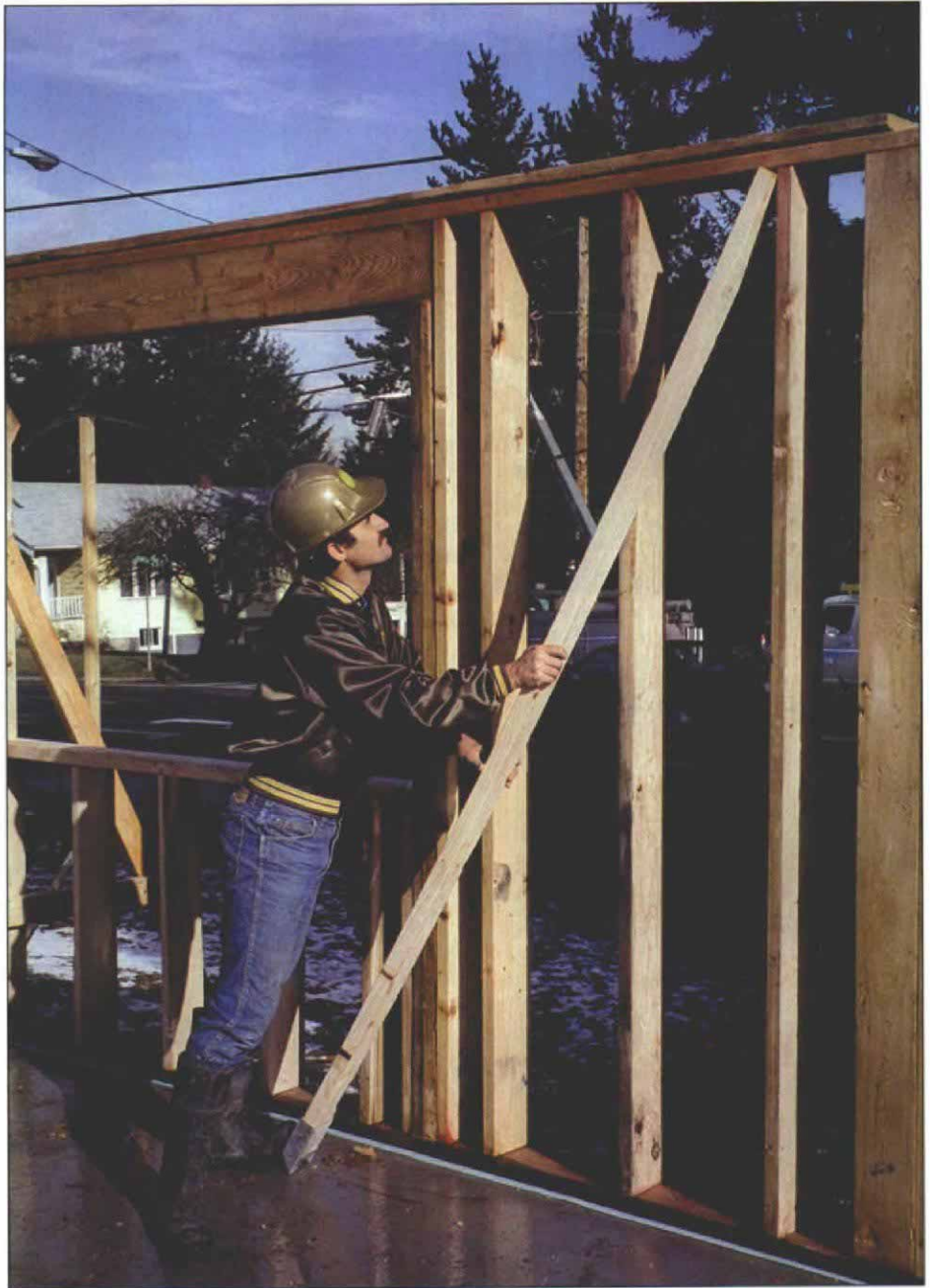
When let-in braces are required, you can use a push stick to square up the walls (photo, right). A push stick is usually just a 2x4 that you place against the face of a stud toward the top of the wall. The bottom of the push stick rests on the floor. I bought a bracket (Rack-R, P. O. Box 974, Novato, Calif. 94948; 415-897-7044) that fastens to the bottom of a push stick and keeps it from kicking out. You lean or even step on the push stick to move the wall into plumb. When the person on the level says right on, the let-in bracing is nailed off, pinning the wall plumb.

Unfortunately, a push stick doesn't produce enough force to move rigid walls. Plus, you still need a brace to hold the wall in place.

Because the walls I frame have sheathing, there's no need for let-in wall braces. But I still have to push walls plumb and hold them there until the sheathing goes on, so I use a racking brace. A racking brace is a 10-ft. or 12-ft. 2x4 placed diagonally on the face of a wall. The high end of the brace points in the direction the wall needs to be pushed.

You nail the brace to the top plate. If you're nailing by hand, you probably will want to start two nails in the end before you lift the racking brace into position. Make sure the brace doesn't stick above the wall in the way of joists or rafters.

The bottom end rests on the floor, and you use a crowbar to shove the brace forward, which pushes the wall. A brace installed at a 45° angle gives the best leverage; a steeper angle tends to push the top plate up.



**A metal fitting lets you work alone.** A push stick—a relatively knot-free 10-ft. 2x4—is used to nudge a wall plumb, but it doesn't supply as much leverage as a racking brace and a crowbar. The metal fitting at the bottom of the push stick keeps the brace from slipping.

When the person on the level says the wall is plumb, the brace person drives one nail through the brace into the bottom plate. Then, he releases the crowbar from the brace while the other person checks both ends of the wall for plumb. If both ends are good, then a second nail is put into the bottom plate and one nail is set into a stud in the middle of the brace.

Move to the next corner down the line. Move in one direction until all exterior walls are plumb.

Sometimes, the wall doesn't want to rack with a crowbar, but hitting the double-top plate at the

end of the wall with a sledgehammer tends to loosen it up. Also, you can nail a block behind the crowbar to increase leverage when forcing the racking brace.

**Lining exterior walls**—Now, you've got all exterior corners plumb. Next, straighten the walls. I use two methods to straighten walls. First, I rack any interior walls butting into the exterior walls. When these interior walls are plumb and square, the walls they butt into should be straight. I say "should" because sometimes it just doesn't work



**Blocks make sure the line stays straight.** A traditional method of lining is to nail blocks at each corner and to string line across the blocks. Blocks hold line away from the plate. Another block gauges distance between string and plate.

**Tying off a line.** To secure the line on the nail, pull the string tight, twist your finger around the string thrice and slip the loop over the nail. Then, just wrap the loose end around the nail.



**Using a line without blocks.** You can tell if a wall is straight by stringing a tight line from one end of a top plate to another. A nail is bent flush with the outside plane of the wall, and another nail is tacked to the opposite corner.

that way, and you've got to find the problem and fix it. I'll get to how you fix it a little later.

In places where there are no interior walls to rack and push the exterior walls straight, I use line braces (photo, right) to push or pull the top plate into alignment. A line brace is usually a 2x4 face nailed to a stud just beneath the top plate and spiked to a cleat on the floor or to another wall's bottom plate.

Line braces hold the top of a wall in place like a prop, and they keep the wall straight and stable so that it's safe to walk on as you're nailing off joists. Even if the wall is straight, these braces should be placed every 10 ft. along the wall and at breaks in the top and double-top plates, which are typically weaker points. Make sure the line brace doesn't interfere with wall sheathing. Racking braces and line braces usually stay in place until the roof has been framed and the walls and roof have been sheathed.

**Using a stringline**—Some carpenters determine where to straighten a wall by sighting along the top plate the way you'd check a board to see which way it crowns. I don't like to sight the plates because it's not always accurate. Often, the edges of the plate lumber are waned: curved instead of square due to bark or defects. And it's easy to be confused by the many lines in a house's frame, which can cause optical illusions.

For a better look at how straight the top plates are, I run a line from one corner of a wall to another, pulled tightly between nails at each end of the top plate. The line tells me how far in or out the wall is, and by matching the top of the wall with the line, I can straighten the wall.

Commonly, lining is done using blocks. You



**Line braces hold walls straight.** This gable end is straightened and held straight with 2x4 line braces. Note the line running along the blocking. The top of each brace is nailed to the wall just below the plate. The bottom of each brace is left square so that it can be pushed forward with a crowbar, just like a racking brace. When the wall is straight, the line braces are nailed to cleats. The cleats are spiked to the floor joists, not just to the plywood deck.

face nail a piece of 2x lumber at the top corners of a wall, and then string a line on the outside of the blocks (photo above, left). Then, you slide a 2x4 block along the top plate, checking to see where the block pushes against or pulls away from the line. These are the spots where the plate waves in or out, so you'll need to set a line brace or rack an intersecting wall to straighten the top plate. The purpose of the blocks is to hold the line away from the wall so that the line remains perfectly straight regardless of imperfections in the plates. Without blocks, a crooked plate touching the string somewhere along its length would make the string crooked.

For years I used the blocking method. But I once tried a different method, and I haven't gone back. The line method is the better system. It eliminates the extra steps of putting on and taking off the blocks. It also eliminates the problem of getting an accurate reading if the double-top plates aren't exactly flush. With no blocks, you see the line in relation to the whole wall, not just a protruding edge on the top plate.

To set the line, start a 16d nail in the top of the double plate near the end and edge of the wall (photo above, right). Then, bend the nail so that the string will be in line with the edge of the top plate and wall below. Cinch a string to the nail about 1/2 in. above the plate, extend the string to the other end of the wall and set another nail. Attach the string, pull tight and secure. The easiest way to secure the string is by placing it around your finger and twisting it three times (photo above, center). Then, put the string over the nail. Use one hand to pull the string coming onto the nail while the other hand pulls the end of the string coming off the nail. Once the string is

tight, wind the loose end around the nail and tie it off so that the coils trap the loose end.

The key to the line method is that the string is in line with the edge of the wall but is  $\frac{1}{2}$  in. above the plate. Hence, no blocks are necessary because imperfections in the plate won't touch the string. And with the plate and string so close to each other, you visually can compare the top plate to the string, and you can adjust the plate accordingly.

To straighten exterior walls, attach a racking brace to each interior wall that runs into the exterior wall. Rack each interior wall until the lined wall is straight, then nail the brace. If an interior wall runs between two exterior walls, you have to line both exterior walls before racking the interior wall with a racking brace.

For sections of wall that do not have walls running into them, place line braces wherever necessary to hold the wall straight.

If the top of a wall leans into the house, I use a crowbar to shove the bottom of a line brace forward and push the wall out.

If the top of a wall leans away from the house, I first try to pull the wall in line by hand with a line brace. If the wall won't budge, I use a pulling brace (photo, right). This brace is pretty much like a line brace, except a pulling brace is installed on the flat instead of on edge, and it draws the top of a wall in instead of pushing it out.

The top end of a pulling brace is nailed under the top plate. The bottom end is trapped under a pair of blocks nailed to the floor. I usually nail the blocks perpendicular to the brace, with the top block offset from the bottom one so that it holds the brace down. The object is to bow the pulling brace upward—which shortens it and draws the top of the wall in—and the blocks hold the brace down better than if nailed to the floor.

To bow the pulling brace, I nail the bottom of a 4-ft. 2x4 block to the floor, jam the top of the block under the brace and pull the block tighter and tighter under the pulling brace. If the wall's stubborn, I bash the block under the brace with my hammer. Eventually, the block should bend the brace enough to pull the wall into line; at that point I drive a few nails through the pulling brace into the top of the block, which holds the wall in place.

Walls with long headers are notoriously difficult to line, and sometimes you need more oomph than you can get from a pulling brace. That's when I break out a come-along

**Making adjustments**—If the walls were built perfectly and the floors were all level, you shouldn't have to make any adjustments to your plumbed and lined walls. However, when you're dealing with lumber that varies in dimensions and often is warped and bowed, and when the plate's end cuts may not be exactly square or the sections of plate are not nailed tightly together or kept tight, it's not unusual that some trimming or stretching becomes necessary to get everything straight and plumb.

The first thing to do when an adjustment is needed is to find the mistake. I check the typical trouble spots. First, I check for a tight fit between intersecting top plates. A gap here usually



**Pulling braces need to be anchored to the floor.** When a top plate has to be pulled in, you need a pulling brace, a 2x4 nailed on the flat under the top plate. A short 2x4 then is used to bow the brace upward, hence pulling in the wall's top plate.

can be corrected by toenailing a 16d nail up through the top plate of the bywall into the top plate of the intersecting wall.

Then, I check that the top and the bottom plates are the same length. Sometimes there are spaces where plates lap; sometimes the plates are different lengths. If plates aren't the same size, you have to make the top plate longer or shorter.

The wall can be made longer with a few easy steps. Pull the nails where the plates lap. Then, plumb the corner, creating a gap in the top plates of the connecting walls. Nail the end stud of the one wall tight to the connecting stud of the other wall and renail the double plate. You'll have a

gap in the top plates at the corner, but the walls will be plumb.

The wall can be shortened by loosening the double plate from the top plate, cutting the top plate shorter with a reciprocating saw and nailing the top plates of the two walls tight. If the double-top plate overhangs the exterior, trim it. □

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