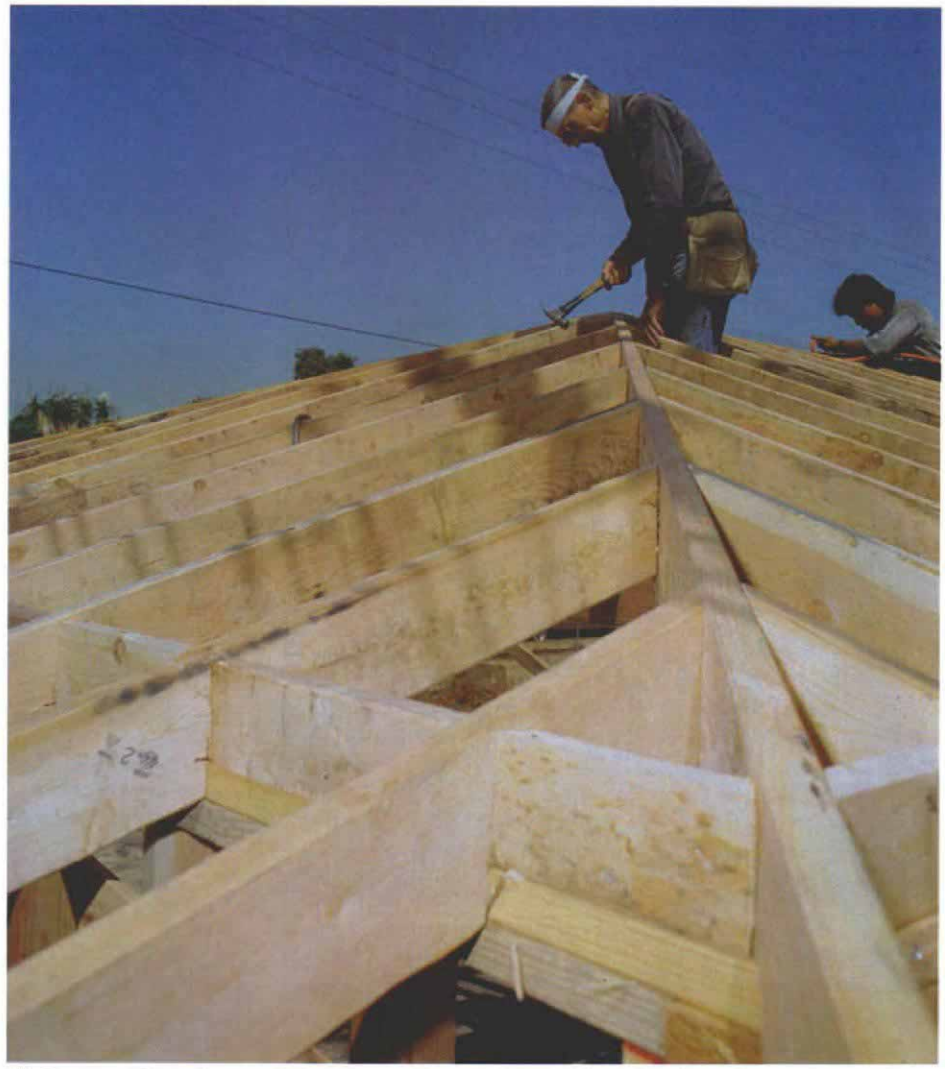
Framing a Hip Roof

After you've framed a gable roof, rafter templates and rafter tables are all you'll need to make a hip

by Larry Haun



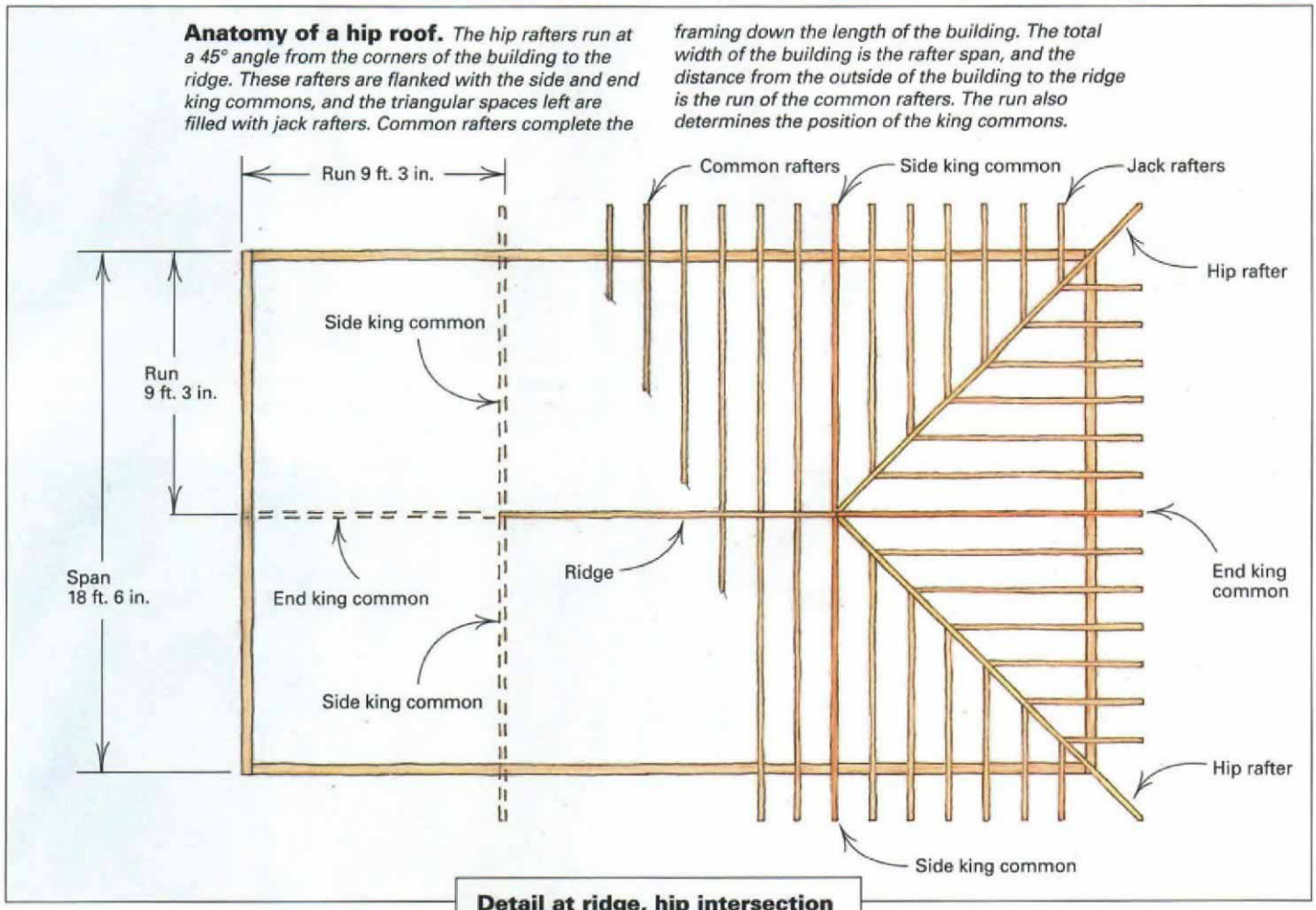
Fitting together pieces of the hip-roof puzzle. If all of the rafters have been cut properly, assembling a hip roof should be a painless process. Here, the author lines up a jack rafter for nailing.

I built my first hip roof in 1951 while in the Navy being trained as a carpenter. I dutifully laid out my rafters by stepping them off with a framing square. When I was finished, the commons were fine, but the hips came out short. Ever since then, I've relied on a book of rafter tables to determine rafter lengths rather than trust my ability to count steps with a square. Having framed hip roofs for so many years, I'm surprised that so many carpenters seem reluctant to build hip roofs. Maybe they're afraid that the framing is too complicated or beyond their abilities. I think that once you've learned to frame, a gable *(FHB* #60, pp. 83-87), cutting and building a hip roof requires few additional skills.

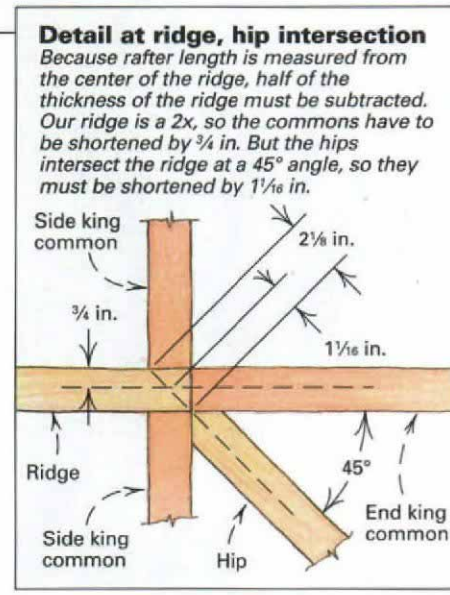
A hip roof has the advantage of being inherently stronger than a gable roof. The hip rafters act as braces in the roof to resist the destructive forces of earthquakes, and the roof sloping up from all four sides of a hip roof offers no flat ends to catch high winds. Another advantage to hip roofs is that changing the roof style from gable to hip can transform the appearance of a house, offering a nice variation from the gable roof.

A hip roof begins with common rafters- Hip rafters extend from the corners of the building up to the ridge. On both sides of the hips, common rafters, called king commons, meet the ridge at the same point as the hips (top drawing, facing page). The side and end king commons and the hip rafters are the main framing components of the hip roof.

The end king common runs from the middle of the end wall to the ridge. This rafter is the same pitch as the rest of the roof, and it is the key to the hip roof's ending with a pitched plane instead of the more common vertical gable. The hip rafters form the line of intersection between the side-roof and end-roof planes. The fiist step in framing a hip roof is determining the span of the roof, which establishes the location of the king commons. The garage featured in the photos in this article is 18 ft. 6 in. wide. The end king common, which is at the exact center of the span, is 9 ft. 3 in. from the outside of the garage. This number also represents the run of the rafters. After marking the location of the end king commons, I measure down the sides of the building the same distance, and then I mark the position of the side



Anatomy of a hip roof. *The hip rafters run at a 45° angle from the corners of the building to the ridge. These rafters are flanked with the side and end king commons, and the triangular spaces left are filled with jack rafters. Common rafters complete the framing down the length of the building. The total width of the building is the rafter span, and the distance from the outside of the building to the ridge is the run of the common rafters. The run also determines the position of the king commons.*



Detail at ridge, hip intersection
Because rafter length is measured from the center of the ridge, half of the thickness of the ridge must be subtracted. Our ridge is a 2x, so the commons have to be shortened by ¾ in. But the hips intersect the ridge at a 45° angle, so they must be shortened by 1⁹⁄₁₆ in.

king commons (drawing above). Next I lay out the rafter locations on the double-wall plates.

Rafter templates streamline measurement and layout—The roof of our garage has a 4-in-12 pitch, which means that the common rafters rise 4 in. vertically for every 12 in. they run horizontally. Because hip rafters run at a 45° angle to their neighboring commons in plan view, hip rafters must run 17 in. for every 4 in. of rise (drawing above). (By the way, 17 in. is the hypotenuse of a right triangle with 12-in. legs.)

When cutting rafters for any type of roof, especially a hip roof, rafter templates are a great way to speed the layout process. These neat little site-built aids have the rafter plumb cut on one end and the bird's mouth layout on the other. For this project I will need templates with pitches of 4-in-12 for the common rafters and 4-in-17 for the hips.

For the common-rafter template, I use a 2-ft. long piece of 1x6, which is the same width as my rafter stock (photos p. 93). I place my rafter square, or triangle square, on the template stock, pivot it to the correct pitch number (4) on the row of numbers marked "common," and mark the ridge plumb cut along the pivot side (photos p. 93). I then slide the square down the template about 1 ft. and make a second plumb mark for the heel cut of the bird's mouth. I square this line across the top edge of the template so that I can use the line as a reference when marking the rafters.

A level seat cut combines with the plumb heel cut to make up the bird's mouth of the rafter. The seat cut of the bird's mouth lands directly on the 2x4 top plate, so I make the seat cuts about 3½ in. long, squared off to the heel-cut line. The plumb distance from the seat cut of the bird's mouth to the top edge of the rafter is the height above plate and must be the same for both hip-rafter and common-rafter templates in order to maintain the plane of the roof sheathing. Hip rafters are cut out of stock that is 2 in. wider than the commons so that the jack rafters will have full bearing on the hip. The hip template is also cut out of out of wider stock, in this case 1x8 (photos p. 93). The ridge cut is laid out the same as for the common-rafter template except that the square is pivoted to 4 and 17 if you're using a framing square or 4 on the hip-valley index of a triangle square. Again, I move the square down the template about 1 ft. and scribe a second plumb mark for the heel cut, with the line squared across the top. Next, I mark off the height above plate on the heel plumb line of the hip template and scribe the level seat-cut line at a right angle from this point.

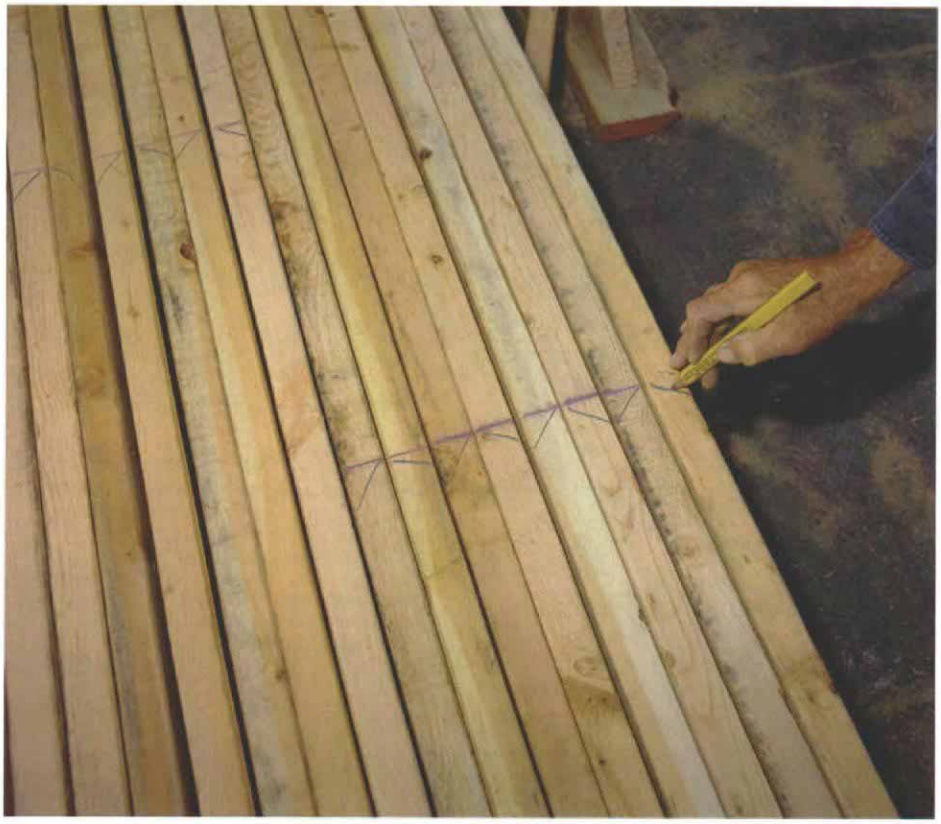
Hip rafters need to be lowered at the seat cut—The height above plate for the hip rafters is measured from the centerline of the rafter. Because the two roof planes intersect at an angle, the top edge of the hip rafter needs to be beveled slightly from the centerline to maintain the roof planes (top drawing, p. 94). This process of beveling a hip rafter (or a valley rafter) is known as backing.

A more efficient solution to this problem is lowering the hip rafter slightly (called "dropping the hip") by simply cutting the seat deeper. The size of the drop depends on the thickness of the rafter

Drawings: Christopher Clapp

Bird's mouths are overcut. A wedge shape is cut out of each rafter to give it a place to land on the plate. These bird's mouths can be overcutjust enough to remove the wedge.

All four hip rafters are laid out and cut at the same time. Short site-built sawhorses hold the rafter stock for layout and cutting. With all of the boards stacked together, only one set of measurements needs to be taken. Templates (photos facing page) do the rest.



Jack rafters are laid out four pairs at a time. Jacks oppose each other in pairs along both sides of the hip rafter. Each successive pair is shorter by a specified length than the pair above it Diagonal marks remind the author to make his 45° cuts in opposite directions.

stock and the pitch of the roof. I determine this distance by using a framing square (drawing bottom right, p. 94). For this 4-in-12 pitch roof, I need to drop the hip about in.

I subtract that in. from the height above plate on my hip-rafter template and make a new level seat-cut line at this point. When my layouts are complete, I cut out the templates carefully to ensure their accuracy. After cutting the bird's mouth in the hip-rafter template, I rip the tail section to the same width as the common rafters, which allows the soffit material to be properly aligned. I finish the templates by nailing a 1x2 fence to the upper edge of the template.

The quickest way to get rafter lengths is from tables—All of the information needed to calculate rafter lengths is right there on any framing square. But out here in southern California, I don't know of any framers who still use one for this purpose. Some framers determine rafter length using a feet-inch calculator like the Construction Master (Calculated Industries Inc., 4840 Hytech Drive, Carson City, Nev. 89706; 800-854-8075). However, I prefer to get my figures from a book of rafter tables, such as *Fall Length Rafter Framer* by A. F. Riechers (Box 405, Palo Alto, Calif. 94302).

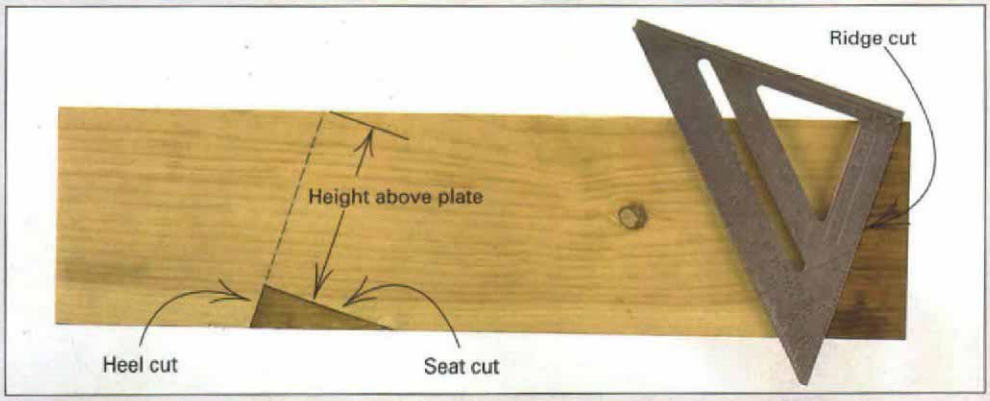
First, I find the page in the book that lists the rafter lengths for a 4-in-12 pitch roof. The length of a common rafter for a span of 18 ft. 6 in. is listed as 9 ft. 9 in. The length of the hip rafter for the same span is 13 ft. 5 in. These distances are from the plumb cut at the center of the ridge to the plumb heel cut of the bird's mouth at the outside of the wall. If the calculation method is based on run instead of span, don't forget to split the span figure in half.

Because these lengths are figured to the center of the ridge, the actual rafter length has to be shortened by half the thickness of the ridge (bottom drawing, p. 91). For a 2x ridge, common rafters must be shortened ¾ in., and because hip rafters meet the ridge at a 45° angle, they have to be shortened 1 1/16 in. These amounts are subtracted from the rafter by measuring out at 90° to the ridge plumb cut.

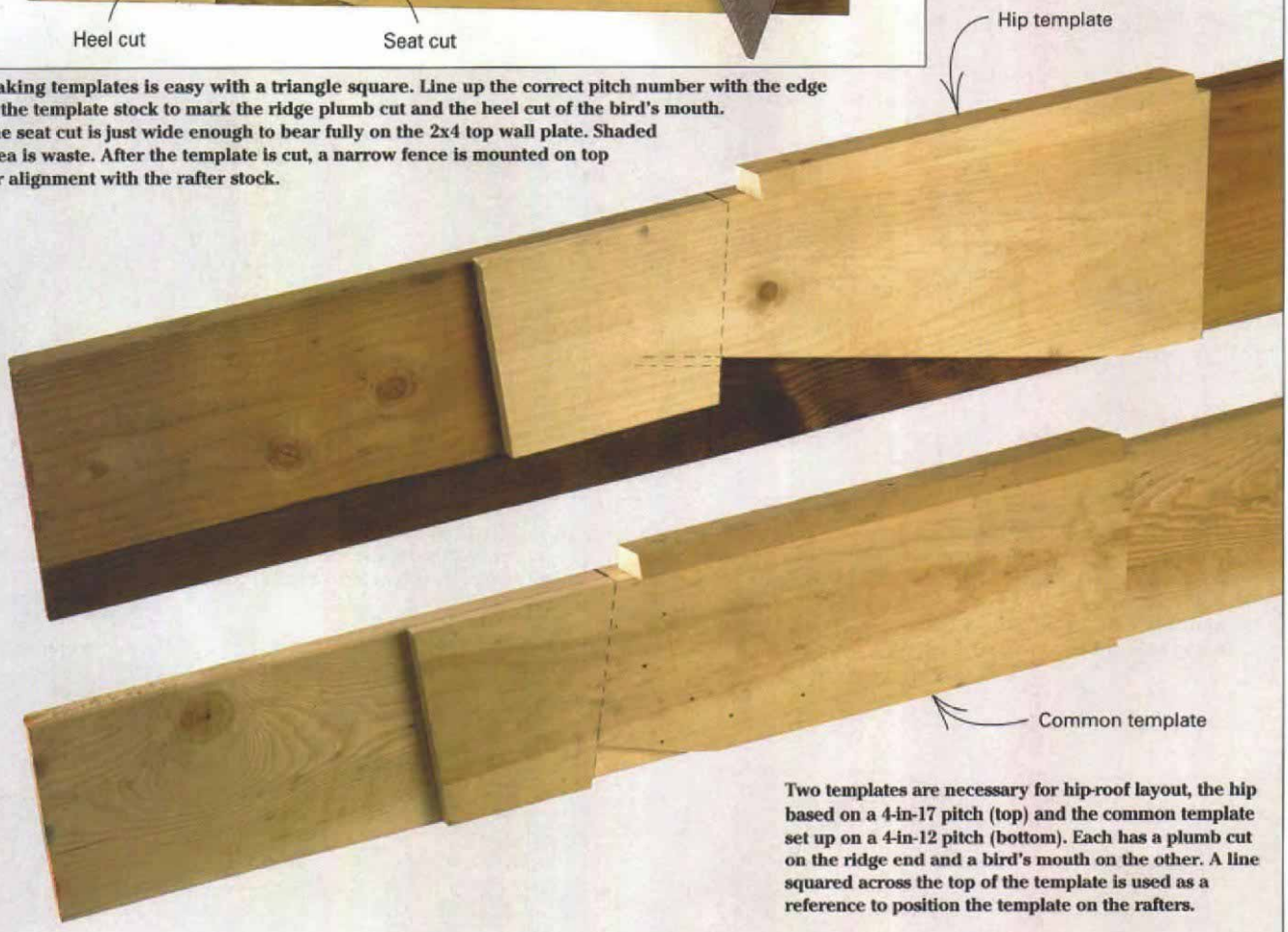
Lay out rafters in stacks of similar lengths—Once all of the rafter lengths have been determined, it's time to lay out my stock for cutting. I usually use the house plans to get a count of the rafters, keeping in mind that a hip roof has an extra common rafter on each end. Using a pair of low site-built horses, I rack up all of the commons on edge with the crowns up. Next, I flush the ridge ends by holding the face of a 2x4 against the end of the rafters and pulling the rafters up to it one at a time with my hammer claw. From the flushed end, I measure down my length on the two outside rafters, shortening my rafter measurement for the ridge. I snap a chalkline across the tops of the rafters as a registration mark for aligning the bird's mouth on the rafter template.

I then place my common-rafter template against the first rafter flush with the ridge end and scribe the ridge plumb-cut line. I slide this rafter to one side and continue down the line, leaving all of the rafters on edge. Next, I align the bird's mouth registration mark on the template with the chalkline on the rafters and mark my bird's mouth cutlines on each rafter. When all of the rafters are marked, I cut the ridges, moving the rafters over one at a time. Next, I flip the

Templates facilitate rafter layout



Making templates is easy with a triangle square. Line up the correct pitch number with the edge of the template stock to mark the ridge plumb cut and the heel cut of the bird's mouth. The seat cut is just wide enough to bear fully on the 2x4 top wall plate. Shaded area is waste. After the template is cut, a narrow fence is mounted on top for alignment with the rafter stock.



Two templates are necessary for hip-roof layout, the hip based on a 4-in-17 pitch (top) and the common template set up on a 4-in-12 pitch (bottom). Each has a plumb cut on the ridge end and a bird's mouth on the other. A line squared across the top of the template is used as a reference to position the template on the rafters.

rafters onto their sides and cut the bird's mouths, overcutting my lines just enough to remove the wedge without weakening the tail section (photo top left, facing page). I leave the rafter tails long and cut them to length after all of the rafters are in place.

A double cut brings the end of the hip rafter to a point—I try to pick out long, straight stock for the hips. The hip rafters need to be long enough to include the overhanging tail, which is longer than the tails on the commons. Most carpenters like to give hip rafters a double-side (or bevel) cut at the ridge so that they will fit nicely into the corner formed by the end and side king commons (bottom drawing, p. 91). I do this by laying the hip-rafter template on the rafter stock and marking the ridge cut (drawing bottom left, p. 94). I then slide the pattern down 1½ in. and make a second mark parallel to the first. With my saw set at 45°, I cut along the first line in one direction and the second in the opposite direction, which leaves me a pointed end that will fit in between the king common rafters.

I set the hip stock on edge and flush up the pointed ridge ends (photo top right, facing page). Then I measure down from these points and make my plumb-heel-cut reference marks, shortening the rafters 1 1/16 in. for the 2x ridge. Now the registration mark on my hip template can be aligned with the marks on my rafters, and I can scribe the bird's mouths.

To scribe the hip-rafter tails to the proper width, I hold a pencil against the tail part of the hip template and slide the template along the length of the tail. The bird's mouth of the hip rafters is cut just like the common rafters, and the tails are ripped to complete the cutting.

Jack rafters are cut in pairs—Jack rafters run parallel to the king commons and frame in the triangular roof sections between the king commons and the hip rafters. They are nailed in pairs into both sides of the hip rafter with each pair cut successively shorter as they come down the hip. The difference in length between each pair of jack rafters is constant (it's called the common difference), and it can be found in the rafter ta-

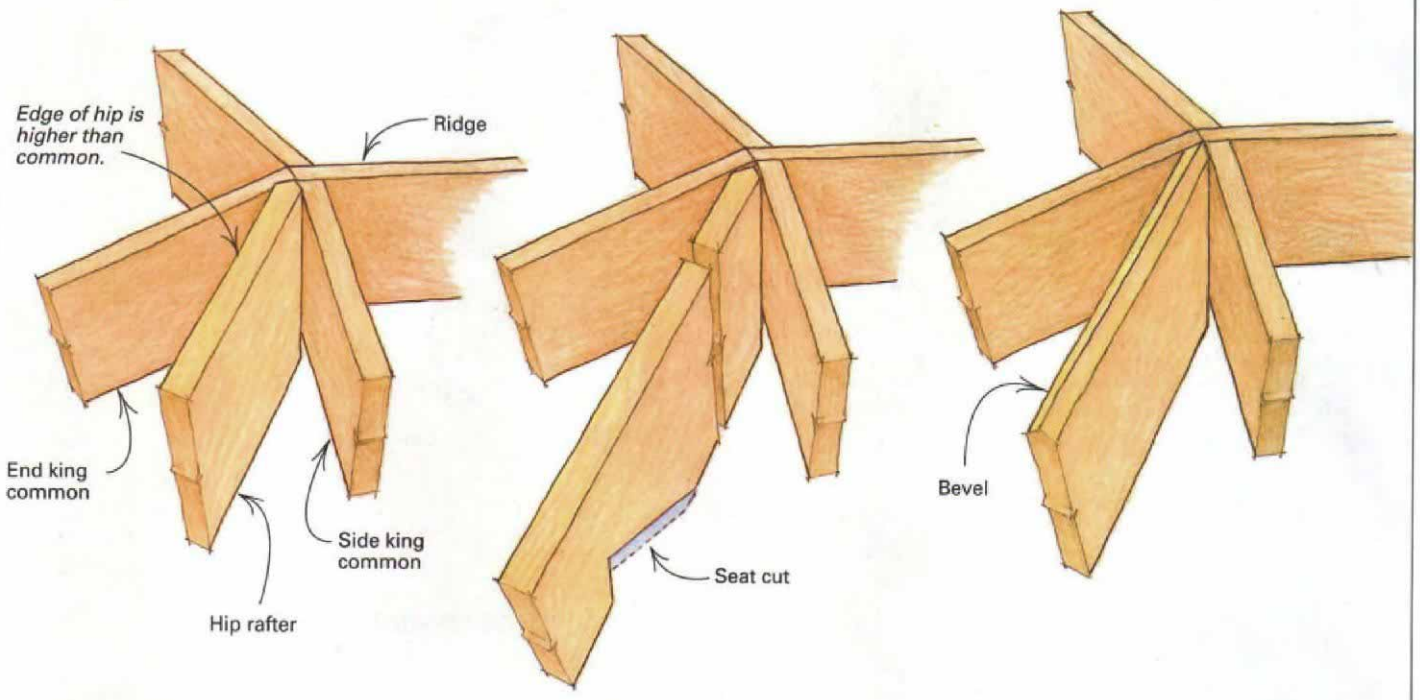
Photos this page: Robert Marsala

Two ways of dealing with hip rafters

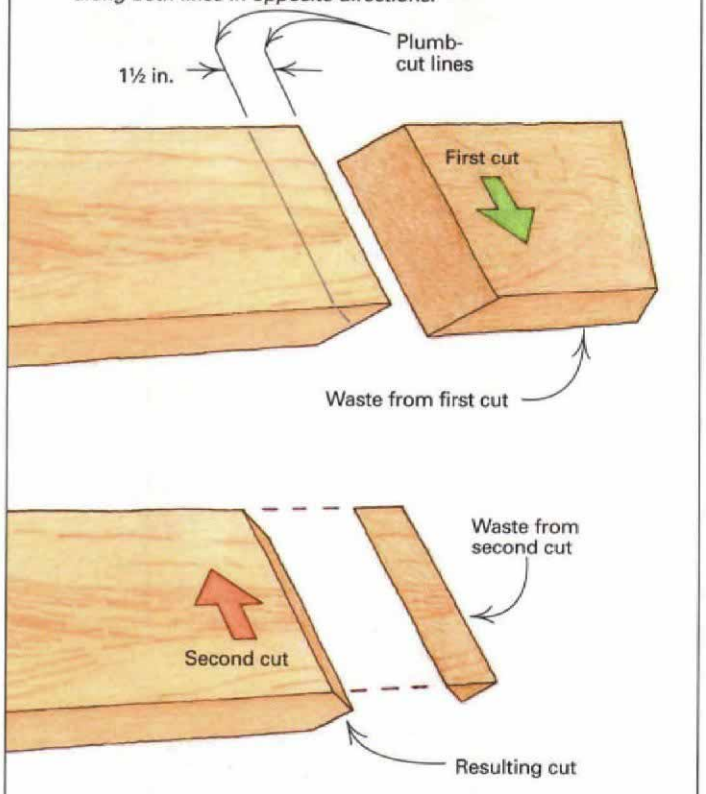
The problem. *Without modification, the top edges of the hip rafter would be higher than the king commons.*

Dropping the hip. *The entire rafter can be lowered by deepening the seat cut. See drawing bottom right.*

Backing the hip. *The top edge of the hip rafter can be beveled slightly from the centerline to the outer edge.*

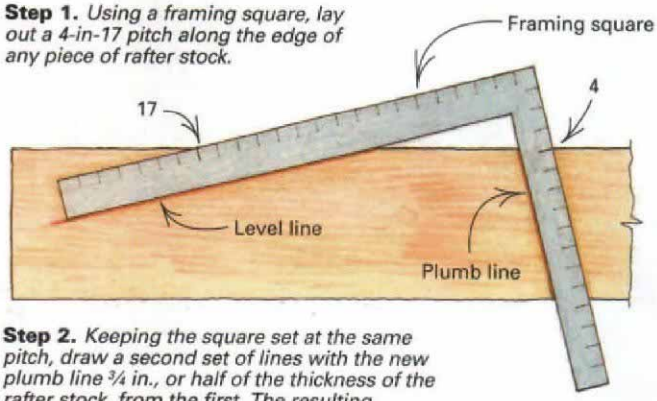


The hip-rafter ridge cut. *A double side cut on the ridge end of the hip rafter lets it fit nicely between the side and end king commons. To make this cut, scribe two parallel plumb-cut lines from the ridge end of the hip template 1½ in. apart. With the sawblade set at 45°, saw along both lines in opposite directions.*

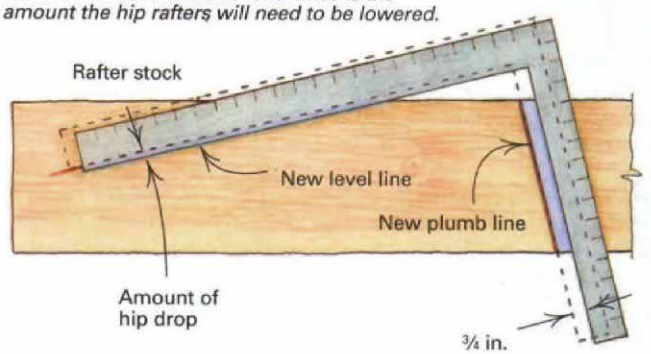


Finding the hip-rafter drop. *Hip rafters can be lowered slightly to put their edges in the same plane as the common rafters (see drawing below).*

Step 1. *Using a framing square, lay out a 4-in-17 pitch along the edge of any piece of rafter stock.*



Step 2. *Keeping the square set at the same pitch, draw a second set of lines with the new plumb line ¾ in., or half of the thickness of the rafter stock, from the first. The resulting distance between the two level lines is the amount the hip rafters will need to be lowered.*



bles. For jack rafters spaced at 16 in. o.c. at a 4-in-12 pitch, the difference in length is 1 ft. 4⅞in. For 24-in, spacing, the difference is 2 ft. 1¼ in.

I lay out the jacks by racking together eight pieces of rafter stock the same width but slightly shorter than the common rafter (bottom photo, p. 92). (I rack eight pieces because there is a pair of jacks of equal length for each of the four hips.) Next to these I rack eight more pieces a foot or so shorter than the first eight and so on for each set of jack rafters. When the jack-rafter stock is laid out, I flush up the tail ends this time. The tails of the jack rafters are the same length as the tails of the commons, so I snap a line at that distance across all of the edges for my plumb heel cuts.

Next I lay an unshortened common rafter alongside my rack, lining up its heel-cut line with the heel-cut line on the jack stock. From the ridge cut of this common, I measure down the common difference. I shorten this first set of eight jacks by 1⅛ in. just like the hip rafter and make diagonal marks in opposite directions on each pair of jacks to remind me which way my cuts will go (bottom photo, p. 92). For each successive set of jacks, I measure down the common difference in length from the previous set. These measurements do not need to be shortened by the width of the hip rafter because I subtracted 1⅛ in. from my first measurement.

Using the common-rafter template, I mark the plumb side cut and the bird's mouth cut. Because pairs of jacks land on opposite sides of the hip, the 45° plumb cuts have to be laid out on opposite sides of each pair of rafters.

The hips and king commons come together at the ridge. The end of the ridge is the meeting point for all of the major framing members of the hip roof. After the end king common is nailed in, the hip rafters are installed, and the ends of the side king commons are nailed in next to the hips.

Assemble common rafters first—If everything is cut accurately, the roof members should fit together like a puzzle (photo p. 90). I always tack down plywood sheets on top of the ceiling joists for a safe place to work. The ridge length and rafter layout can be taken directly from layout on the wall plate, but I prefer to bring up a ridge section and begin my rafter layout about 6 in. from one end. I like having this extra length to compensate for any discrepancies in my layout.

With a partner, I set up my first pair of side king commons and nail them to the plate and into the ceiling joist. (In high-wind areas, rafters may need to be tied to the plates with a metal framing anchors.) Next, I go to the other end of the ridge and nail in another set of commons.

The ridge board then gets pulled up between the two sets of commons and nailed in place. I just tack the side king commons to the ridge until the end common has been installed. At this point I make sure the ridge is level by measuring from the tops of the ceiling joists at each end. I support the end of the ridge with a 2x4 leg down to a ceiling joist or to an interior wall and run a diagonal sway brace to keep everything in place temporarily. Next, I slide one of my side king commons out of the way, hold the end king common next to the ridge and mark the end of the ridge. After the ridge is cut to length, I nail my end king common in place.

Next, a hip rafter is toenailed to the wall plate directly over the outside corner. The side cut on the ridge end gets nailed to the end common next to the ridge. I nail the opposing hip in place, and the two side king commons can be slid back against the hips and nailed in permanently.

If the roof is long, additional ridge sections may be installed using other pairs of common rafters for support. Again, I make sure additional ridge sections are level. At the other end of the building, I mark and cut the ridge and assemble the hips and side king commons as at the first end.

Frieze blocks stabilize the rafters—Before nailing in the jack rafters, I sight down the hip rafter and make sure it is straight from the ridge to the plate. If it's bowed, I brace it straight temporarily until the jacks are in. I start with the longest pair of jacks and nail them to the plate along with frieze blocks, which are nailed in between the rafters at the plate (photo p. 90).

Local codes don't always call for frieze blocks, but I use them to stabilize rafters and provide perimeter nailing for roof sheathing. If necessary, they can be drilled and screened for ventilation and are a good way to use scrap lumber. I cut a bunch of blocks ahead of time to either 14½in. or 22½ in., depending on my rafter spacing.

Frieze blocks can be installed flush with the wall, where they serve as backing for the exterior siding. However, with this method the blocks need to be ripped to fit below the roofline. Another method is installing the blocks perpendicular to the rafter just outside the plate line. I like this second method because it requires no ripping and provides a stop for the top of siding.

I nail in the frieze blocks as I install the remaining pairs of jack rafters. Each jack is nailed securely to the hip rafter; I take care not to create a bow. Once all of the pairs of jacks are installed, the hip will be permanently held in place.

The comer frieze blocks get an angled side cut to fit tight against the hips. Once all of the jacks and commons are nailed in, the rafter tails can be measured, marked and trimmed to length. Remember to measure the overhang out from the wall and not down along the rafter. For this building the overhang is 20 in., and the fascia stock is 2x (1½ in. thick). I mark a point on the top edge of the rafters 18½ in. straight out from the walls at both ends of the building and snap a line across the rafters between my marks. I extend my chalklines out over the tails of the hip rafters to mark the overhang at the corners. When marking the plumb cut on the rafter tails, use the common-rafter template on the commons and the hip template on the hips. □

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