Framing Cathedral Ceilings

The challenge boils down to keeping the walls from spreading during and after construction

by Brian Saluk

Photo this page: Scott Gibson

I started framing houses years ago, before cathedral ceilings came into fashion. When asked to frame my first cathedral ceiling, I went at it much as I did any other roof. After bracing the walls plumb with leftover 10-ft. 2x4s, my crew set the ridge and the rafters, seemingly without a hitch. It was just another gable roof, only without the ceiling joists. When we finished setting the rafters, it was lunchtime.

I remember biting into my ham-and-cheese sandwich and looking back at the roof. I expected that feeling of satisfaction one gets looking on the results of a good morning's labor. Instead, I got a sinking feeling: The center of the ridge was sagging.

Back in the house, I saw that the weight of the roof pushing out on the walls had actually pulled some of the braces from the floor. Fortunately, it took only a couple of hours to jack the ridge level and pull the walls straight with a come-along. But I was lucky that the only serious loss that day was my uneaten lunch.

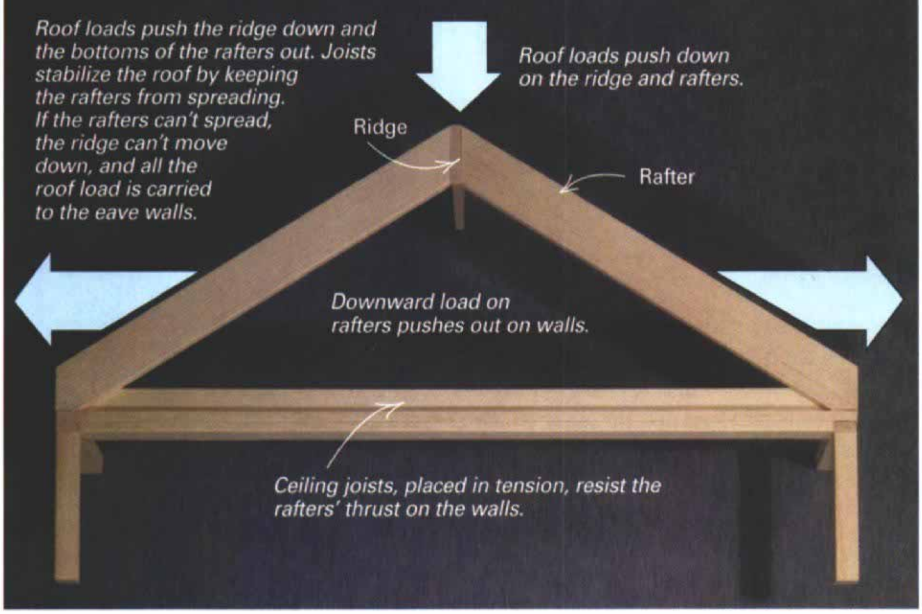
Brace the walls to resist roof thrust—The strength of a typical roof derives from the triangular shape made by the rafters and ceiling joists (photo top right). The ceiling joists tie the exterior walls together, resisting the outward thrust on the exterior walls. Because the joists tie the rafters together as a unit, the rafters carry the downward load on the ridge to the eave-walls. Remove the joists, as with a cathedral ceiling, and two things happen. The rafters push out and bow the eave-wall plates, and the ridge becomes load bearing and sags because it isn't sized to bear a load (photo top right).

Building cathedral ceilings means finding ways to duplicate the joist's function or eliminating the need for it, both during construction and as part of the permanent structure. Simply put, if you keep the bottoms of the rafters from spreading apart or if you keep the ridge from sagging, the roof will be strong and stable.

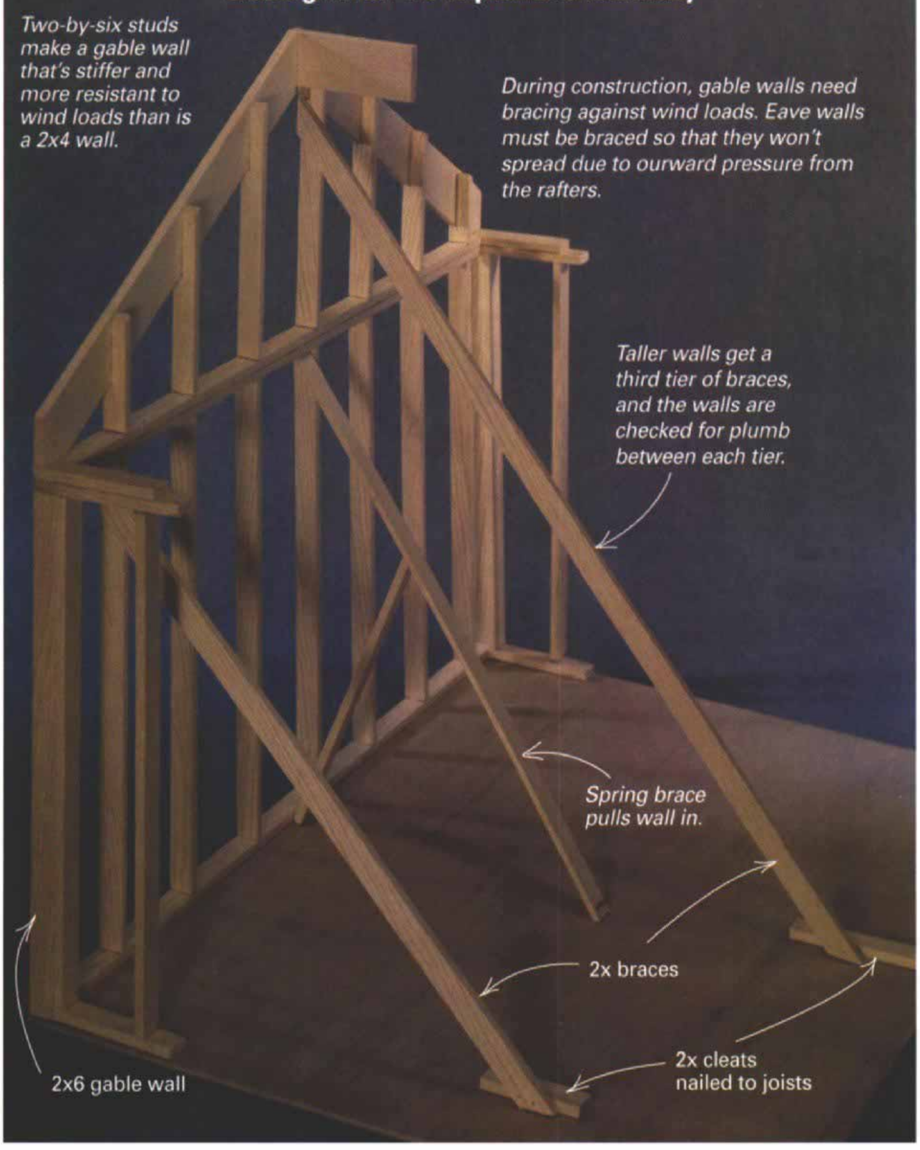
Proper bracing is the most important consideration during construction. If the walls aren't properly braced, the rafters' thrust will bow the plates, and their weight will sag the ridge. And the wind, blowing against the tall gable-end walls typical of cathedral ceilings, can knock down the whole assembly.

I brace the eave and gable walls plumb at least every 8 ft., with 2x4s half again as long as the wall is high, or 12 ft. for an 8-ft. high wall. One-story gable walls call for two tiers of braces, one high and one low (photo bottom right). Two-story gable walls get three tiers of braces, and I check the walls for plumb between each tier. I

Ceiling joists hold a standard roof together



Bracing holds walls plumb and steady



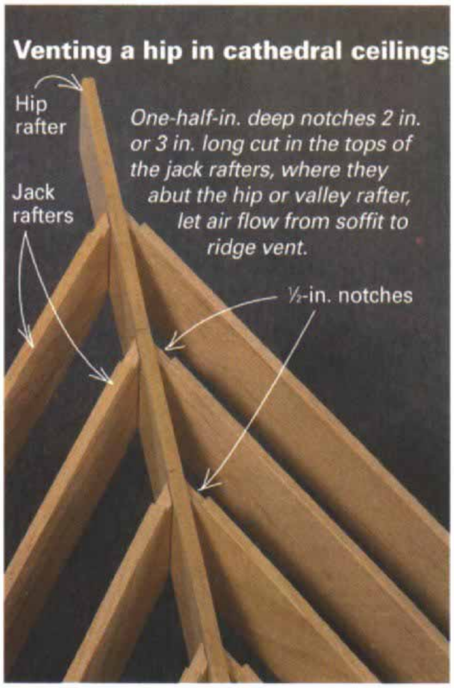
Models: Linden Frederick

sometimes use 2x6s for the longest braces. The braces are nailed to the tops of studs and to 2-ft. long 2x4 cleats that are nailed to a floor joist. I use at least two 12d nails at each end of a brace.

Straightening the top plates usually involves pulling the walls in as well as pushing them out. I pull them in with spring braces made from long 2x4s nailed on the flat to the top of the top plates and to the floor at a joist. Jamming a shorter 2x4 under the middle of a spring brace bends it and pulls in on the wall.

T-shaped posts support the ridge—If the ridge of a cathedral ceiling can be kept from sagging, the rafters can't push out the wall plates, and the roof stays put. This is the principle behind the structural-ridge roofs that I will be describing later. With the other types of cathedral ceilings, though, the ridge board isn't load bearing except during the construction process. Because of this, the ridge board is not sized to take a load and can sag from the weight of the rafters during construction.

To avoid this sagging, I support the ridge with T-shaped posts made by nailing a 2x4 on edge to the center of a 2x6. The T-shape of the post resists buckling under load better than does a single piece of lumber. I space the posts no more than 12 ft. apart and make sure that each one sits over well-supported floor joists. If I have doubts about a post sitting on one joist, I stand



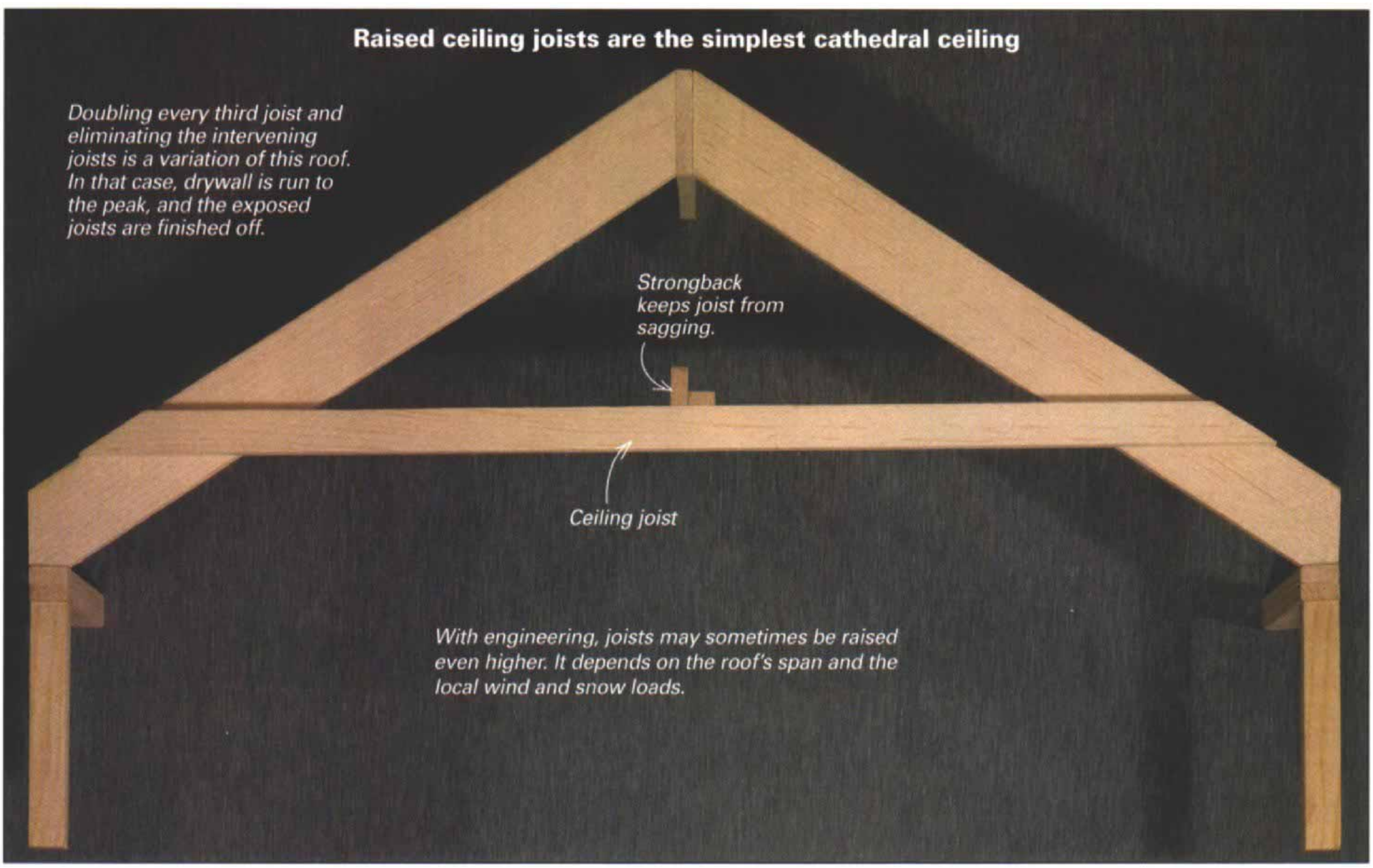
the post on a 2x10 or 2x12 laid flat over several joists to spread the load.

Working from scaffolds speeds construction—I find it's faster and safer to build cathedral ceilings from scaffolds than to work from ladders. I site-build scaffolds from framing lumber and plywood. Ideally, the scaffold should be high enough so that you can nail the rafters to the ridge and low enough to ease nailing the joists, if any, to the rafters.

The main supports for the scaffolds I build are goalpost-shaped assemblies with 2x4 legs and at least 2x6 horizontal members. I cross-brace these with more 2x4s and space them about 8 ft. apart. Two-by-tens are laid across the goalposts and covered with sheets of plywood. The posts should be high enough to support toeboards and guardrails.

Rafters must make room for insulation—Many framers lay out roofs so that opposing rafters are staggered, making it easy to nail through the ridge into rafter ends. But it's usually best to align opposing rafters in a cathedral ceiling to allow subsequent members to be nailed evenly, instead of at an angle. I keep this in mind when I lay out the mudsills so that floor joists and studs stack under the rafters.

Once I start framing and the customers can finally begin to see the house three-dimensionally, it's common for them to ask if a flat ceiling could become cathedral. If the rafters and ceiling joists aren't already cut, accommodating this request is usually a simple matter of stepping up the original rafter size at least one dimension. For example, I can use 2x8 rafters on a 28-ft. wide house that has a conventional roof. If the



roof were changed to a cathedral style, I'd use at least 2x10 rafters. The reason is twofold. Extra heft helps to keep the rafters from sagging over time. And without flat ceiling joists, the insulation goes in the roof. The rafters must be wide enough to accommodate the insulation plus space for ventilation.

I have to be selective with rafter material when building cathedral ceilings. The underside of the rafters forms the ceiling plane, so any rafter material with extreme crowns that might show through the finish ceiling gets culled.

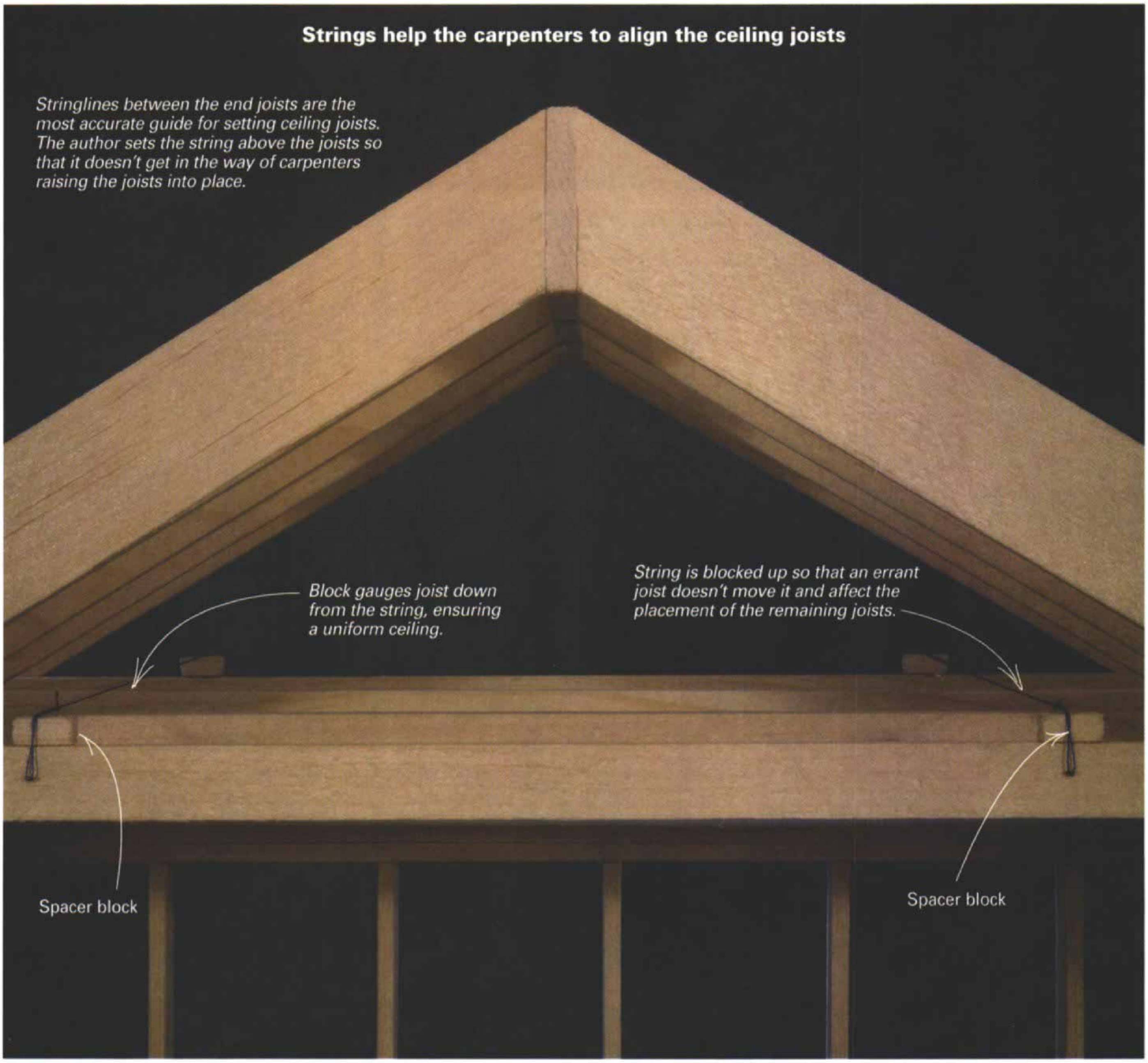
The bird's mouths in cathedral rafters have to be cut so that the bottom of the rafter intersects the corner of the top plate. If it doesn't, there would be an area between the ceiling plane and the wall with no nailing for drywall.

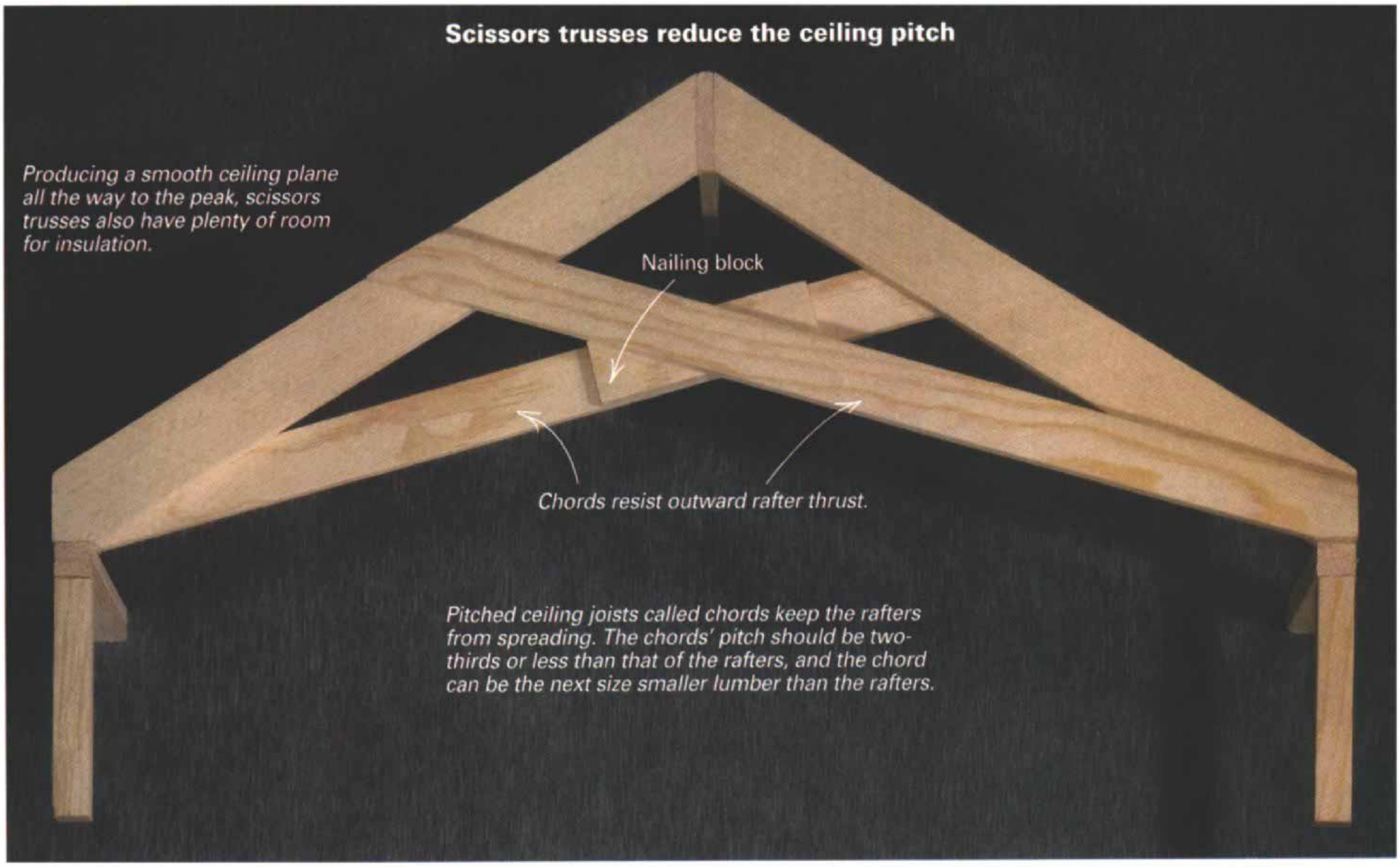
Hip and valley rafters can't hang below commons and jacks–Hip and valley rafters are often sized deeper than the rest of the rafters because they carry the combined loads of the jack rafters. Normally, nobody cares if a beefed-up hip or valley rafter hangs down below the other rafters into the attic. But with a cathedral ceiling, a deep rafter would protrude through the finish ceiling. Because of this, if your plans call for an oversize hip or valley rafter, they may have to be made from two smaller members nailed together. If you have any doubts about hip-rafter or valley-rafter size, consulting an engineer is wise. Alternatively, you could fur the ceiling out to the level of the protruding hip or valley. Finally, ventilation along a hip or valley requires some thought (top photo, facing page).

Once all the rafters are up, I usually sheathe the roof. The ridge is still supported with temporary posts, so the roof assembly is strong enough for my men to work on. Sheathing the roof at this point stiffens it and takes the bounce out the rafters, making it easier to nail the subsequent members to them.

Raising the ceiling joists is the simplest cathedral ceiling–Raising the stable triangle of joists and rafters upward is not much more complex than framing a standard gable roof (bottom photo, facing page). It's probably the least expensive route, and the mix of angles and flats makes for an interesting ceiling. But if the triangle becomes too small, it can't stabilize the roof. I'll raise these joists about one-third of the

Strings help the carpenters to align the ceiling joists





distance from the top of the wall to the underside of the ridge. Lower is stronger.

Ceiling joists can often be raised higher than this, but a variety of factors comes into play. The room width, the roof pitch and the snow-load all must be considered. It's wise to consult a structural engineer before raising the joists higher.

I frame this roof much as I would a normal gable roof, starting with the end rafters, the gable walls and the ridge. After supporting the ridge with a T-post, my crew sets the rafters.

After deciding their height, I install the joists. They must be level and in plane with each other. I measure up from the floor and mark the height on both gable walls. A joist is nailed at both ends of the room and checked for level.

I locate the rest of the joists with strings, rather than by snapping chalklines on the underside of the rafters. The rafters are never crowned exactly the same; thus, a chalkline won't be straight, and the ceiling won't be flat. I cut blocks from a piece of scrap and nail them atop the ends of the gable joists. I string a line on each side of the room from these blocks and space the remaining joists down from the lines with other blocks (photo p. 71). The joists don't touch the string, reducing the chance of accidentally pushing it out of line. The strings are set above the joists so that my crew doesn't have to wrestle them over the strings. Variation in joist width isn't usually a problem, particularly if all the stock comes from the same pile of lumber. The joists are nailed to the rafters with at least six 12d nails in each joint. I cut the joists to the roof angle so that there is more wood to nail into than if the joists were square-cut. I cut them just short enough so that they won't touch the roof sheathing. This way, the rafters won't shrink past the joist ends, creating bumps in the roof.

If the span is sizable, I use wider joists. For spans up to 14 ft., 2x6s are fine; beyond that, I increase to 2x8s. If the joists span more than 12 ft., I nail a 2x4 flat to the top of the joists, running perpendicular to the joists and centered in the span. A 2x6 on edge is nailed to the 2x4, creating a strongback. I place the strongback material on top of the joists before installing all of them. Otherwise, I won't be able to get the material up there at all.

A variation on this ceiling is to double the joists on every third rafter pair and leave out the intervening joists. Similar caveats about not raising the joists more than one-third the roof height apply. On this ceiling, the drywall goes all the way to the peak. The doubled joists are exposed, and either drywalled or finished with trim stock.

Scissors trusses can be site-built—A scissors truss consists of two opposing rafters braced by two pitched ceiling joists (or truss chords) that resemble lower-slope rafters (photo above). The chords cross at the ceiling's peak and continue upward to lap the rafters. This ceiling works well when the customer wants an unbroken ceiling plane right up to the peak. It's also good if the client wants the ceiling to be a shallower pitch than the roof is.

The chord's pitch shouldn't exceed two-thirds of the rafter's pitch. In other words, if the rafters are a 9-in-12 pitch, the chords should be a 6-in-12 or lower pitch. The steeper the pitch of the chords, the less effective they are at bracing the rafters. I make the chords one size smaller in depth than the rafters.

Framing a scissors-truss roof begins similarly to framing a raised-joist roof. Set the gables and the ridge. Brace the ridge, set the rafters, and partially sheathe the roof. Here, it's especially important to lay out the rafters so that they align at the ridge.

The gable rafters are supported by walls, so there is no need to brace them with chords. The gable-end chords essentially serve as drywall nailers and are nailed to the gable walls. I lay them out just like common rafters, without deducting for a ridge. After nailing up the gable-end chords, I cut the bird's mouth on a piece of chord stock that's long enough to span from the wall to the opposing rafter. I hold this chord stock in place, even with one of the gable-end chords. By marking the chord stock where it laps the opposing rafter, I have the pattern for the rest of the chords.

To line up the chords, I string two lines from the top of the end chords, just as I did with the raised-ceiling-joist roof. The chords are nailed on opposing sides of rafter pairs with six 12d nails per joint. I also toenail them to the wall plate. The chords are lined up on the strings and nailed to the rafter on the far side of the ridge. Where the chords cross, they're the thickness of the rafter apart. I nail a 2-ft. block of the chord material flush with the bottom of one chord and nail the second chord to the block.

Design the ridge as a beam, and no joists are needed—Another approach to cathedral ceilings is to make the ridge a beam that's stiff enough not to sag under load (photo right). I build this type of roof when a ceiling that climbs cleanly to the peak at the roof pitch is wanted.

A structural ridge creates point loads that must be carried through the gable wall to the foundation with continuous, stacking framing. Headers in this load path need to be sized accordingly, and their studs may need beefing up, too.

I balloon-frame particularly tall gable walls. The studs in balloon-framed gable walls reach from the bottom plate on the first floor to the top plate just below the rafters. Balloon-framing avoids the plates at the various floor levels common to platform-framed walls. Plates can act as a hinge, weakening tall walls. To stop the chimney effect these continuous stud cavities can have in a fire, codes specify fire blocking at least every 8 ft. and where the wall intersects floors and ceilings.

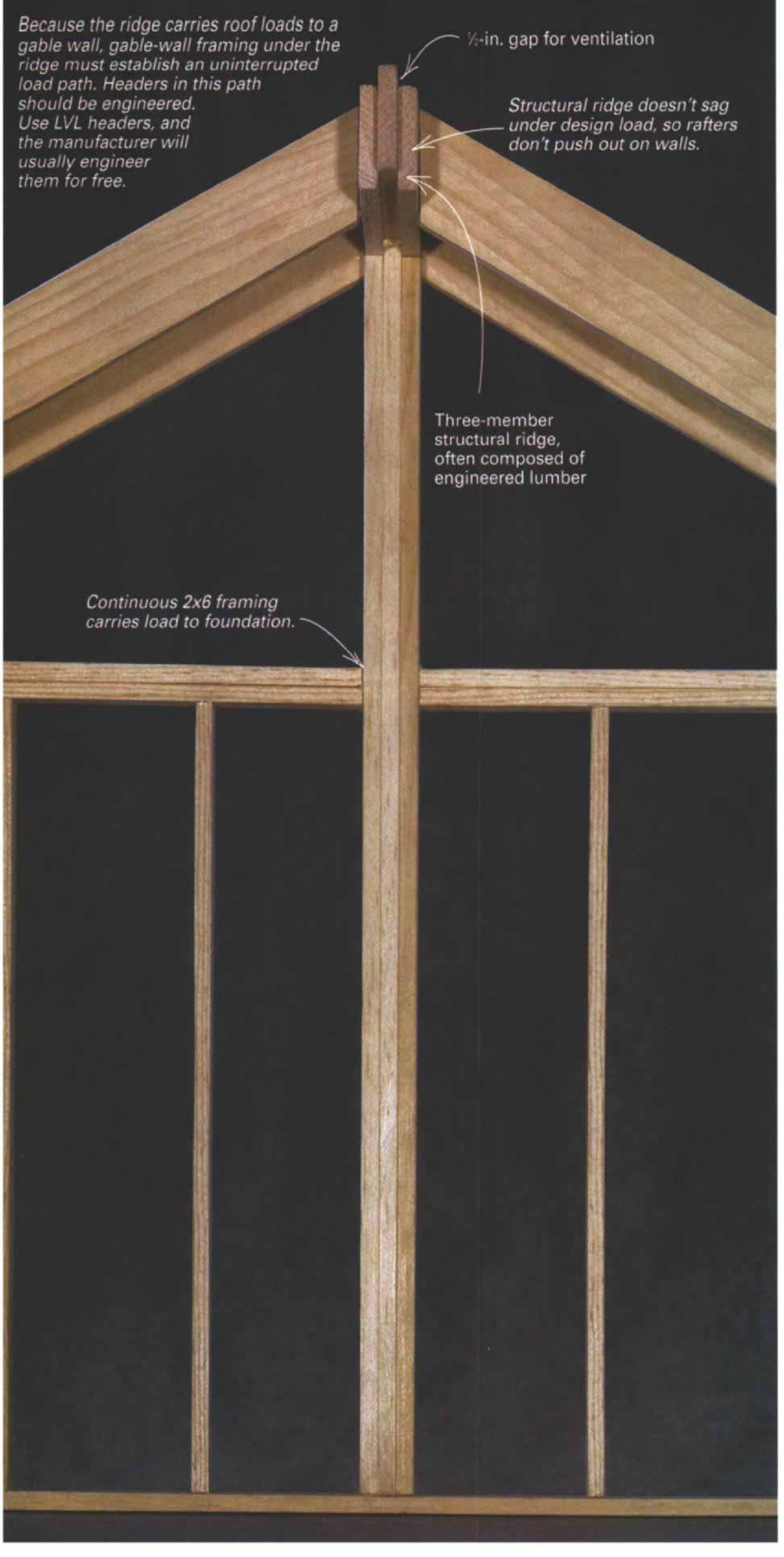
In areas where gable walls are subject to high wind loads, I frame gable walls with continuous 2x6 laminated-strand lumber (LSL) studs. LSL is factory made by shredding lumber and gluing the strands back together. LSL is denser and stiffer than solid-sawn lumber, and makes for a stronger but more expensive wall.

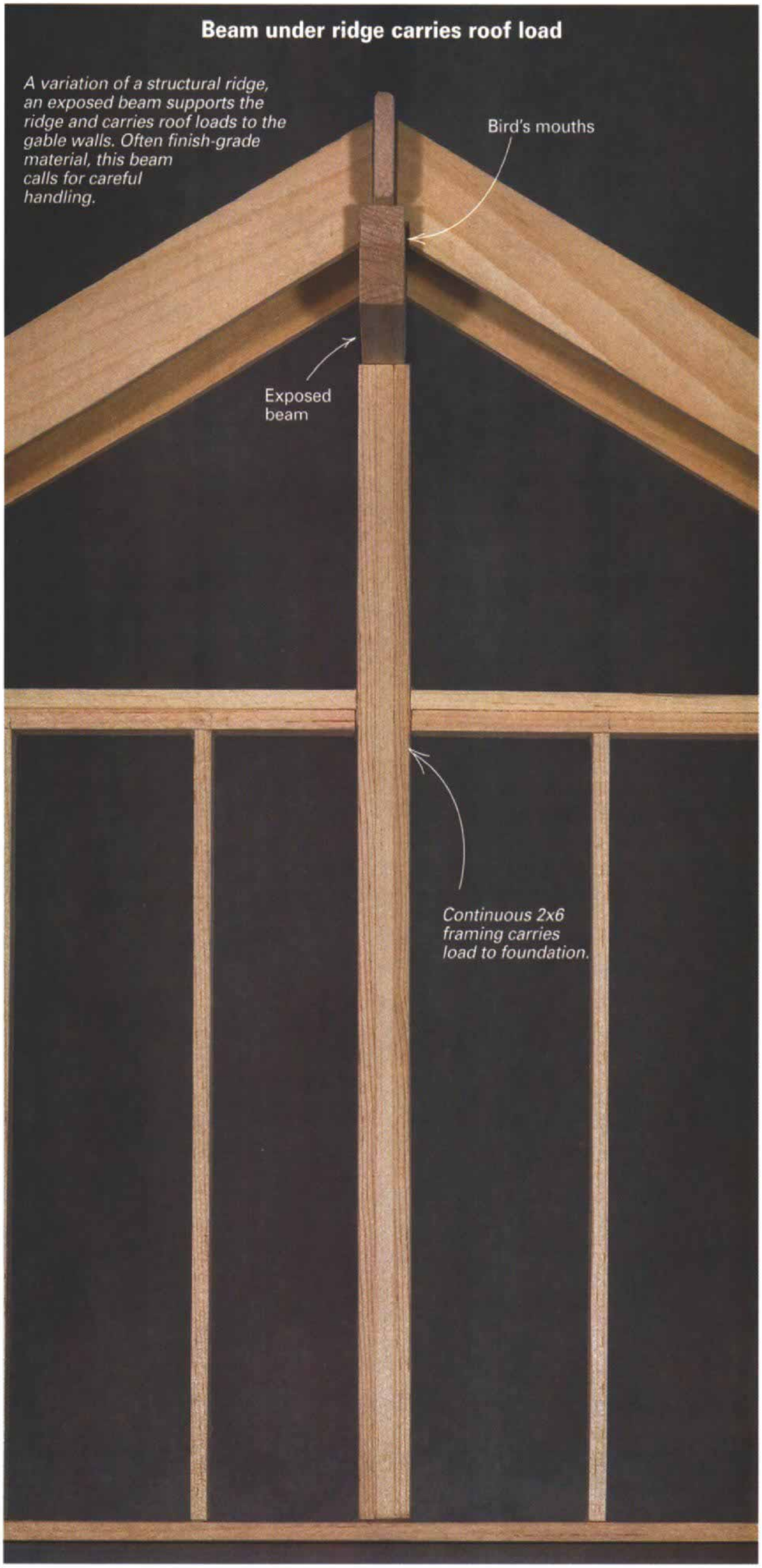
I avoid large, single-member ridge beams. They're heavy and often must be placed with a crane. I prefer to assemble in place two, three or even four full-length laminated-veneer lumber (LVL) members that can be lifted by hand. LVLs can span greater distances than standard lumber and are made from material similar to LSL studs. And LVL manufacturers will usually size the beam for you at no extra cost.

Individual ridge members longer than 24 ft. are usually too heavy to lift by hand. In that case, I'll assemble the beam on the ground and lift it with a crane. It's important to build beams straight; once nailed, they're nearly impossible to straighten.

Before nailing together a multimember beam in the air, I set the gable rafters and wall. On 2x6 gable walls, my crew sets the first beam member between the gable rafters just like a ridge board. The subsequent members are cut shorter so that

Structural ridge beam keeps roof from sagging





they butt to the inside of the gable rafters. Even after deducting 1½ in. for the gable rafter, the beam has a full 4 in. of bearing. I stagger these shorter members down so that they're about ½ in. lower than the top of the rafters. This method allows air to flow to the ridge vent. After nailing the beam together, I measure, cut and then install the post under the beam to carry the load downward.

For 2x4 gable walls, all members of the ridge beam must run through the entire width of the wall to gain sufficient bearing. This means that all the beam members have to be placed at the same time as the gable rafters, a trickier operation. Because of this situation and because 2x6 gable walls are stiffer, I rarely build 2x4 gable walls when using a structural ridge.

Show a finished beam beneath the ridge— This roof goes up similarly to the previous example, except that the beam is installed below and supports a standard ridge (photo left). I build this type of roof when the customer wants to show a large finished beam or when the ridge beam is so deep that it would hang below the rafters anyway. In that case, I often put collar ties just below the beam for drywall nailers. This eliminates the need to drywall and finish that awkward triangular space between the rafters and the side of the beam.

Shorter beams that are light enough to be handled by a couple of carpenters can be installed after the rafters are set. With longer beams, however, especially big single-member beams, it's easier to set the beam first, then build the roof around it.

Again, the first step is building the gable walls and setting the gable rafters. The wall must have a post to support the beam, just as in the structural-ridge type of roof. I cut the gable rafters normally and set the beam within them by hand or by crane.

If this beam is to show, I treat it with care. I hoist it with nylon slings instead of chains, which can mar the surface. And I don't nail temporary braces to the finish face. The nail holes might show, and worse, if the nails rust, they'll deeply stain the beam.

The rafter tops will have bird's mouth cuts in them that fit over the beam. I don't toenail through the upper seat cut; this usually splits the top of the rafter. Rather, I nail the rafter to the ridge and toenail the ridge to the beam. When laying out this seat cut, I allow for the height of the ridge board plus ¼ in. or so. The rafters don't have to touch the beam because the ridge does. This ¼ in. allows a bit of play that simplifies setting the rafters. □

Brian Saluk is a framing contractor from Berlin, CT. Photos by Greg Morley, except where noted.