Stacking Supported Valleys

With this simple formula, you can lay out and cut any roof

by Will Holladay

Recently while working on a beautiful Tudor home in the hills outside Medford, Oregon, I had the opportunity to cut the roof shown above, and in plan, at right (see Figure 1). From this roof plan, you'll notice the main roof is four large Versa-Lam hip beams converging to a near peak, with three smaller gable sections and supported valleys hanging from them.

This project contained every possible type of supported valley — a valley-to-hip (valley #1 on roof framing plan), a valley-to-valley (valley #2), and a "disappearing" valley (valley #3). My goal in this article is to explain how to calculate, lay out, and stack these three types of supported valleys. Since the birdsmouth cut for any supported valley is no different from that for a regular valley I'll focus only on the connection at the top.

Valley to Hip

Whether you use a framing square, rafter tables, a crystal ball, or my LL ratio method (see "Using Line Length Ratios"),

Roof Framing Plan

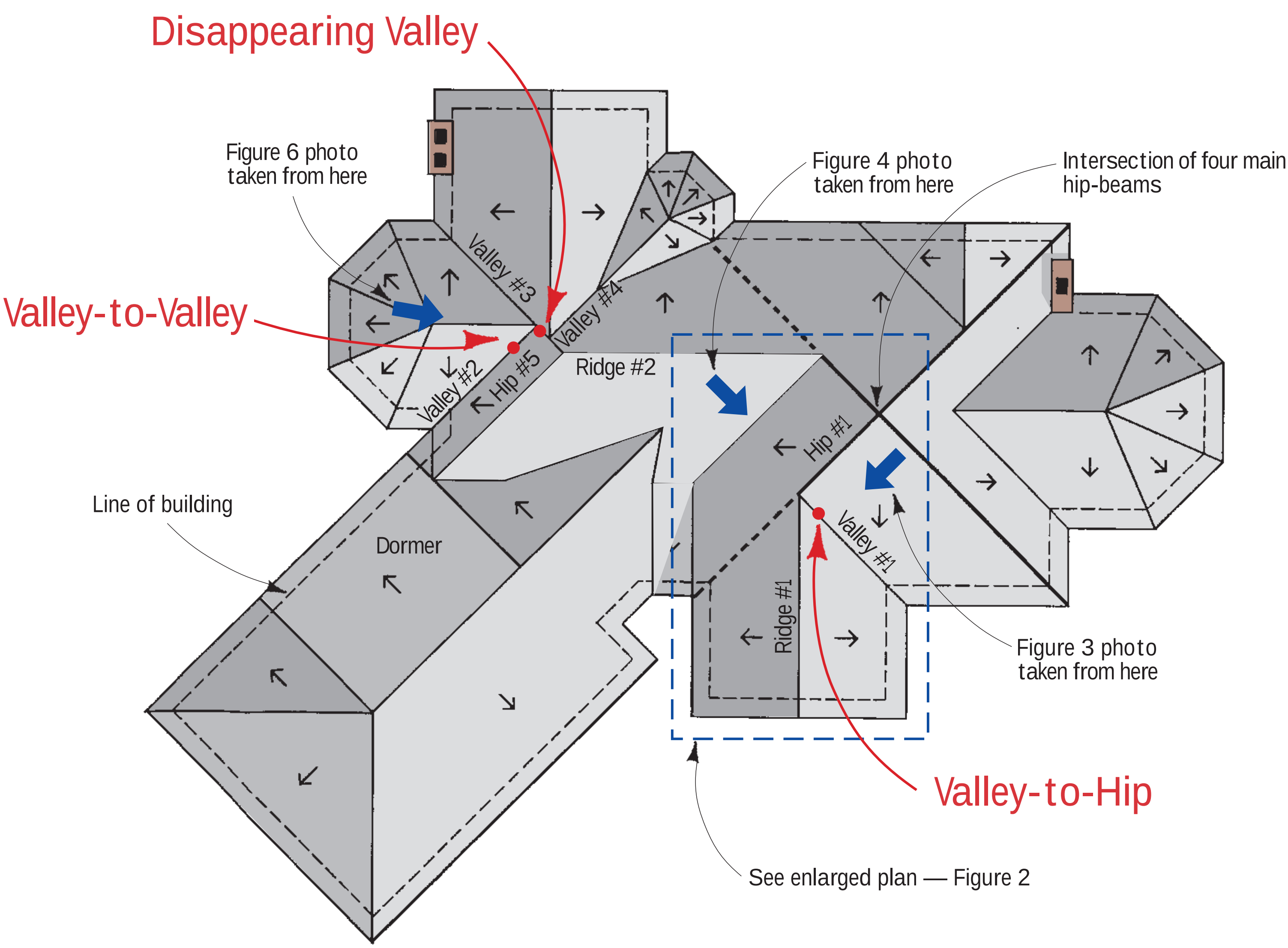


Figure 1. While cutting this multi-planed roof, the author encountered every possible type of supported valley: a valley supported by a hip (valley #1); a valley supported by another valley (valley #2); and a "disappearing" valley that also serves as a hip (valley #3).

Valley-to-Hip

Framing Plan Detail

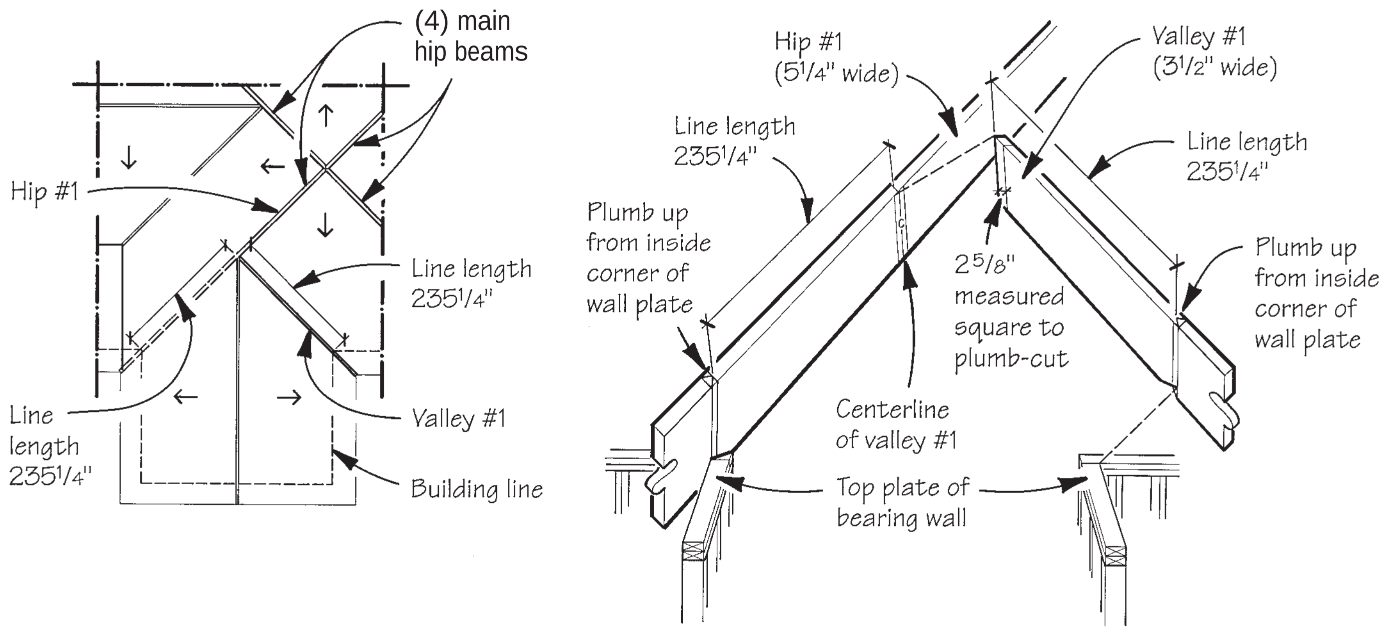


Figure 2. To locate the intersection of the center of valley #1 with the supporting hip beam, mark the line length on the hip, measuring up the hip from the outside of the wall plate. Cut valley #1 to the line length, then shorten it by measuring perpendicular to the plumb cut half the thickness of the hip.

Ridge Cheek Cut

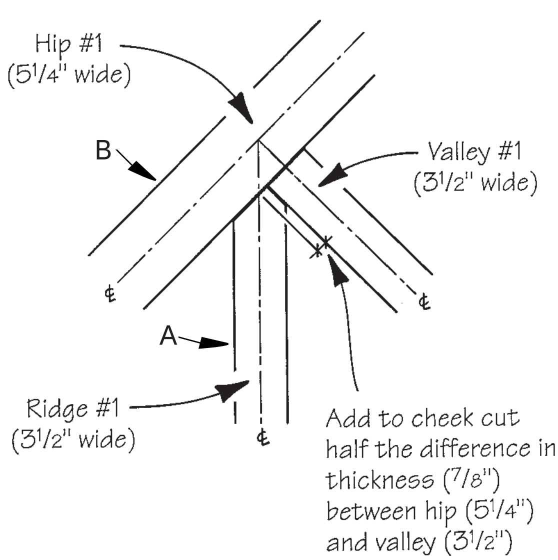


Figure 3. A special cheek cut is required to align the ridge with hip and valley beams of different thicknesses (photo). First, lay out a standard double 45-degree cheek cut, then add 7/8 inch (half the difference between the two beam widths) to the side towards the thinner material (illustration).

the first step is to calculate the correct length of the supported valley. Rafter lengths for supported valleys are figured for the full span and shortened by half the thickness of the supporting member. For example, the overall span for valley beam #1 is 286 5/8 inches and the roof pitch is 10/12, so its line length equals 235 1/4 inches. This length must be shortened by half of the 5 1/4-inch-thick hip, or 2 5/8 inches. Measure this shortening distance perpendicular to the plumb cut.

When stacking valley #1, locate its position by measuring up 235 1/4 inches along hip beam #1, starting from the point where the center of the hip crosses the outside wall plate line (Figure 2). Then, square across and plumb down to mark the center of the supported valley. The center of the valley is then aligned flush with the near edge of the hip it is hanging from.

Ridge cheek cuts. On this house, the hips are 5 1/4 inches thick and the valleys are 3 1/2 inches thick. To properly align the ridge that ties in here (ridge #1), with the centers of the hip and valley, you must make a special cheek cut on the ridge (Figure 3).

To lay out this cheek cut, mark an equal double 45-degree cheek cut on the ridge, then add half the difference between the two beam widths (5 1/4 – 3 1/2 = 1 3/4 ÷ 2 = 7/8) to the side towards the thinner material, as shown in Figure 3. This will center the ridge correctly.

The correct ridge height at this hip-valley connection is located where the side of the ridge nearest the hip (side A in Figure 3) planes in with the far side of the hip (side B).

The easiest way to stack this connection is to set a temporary ridge post at each end of the ridge. With this temp ridge set to the correct height, everything will automatically line up if there aren't any other problems.

When filling in with jacks, the "con-

Figure 4. Because the main hip interrupts the gable rafters (above), the upper jacks will meet high on the hip (left) to stay in plane with the lower jacks.

Valley-to-Valley

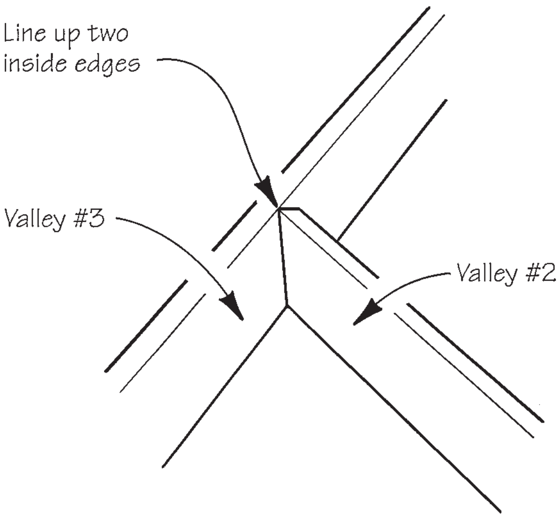
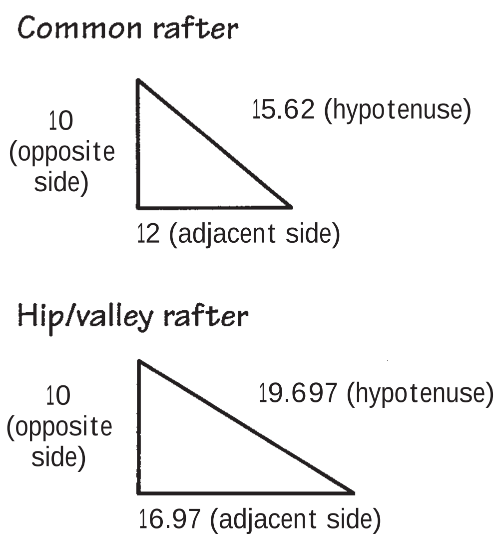


Figure 5. At a valley-to-valley connection, the two inside edges of the valleys meet at the top.

Using Line Length Ratios

I think people make roof framing much too complex. I'm not a math wizard, and most roof framing books are way too complicated for me. So I've relied on a simple system of using ratios to calculate rafter lengths, which I call LL ratios. This method does not require a fancy calculator with trig functions and fractions, pages of rafter tables, or a computer program (which I understand you can get now). A low-budget calculator with standard functions (+, –, x, ÷) will do.

Rafter Geometry



$$\text{LL ratio} = \frac{\text{Hypotenuse}}{\text{Adjacent side}}$$

Figuring LL Ratios

LL ratios can be figured for any roof slope (see chart at right). For example, from the Pythagorean theorem we know that a triangle with a rise of 10 and a run of 12 has a slope, or hypotenuse, of 15.62 (see illustration). To find the LL ratio, divide the slope by the run: 15.62÷12 = 1.3017.

For hips and valleys, the LL ratio is figured using the hip/valley run: a diagonal distance of 16.97 for every 12 inches of run. For a 10/12 roof, divide 19.697 by 12 = 1.6414.

When I walk onto a job, I write all the LL ratios I'll need on the floor deck and on the prints where I can always see them. That way I don't have to memorize all the different ratios I might be using on one roof, or stop to figure them out.

Figuring Rafter Lengths

Use the following formula to figure any line length:

$$\frac{\text{Total span} - \text{Ridge thickness}}{2} \times \text{LL ratio} = \text{Line length}$$

When figuring this dimension, I prefer to subtract the ridge thickness out at the beginning, so I don't have to remember to shorten the rafter later while laying it out. (Note: This works for standard rafters, but for a supported valley, follow the shortening method described in the text on previous page.)

Rafter LL Ratios

Pitch	Common	Hip/Valley
1	1.0034	1.4166
1 1/2	1.0077	1.4196
2	1.0137	1.4239
2 1/2	1.0214	1.4294
3	1.0307	1.4360
3 1/2	1.0416	1.4439
4	1.0540	1.4529
4 1/2	1.0680	1.4630
5	1.0833	1.4742
5 1/2	1.1000	1.4865
6	1.1180	1.4999
6 1/2	1.1372	1.5143
7	1.1577	1.5297
7 1/2	1.1792	1.5461
8	1.2018	1.5634
8 1/2	1.2254	1.5816
9	1.2500	1.6007
9 1/2	1.2750	1.6206
10	1.3017	1.6414
10 1/2	1.3287	1.6629
11	1.3567	1.6852
11 1/2	1.3850	1.7083
12	1.4142	1.7320
14	1.5366	1.8333
16	1.6666	1.9436
18	1.8028	2.0615
24	2.2361	2.4495

This chart lists Line Length ratios for roof pitches up to 24/12. Find the pitch of the roof in the first column, then select the ratio for either common or hip/valley rafters.

tinuation jacks" between the hip and the intersecting ridge must be held high to plane in with the far edge, as shown in Figure 4.

Valley-to-Valley

At the connection of valley #2 (supported) and valley #3 (supporting), the two inside edges of the valleys must align at the top (Figure 5), rather than as I've described for the valley-to-hip connection.

On a ridge that hangs between two valleys (as in the case of ridge #2 at valleys #2 and #3), the top edge must plane into the centers of the valleys on each side.

Disappearing Valley

Valley #3 is a special case. Notice in Figure 1 how this beam acts as a valley between the plate line and the intersection with valley #2. Then, for all practical purposes, the valley disappears, and reappears as a hip above the intersection with valley #4.

To make the upper section of valley #3 a hip, it must be backed (Figure 6). Back it on the right side (looking up the hip from the outside) from valley #2 up to ridge #2, and on the left side from valley #4 to ridge #2. A skilled craftsman would rip these angles on the ground prior to stacking. But wood butcher that I am, I simply eyeballed the backed section and cut it with a chain saw after it was stacked.

With valley #3 backed, the top inside edge will line up with the top edge of hip #5 and ridge #2. But the top center of the backed portion will be higher (Figure 7). Also notice that valley #3 and hip #5 must be cut full span to butt together at the end of ridge #2.

Will Holladay *is author of* A Roof Cutter's Secrets *and works as a freelance roof framing contractor throughout the U.S.*

Figure 6. When a single beam serves as both a valley and a hip, it must be backed. The right side of this valley (valley #3 in Figure 1) is backed from the valley-to-valley connection up to the ridge, and on the left side from the ridge back down to the gable ridge (coming in from the left side in the photograph). These rips can be made on the ground or in the air after the roof has been stacked.

Disappearing Valley

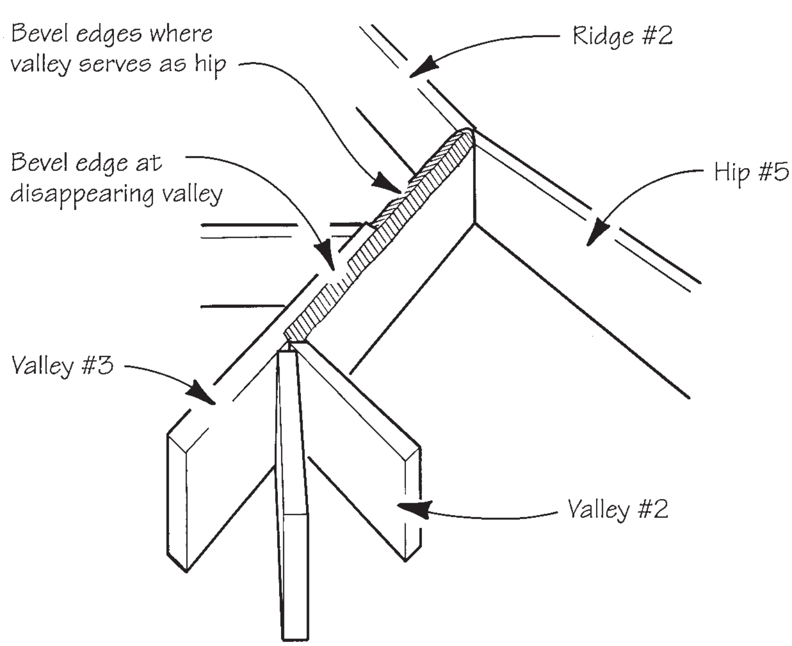


Figure 7. The inside edge of the back cut on valley #3 lines up with the top edge of the hip and ridge; the peak of the backed portion, however, will be higher.