

ROOFING

CONSTRUCTION & ESTIMATING

by Daniel Atcheson

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*To my grandchildren Sophie & Cole Painter
And to my Lord and Savior, Jesus Christ, who gave me eyes to see, hands to type and a mind to think.*

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1 Measuring and Calculating Roofs

► If you're like some roofing contractors, you estimate roofing quantities by calculating the area of a roof, then adding 10 percent for waste. That might be OK in a fat building market, but in a tight market you'll need a sharper pencil to compete successfully for the good jobs, and then make money on them. In this book, I'm going to show you how to make a quick and accurate takeoff for any kind of roof.

You'll also learn the latest and most acceptable roofing methods in an industry where installation practices are closely related to warranties. That's because material warranties may be invalid if you don't follow the manufacturer's recommendations for installation. Look here for general guidelines, but always follow the manufacturer's instructions to the letter.

New products come on the market every day to solve the complex roof covering requirements presented by modern building technology. Your job is to know as much as you can about those products. You also have to know how to install them so the job passes inspection and presents no future repair and maintenance problems. Callbacks are hard on your profit margin — and they don't do your reputation any good either. Know as much as you can about your roofing business, and you'll avoid them.

This book is more than an estimating book for roofing contractors. It develops a *system*, beginning with Chapter 1, for all types of roofing materials and installation methods. We'll cover the entire roofing trade, including how to manage your crews and keep them safe. So let's get started.

Before you can bid any job, you have to figure your costs. And before you can figure the costs, you have to know the size of the job. So you have to do two things: First, measure the roof and calculate the total area. Then find the lengths of the eaves, gables (or rakes), ridges, hips and valleys.

When you construct a roof on a new building, you can get these measurements from the plans. On repair or replacement jobs, you'll probably have to take your pencil, clipboard and tape measure, haul out your ladder, climb onto the roof, and start measuring.

To avoid mistakes, or a second trip to the job site, develop a system for taking measurements. Use a 100-foot flexible tape which has a ½-inch grommet hook at the "stupid" end of the tape. Flexible tapes are made of metal, or fiberglass-reinforced nylon fabric. Find a tape that's marked with highlights at 5-inch intervals to match the exposure of most composition shingles.

There is no cardinal rule for the sequence you use to measure a roof, as long as you don't miss anything. Here's a system that works for me:

Start by measuring the length of the eaves. On a gable roof, you only have to measure in one direction. On a hip roof, you'll have to measure the eaves in two directions.

Next, measure the width of the roof. On a gable roof, hook the tape over one of the eaves, and run it over the ridge to the opposite eave. On a hip roof, measure the width the same way. To measure the length, hook the tape to the eaves at the ridge rafter (look ahead to Figure 1-16 on page 13 for an illustration of the parts of a roof), run the tape the length of the ridge and down the opposite ridge rafter. Measure the ridge at the same time.

Now, measure the hips and valleys by hooking the tape to a building corner and running the tape to the ridge. You use these measurements to calculate material requirements such as valley flashing and hip-covering material.

When you measure, some dimensions need to be more accurate than others. For instance, you could miss the length of ridge, hip or valley by a foot or more, and the error wouldn't affect your total bid price too much. But don't make a mistake in the length and width, because that error could be substantial. For example, assume you measure a roof at 100 feet by 200 feet, while the actual measurements are 100'6" by 200'6". The difference between the two measurements is 150 square feet, or 1½ squares of material.

Always make a sketch of the roof layout, including dimensions, roof slopes, location of penetrations and any unusual circumstances such as rotten deck areas, ventilation problems, or overhanging tree branches or other obstructions.

Once you have the measurements, you'll use them to calculate areas, slopes, angles, and allowance factors. Let's begin with an easy example.

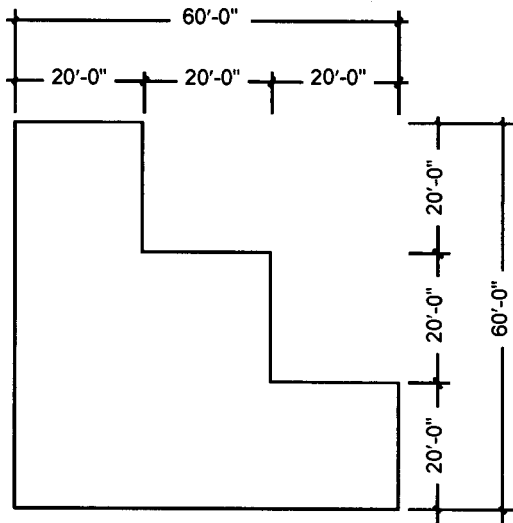


Figure 1-1 Roof plan of level roof

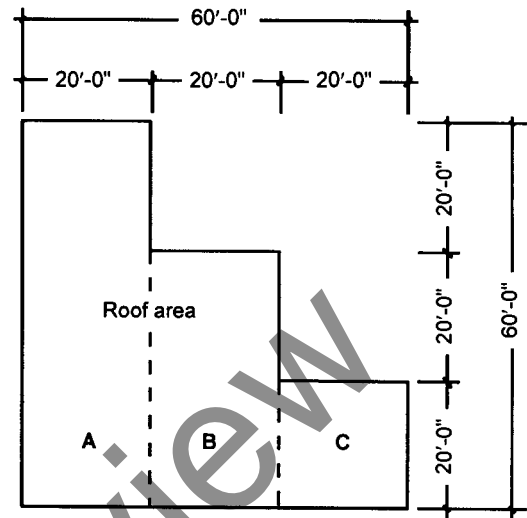


Figure 1-2 The positive method

Level Roofs

The dimensions on the plans give you the actual measurements for a level roof. To get the area of a rectangular roof, multiply its length by its width.

Area of a level rectangular roof = $L \times W$

where L is the length and W is the width.

Equation 1-1

Of course, not every roof you work on will be a single rectangle. You may need to figure the area of a roof like the one in Figure 1-1. There are two ways to calculate this area:

- 1) The positive method
- 2) The negative method

In the *positive* method, you divide the roof into rectangular areas, then add the parts to get the total area. See Figure 1-2.

With the *negative* method, you extend the roof lines to form a single rectangle. Calculate the area of this rectangle, and subtract the areas of the rectangular spaces which lie outside the actual roof. Figure 1-3 illustrates this.

▼ Example 1-1: The Positive Method

Divide the roof into rectangles as shown in Figure 1-2. Calculate the area of each rectangle, then add them together:

Area A = 20 feet by 60 feet, or 1,200 square feet

Area B = 20 feet by 40 feet, or 800 square feet

Area C = 20 feet by 20 feet, or 400 square feet

Then, the total area = 1,200 SF + 800 SF + 400 SF, or 2,400 SF

▼ **Example 1-2: The Negative Method**

Extend the roof lines to form one rectangle, as in Figure 1-3. Calculate the total area of that rectangle, then subtract the areas of any rectangles which aren't in the actual roof:

Extended rectangle = 60' x 60' = 3,600 SF

Area A = 40 feet by 20 feet, or 800 square feet

Area B = 20 feet by 20 feet, or 400 square feet

Total area outside the roof layout is 800 SF + 400 SF, or 1,200 SF. Subtract that from the extended area to get the total area:

3,600 SF - 1,200 SF = 2,400 SF

You get the same answer both ways. So you might as well use the easiest method — the one that requires the fewest calculations. For example, in Figure 1-4 you'd have to calculate three areas, then add them together. But in Figure 1-5 you only have to calculate two areas, and then subtract one from the other.

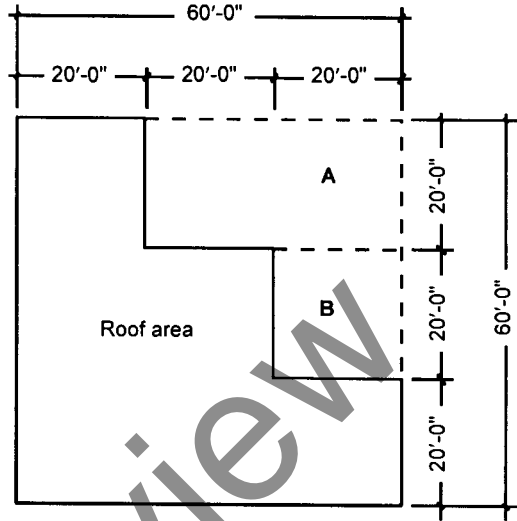


Figure 1-3 The negative method

Perimeter of a Level Roof

The *perimeter* (also called the perimetry or periphery) of a level roof is the total distance around the roof, measured from outside of roof to outside of roof. For example, in Figure 1-6, the perimeter is:

$$L + W + L + W + R + R, \text{ or } 2L + 2W + 2R, \text{ or } 2(L+W+R)$$

Equation 1-2

where L is the roof length, W is the width, and R is the depth of the recess.

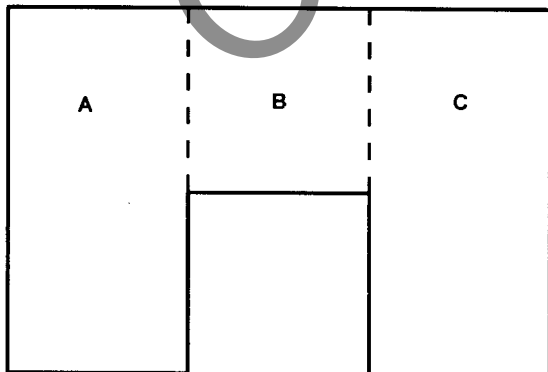


Figure 1-4 The positive method requiring three area calculations

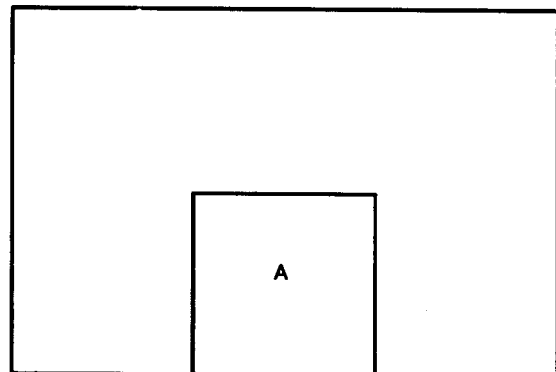


Figure 1-5 The negative method requiring two area calculations

If a building doesn't have any recesses, the equation is simply:

$$\text{Perimeter} = 2(L + W)$$

Equation 1-3

or 2 times the total of length plus width.

▼ **Example 1-3:** Find the perimeter of the level roof shown in Figure 1-7.

$$\begin{aligned} \text{The perimeter of the roof} &= 2 \times (40' + 45' + 12') \\ &= 194 \text{ linear feet} \end{aligned}$$

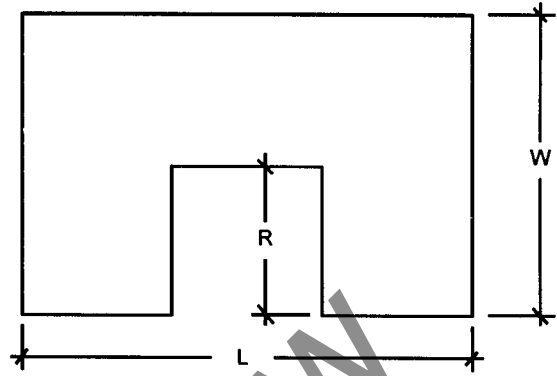


Figure 1-6 Roof perimeter

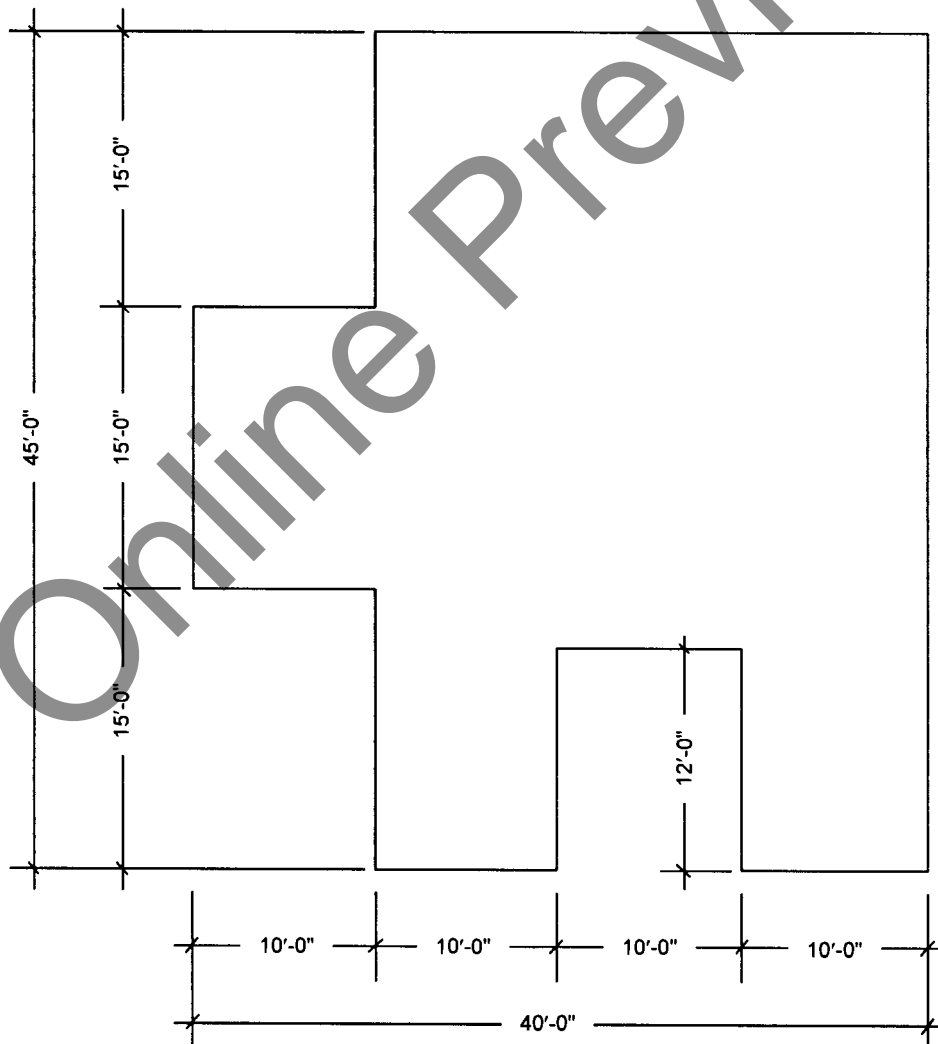


Figure 1-7 Roof perimeter example

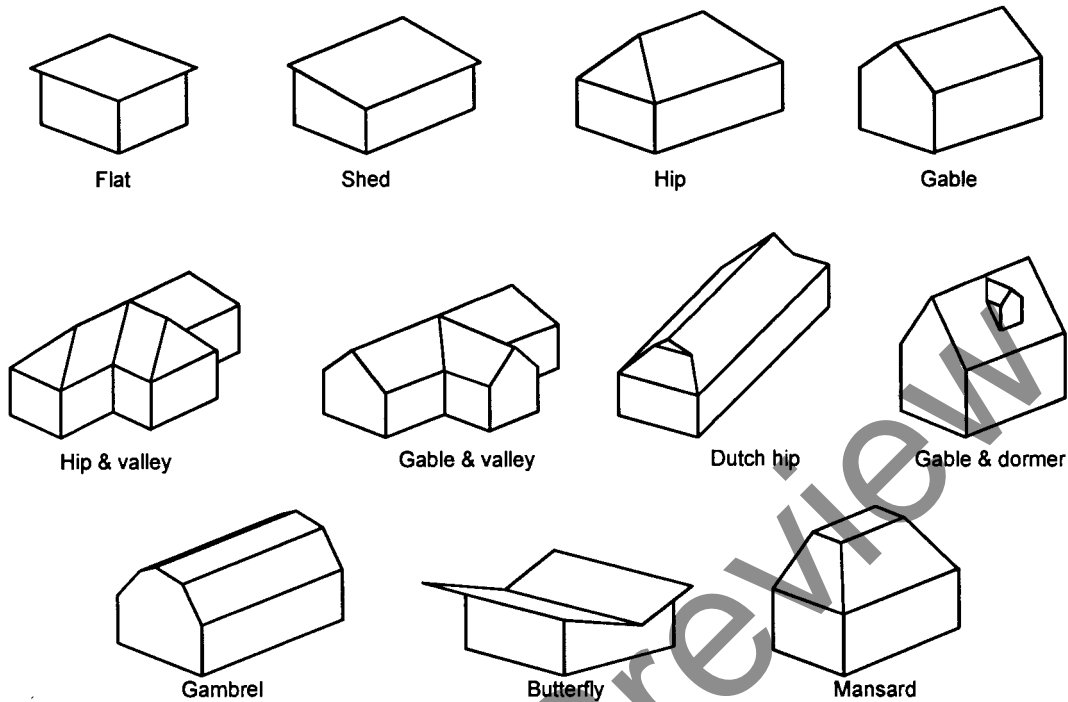


Illustration by Tami Atcheson

Figure 1-8 Roof types

Sloped Roofs

Figure 1-8 shows a few of the almost limitless types of sloped roofs. You define the *slope* of a roof in terms of rise (in inches) per 12 inches of run. For example, a “6 in 12 roof” is a roof that rises 6 inches for every 12 inches of horizontal run. That’s illustrated in Figure 1-9.

You can determine the slope of any roof with the equation:

$$\text{Slope} = \frac{\text{Total Rise}}{\text{Total Run}} = \frac{\text{Rise (in inches)}}{12 \text{ (inches per foot of run)}}$$

Equation 1-4

▼ **Example 1-4:** Use the above equation to find the slope of the roof in Figure 1-10.

$$\text{Slope} = \frac{5 \text{ feet } 5 \text{ inches (total rise)}}{13 \text{ feet (total run)}} = \frac{? \text{ inches}}{12}$$

Step 1: Convert feet and inches into feet and hundredths of a foot. To do that you divide 5 inches by 12 (inches). Notice that throughout the book, we usually round calculations to two decimal places.

$$5 \div 12 = 0.4166 = 0.42' \text{ (rounded off)}$$

Now the equation reads:

$$\text{Slope} = \frac{5.42' \text{ (total rise)}}{13' \text{ (total run)}} = \frac{? \text{ inches}}{12}$$

Step 2: To solve for “? inches,” multiply both sides of the equation by 12:

$$\text{Slope} = \frac{5.42}{13} \times 12 = 0.417 \times 12 = 5.004$$

You'll round that answer down to 5, so the slope of the roof is 5 in 12.

You can change the original formula to find total rise if you already know the slope and the total run:

$$\text{Slope} = \frac{\text{Total Rise}}{\text{Total Run}}$$

$$\begin{aligned} \text{Total Rise} &= \text{Slope} \times \text{Total Run} \\ &= \frac{5}{12} \times 13 \\ &= 5.42' \text{ or } 5'5'' \end{aligned}$$

You can also find the total run if you know the slope and the total rise:

$$\begin{aligned} \text{Total Run} &= \text{Total Rise} \div \text{Slope} = 5.42 \div 0.417 = 13 \\ \text{(Remember, the 0.417 is 5 divided by 12.)} \end{aligned}$$

- ▼ **Example 1-5:** Calculate the total rise for a roof with a slope of 5 in 12 and a run of 20 feet.

$$\begin{aligned} \text{Total Rise} &= 0.417 \times 20 \\ &= 8.34' \text{ or } 8'4'' \end{aligned}$$

Roof Pitch

The total *span* of a roof is the horizontal distance, from one eave to the other, as shown in Figure 1-11. You can use that information in a formula to find roof slope, if you know the roof *pitch*, by:

$$\text{Pitch} = \frac{\text{Total Rise}}{\text{Total Span}}$$

Equation 1-5

$$\text{Slope} = 2 \times \text{Pitch}$$

Equation 1-6

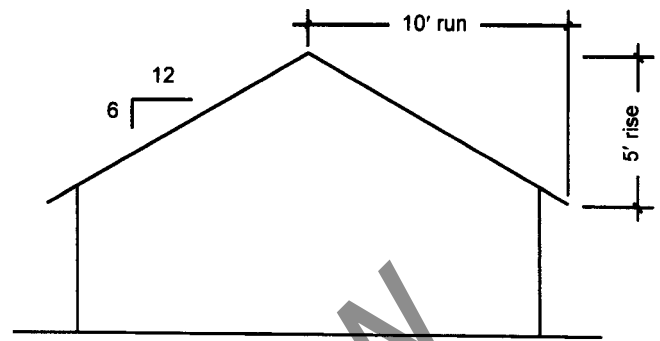


Figure 1-9 Roof rise and run

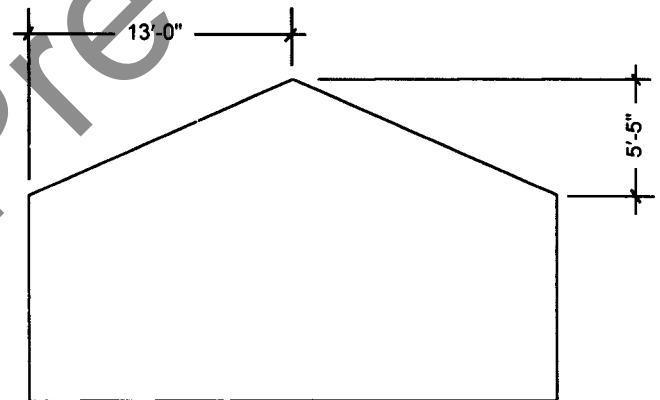


Figure 1-10 Roof slope example

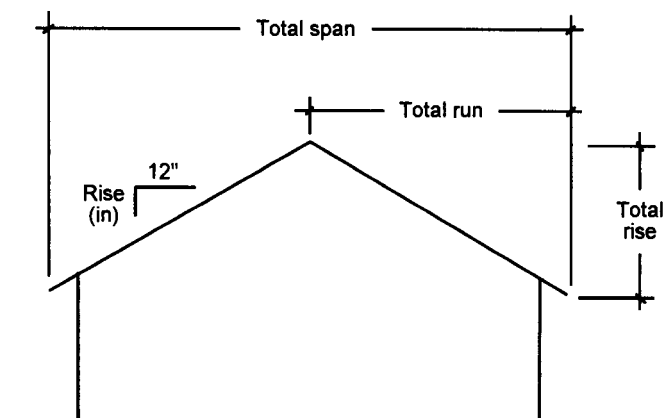


Illustration by Tami Atcheson

Figure 1-11 Roof rise, run and span

Occasionally a roof is described in terms of pitch, although that term means more to the framer than to a roofing estimator. But sometimes the pitch is the only information you have. Here's how to convert roof pitch to roof slope:

▼ **Example 1-6:** Convert a $\frac{1}{3}$ pitch into terms of roof slope.

$$\begin{aligned}\text{Slope} &= 2 \times \frac{1}{3} \\ &= \frac{2}{3}\end{aligned}$$

From Example 1-4, Step 2, you have:

$$\text{Slope} = \frac{2}{3} \times 12 = 8$$

Therefore, the roof slope is 8 in 12.

Roof Slope in Degrees of an Angle

Sometimes roof slope is described in terms of degrees of an angle. When it is, you can use Figure 1-12 to convert roof slope to degrees, and vice versa.

How to Measure Roof Slope

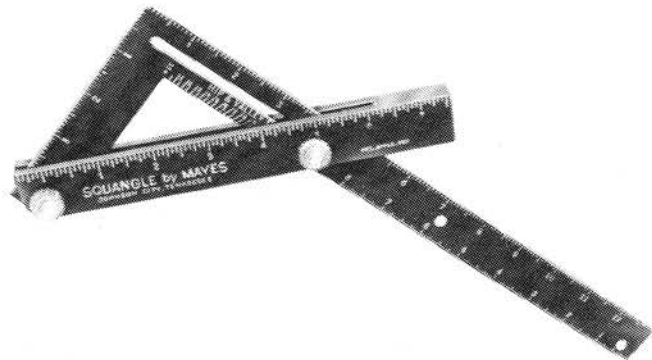
You can determine the slope of a roof with an adjustable device called a *Squangle*®. You simply place the *Squangle*® against an exposed rafter tail or a block placed over the fascia board, adjust the square so that it lines up with the slope of the roof and read the scale. Figure 1-13 shows a *Squangle*®.

You can also use a *sliding T-bevel* to size the angle between the fascia and roof deck. That's shown in Figure 1-14. Then transfer the angle to a board or sheet of paper and measure it with a *Squangle*® or protractor.

You can also place a bubble level and ruler over a straight board on the roof slope as shown in Figure 1-15. Since roof slopes are expressed in terms of rise per 12 inches of run, mark the level at 12 inches from one end. To determine slope, center the bubble in the level, place a ruler vertically so that its scale is lined up at your mark 12 inches from the up-slope end of the level, then read the distance to the bottom of the level. If, for instance, you read 4 inches on the ruler, the roof rises (or falls) 4 inches for each foot of run. Therefore, the roof slope is 4 in 12.

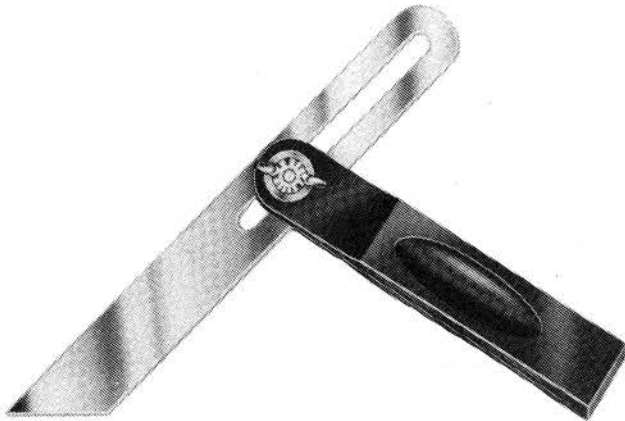
| Roof slope (rise & run) | Roof slope (degrees) |
|-------------------------|----------------------|
| 1 in 12 | 4.76 |
| 2 in 12 | 9.46 |
| 3 in 12 | 14.04 |
| 4 in 12 | 18.43 |
| 5 in 12 | 22.62 |
| 6 in 12 | 26.57 |
| 7 in 12 | 30.26 |
| 8 in 12 | 33.69 |
| 9 in 12 | 36.87 |
| 10 in 12 | 39.81 |
| 11 in 12 | 42.51 |
| 12 in 12 | 45.00 |
| 13 in 12 | 47.29 |
| 14 in 12 | 49.40 |
| 15 in 12 | 51.34 |
| 16 in 12 | 53.13 |
| 17 in 12 | 54.78 |
| 18 in 12 | 56.31 |
| 19 in 12 | 57.72 |
| 20 in 12 | 59.04 |
| 21 in 12 | 60.26 |
| 22 in 12 | 61.39 |
| 23 in 12 | 62.45 |
| 24 in 12 | 63.43 |

Figure 1-12 Converting roof slope to degrees



Courtesy of Mayes Brothers Division of Great Neck Saw Manufacturers Inc.

Figure 1-13 Squangle®



Courtesy of Stanley Tools

Figure 1-14 T-bevel



Figure 1-15 Determining roof slope

Rafters

Rafters are the inclined members of the roof frame. Figure 1-16 illustrates these rafter types:

- A rafter that extends perpendicularly from the top of an outside wall to the ridge board is called a *common rafter*.
- A common rafter that runs parallel to the ridge board is called a *ridge rafter*.

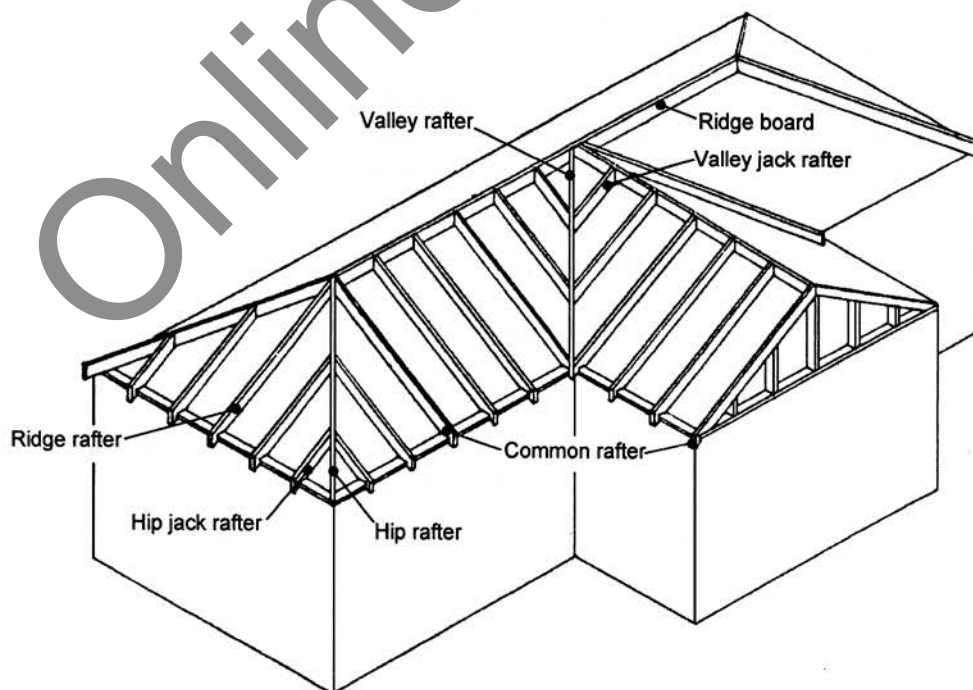


Illustration by Tami Atcheson

Figure 1-16 Various types of rafters

- A rafter that extends diagonally from an outside corner of a building to the ridge board is called a *hip rafter*.
- A rafter that extends diagonally from an inside corner of a building to the ridge board is called a *valley rafter*.
- A rafter that extends from an outside wall to a hip rafter is called a *hip jack rafter*.
- A rafter that extends from the ridge board to a valley rafter is called a *valley jack rafter*.

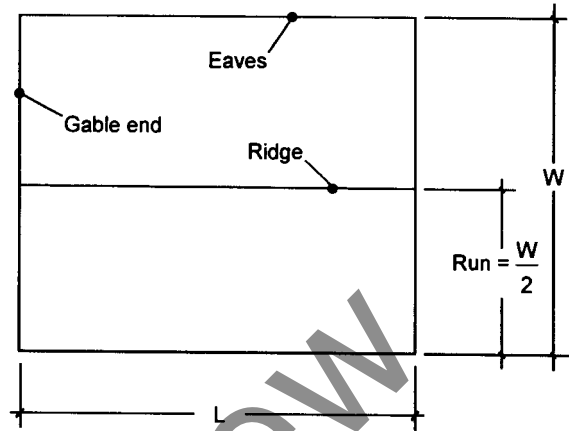


Figure 1-17 Plan view of gable roof

Rafter Length

Figure 1-17 is a plan view of a gable roof. The length (L on Figure 1-17) of the eaves edge (the roof dimension perpendicular to the run of the rafters) is horizontal. Therefore, you can read that dimension directly from the plans. But you can't see the exact size of the width (W in the figure) because the roof slopes. The *plan length* of a common rafter is called the *run* of the rafter. Figure 1-18 illustrates this for three kinds of rafters.

Sometimes you can scale the lengths of common rafters from an elevation or cross section drawing. But it's safer and more convenient to convert the plan dimensions. Figure 1-19 is a table which gives you the appropriate conversion factors. Column 2 of the table gives factors for common rafters, and columns 3 and 4 are for hip or valley rafters.

The values in column 2 are called *roof-slope factors*. The values in columns 3 and 4 are called *hip/valley-slope factors*. The conversion factors in Figure 1-19 assume that all hips and valleys are framed at an angle of 45 degrees with respect to the eaves line.

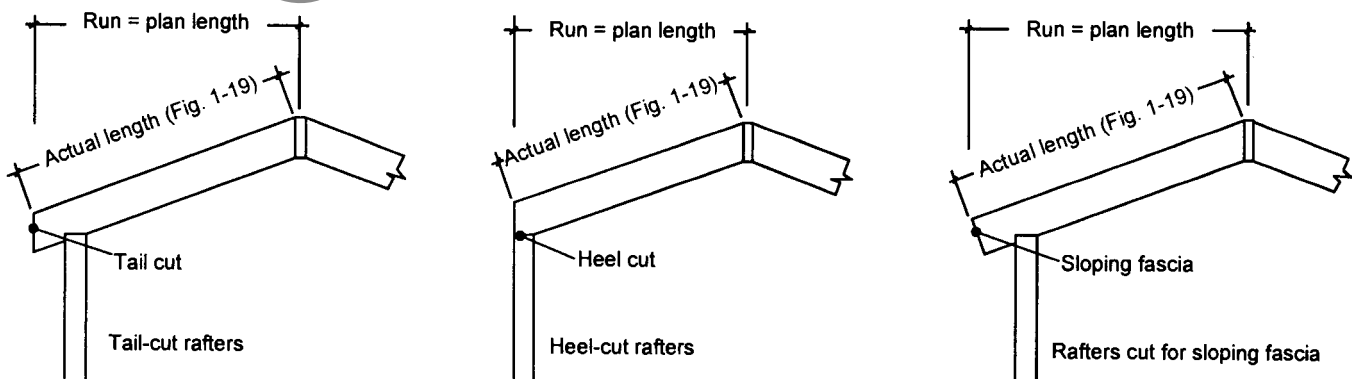


Illustration by Tami Atcheson

Figure 1-18 Run of various types of rafters

| (1) Roof slope | (2) Common or jack rafters (factor x run = actual length) | (3) Hips or valleys (factor x run = actual length) | (4) Hips or valleys (factor x plan length - actual length) |
|-------------------|---|--|---|
| 1 in 12 | 1.004 | 1.417 | 1.002 |
| 2 in 12 | 1.014 | 1.424 | 1.007 |
| 3 in 12 | 1.031 | 1.436 | 1.015 |
| 4 in 12 | 1.054 | 1.453 | 1.027 |
| 5 in 12 | 1.083 | 1.474 | 1.042 |
| 6 in 12 | 1.118 | 1.500 | 1.061 |
| 7 in 12 | 1.158 | 1.530 | 1.082 |
| 8 in 12 | 1.202 | 1.564 | 1.106 |
| 9 in 12 | 1.250 | 1.601 | 1.132 |
| 10 in 12 | 1.302 | 1.642 | 1.161 |
| 11 in 12 | 1.357 | 1.685 | 1.191 |
| 12 in 12 | 1.414 | 1.732 | 1.225 |
| 13 in 12 | 1.474 | 1.782 | 1.260 |
| 14 in 12 | 1.537 | 1.833 | 1.296 |
| 15 in 12 | 1.601 | 1.888 | 1.335 |
| 16 in 12 | 1.667 | 1.944 | 1.375 |
| 17 in 12 | 1.734 | 2.002 | 1.416 |
| 18 in 12 | 1.803 | 2.062 | 1.458 |
| 19 in 12 | 1.873 | 2.123 | 1.501 |
| 20 in 12 | 1.944 | 2.186 | 1.546 |
| 21 in 12 | 2.016 | 2.250 | 1.591 |
| 22 in 12 | 2.088 | 2.315 | 1.637 |
| 23 in 12 | 2.162 | 2.382 | 1.684 |
| 24 in 12 | 2.236 | 2.450 | 1.732 |

Figure 1-19 Roof-slope factors for determining rafter lengths

Use roof-slope factors from column 2 of Figure 1-19 to determine the actual length of a common rafter or jack rafter.

You'll refer to this table again in later chapters. There's another copy, Appendix A, in the back of the book.

▼ **Example 1-7:** Look at the diagram in Figure 1-20. Assume a roof slope of 10 in 12, then find the actual length for the typical common rafters.

$$\begin{aligned}
 \text{Actual Length (common rafter)} &= 10' \times 1.302 \text{ (from column 2,} \\
 &\quad \text{Figure 1-19)} \\
 &= 13.02 \text{ linear feet}
 \end{aligned}$$

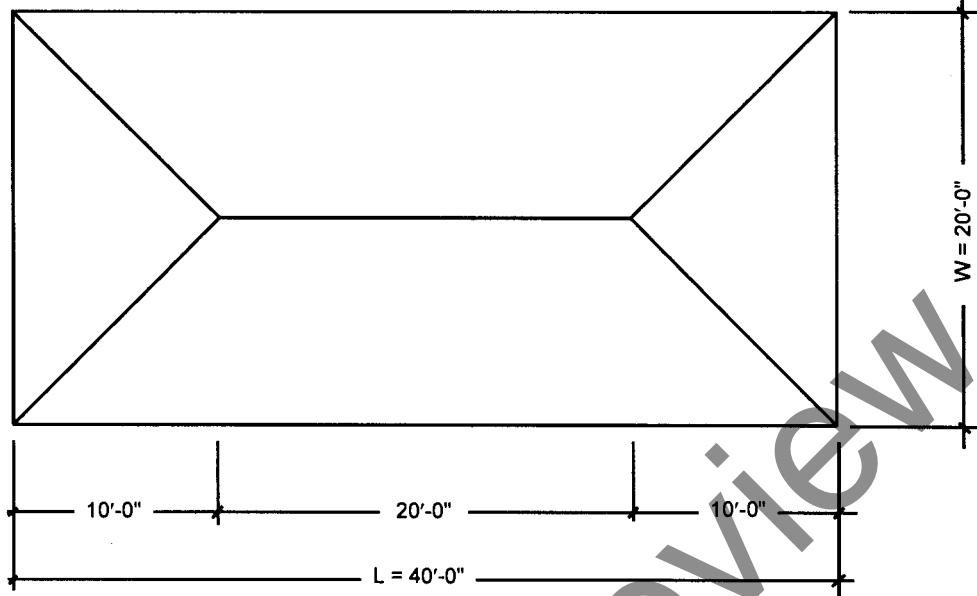


Figure 1-20 Hip roof example

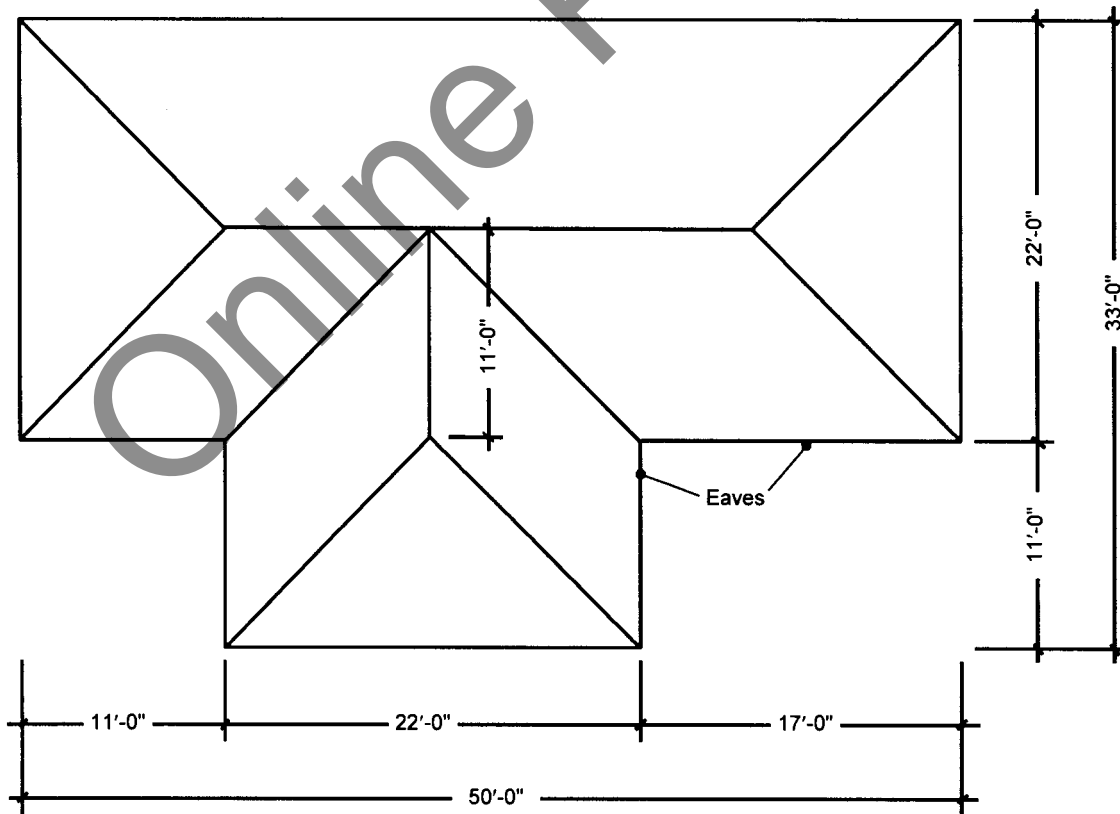


Figure 1-21 Hip-and-valley roof example

Perimeter of a Sloped Roof

The eaves of a hip roof (Figure 1-20) or a hip-and-valley roof (Figure 1-21) run horizontally all the way around the building, so you can determine the perimeter from the dimensions on the roof plan. The formula is the same as that for a level roof:

$$P = 2(L + W + R)$$

Equation 1-7

where L is the roof length, W is the roof width, and R is the depth of the recess.

If the building has no recess, the formula for the perimeter is simply:

$$P = 2(L + W)$$

Equation 1-8

▼ **Example 1-8:** Find the perimeter of the hip roof in Figure 1-20.

$$P = 2(40' + 20') = 120 \text{ linear feet}$$

To find the perimeter of a gable roof like the one in Figure 1-17, the formula is:

$$\text{Perimeter} = 2(\text{Length} + \text{Actual Width})$$

Equation 1-9

$$\text{Actual Width} = 2(\text{Run} \times \text{Roof-Slope Factor})$$

Equation 1-10

$$= 2\left(\frac{W}{2} \times \text{Roof-Slope Factor}\right)$$

$$= W \times \text{Roof-Slope Factor (from column 2 of Figure 1-19)}$$

Thus, the perimeter of a *gable roof* is:

$$\text{Perimeter} = 2[L + (W \times \text{Roof-Slope Factor})]$$

Equation 1-11

▼ **Example 1-9:** Find the perimeter of the gable roof in Figure 1-22 if the roof slope is 8 in 12.

$$\begin{aligned} P &= 2(31' + [26' \times 1.202]) \\ &= 2(31' + 31.25') \\ &= 2 \times 62.25' \\ &= 124.5 \text{ linear feet (For estimating purposes,} \\ &\quad \text{round this to 125 feet.)} \end{aligned}$$

Net Versus Gross Roof Area

The *net* area of a roof is the area of roof sheathing that will be covered with roofing material. But you have to provide materials for an area much larger than the net roof area. You have to allow for such things as:

- Additional felt underlayment at the ridge, hips, and valleys

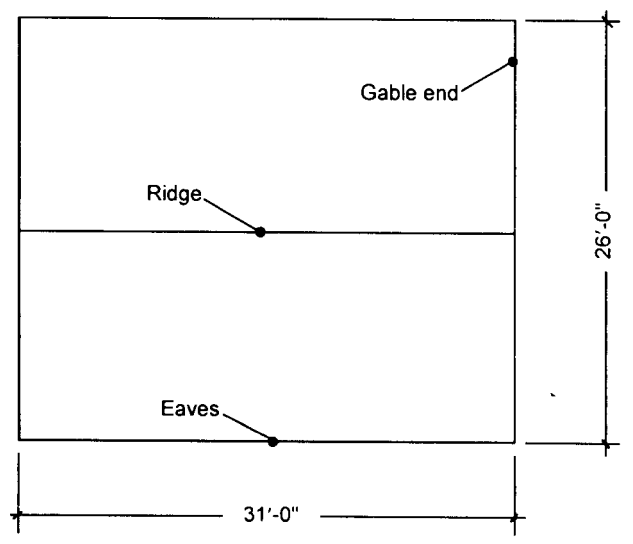


Figure 1-22 Gable roof example

- A starter course
- Hip and ridge units
- Cutting allowances at rakes, hips, and valleys (for shingles)

This larger roof area is called the *gross* area of the roof. For example, the net area of a roof might be 10 squares. However, you might have to provide additional material equal to a roof area requiring 12 squares. A roofing *square* is 100 square feet.

Allowance Factors

The simplest way to account for material required for overcutting and lapping is to use an *allowance factor*. An allowance factor is the ratio of the actual amount of material required to cover the roof (gross roof area) to the net area of roof deck covered:

$$\text{Allowance factor} = \frac{\text{Area Covered (including allowances)}}{\text{Net Roof Area}}$$

Equation 1-12

You can figure the percentage of material overrun by using the allowance factor. Here's an example:

▼ **Example 1-10:** Assume that it will require 12 squares of material (including allowance for waste and lapping) to cover 10 squares of roof deck. Calculate the allowance factor and the percentage of material allowance.

$$\begin{aligned} \text{Allowance factor} &= \frac{12 \text{ squares}}{10 \text{ squares}} \\ &= 1.20, \text{ or a 20 percent material allowance factor} \end{aligned}$$

In later chapters, you'll see that allowance factors can be predicted, based on the roof type, roof size, roof slope, roofing material exposure, and type of roof construction.

Calculating Total Net Roof Area

Since the eaves and ridge of a roof run horizontally, their plan lengths are their actual lengths. And, as you've seen, you can find the actual length of any common rafter by multiplying its plan length by the roof-slope factor in Figure 1-19. So you can use a universal formula to calculate the actual (net) area of any roof that meets the following conditions:

- All roof planes have the same slope
- All hips and valleys are framed at 45 degrees with respect to the eaves

Here's the formula:

Actual (Net) Roof Area = Roof Plan Area x Roof-Slope Factor

Equation 1-13

where Roof Plan Area equals roof area as seen in plan view. The Roof-Slope Factor is from column 2 of Figure 1-19.

▼ **Example 1-11:** Assuming a roof slope of 5 in 12, find the net area of the roof shown in Figure 1-22.

$$\begin{aligned}\text{Net Roof Area} &= 31' \times 26' \times 1.083 \\ &= 873 \text{ SF} \div 100 \text{ SF/square} \\ &= 8.73 \text{ squares}\end{aligned}$$

▼ **Example 1-12:** Assume a roof slope of 4 in 12, then find the net area of the roof shown in Figure 1-21.

$$\begin{aligned}\text{Total Roof Plan Area} &= (50' \times 22') + (22' \times 11') \\ &= 1,342 \text{ SF}\end{aligned}$$

$$\begin{aligned}\text{Net Roof Area} &= 1,342 \text{ SF} \times 1.054 \\ &= 1,415 \text{ SF} \div 100 \\ &= 14.15 \text{ squares}\end{aligned}$$

When the slope of a roof changes from one section to another, you have to do a separate take-off for each area with a different slope. Here's an example:

▼ **Example 1-13:** Compute the net area of the roof in Figure 1-23.

Step 1: Section off the drawing, as shown in Figure 1-24, to isolate the two different slopes. Begin with the large 6 in 12 section. Notice you must deduct the triangle formed by the section of 4 in 12 roof (labeled ABC on the drawing). Multiply the length by the width and subtract the area of the triangle:

$$\begin{aligned}\text{Roof Plan Area (6 in 12)} &= (100' \times 48') - \left(\frac{48' \times 8'}{2}\right) \\ &= 4,800 \text{ SF} - 192 \text{ SF} \\ &= 4,608 \text{ SF}\end{aligned}$$

Step 2: Use the Roof-Slope factors from column 2 of Figure 1-19 to find the net roof area for the 6 in 12 roof:

$$\text{Net Roof Area (6 in 12)} = 4,608 \text{ SF} \times 1.118 = 5,152 \text{ SF}$$

Step 3: Find the area of the 4 in 12 section. Notice that you *add* the area of the triangle to this section:

$$\begin{aligned}\text{Roof Plan Area (4 in 12)} &= (48' \times 16') + \left(\frac{48' \times 8'}{2}\right) \\ &= 768 \text{ SF} + 192 \text{ SF} \\ &= 960 \text{ SF}\end{aligned}$$

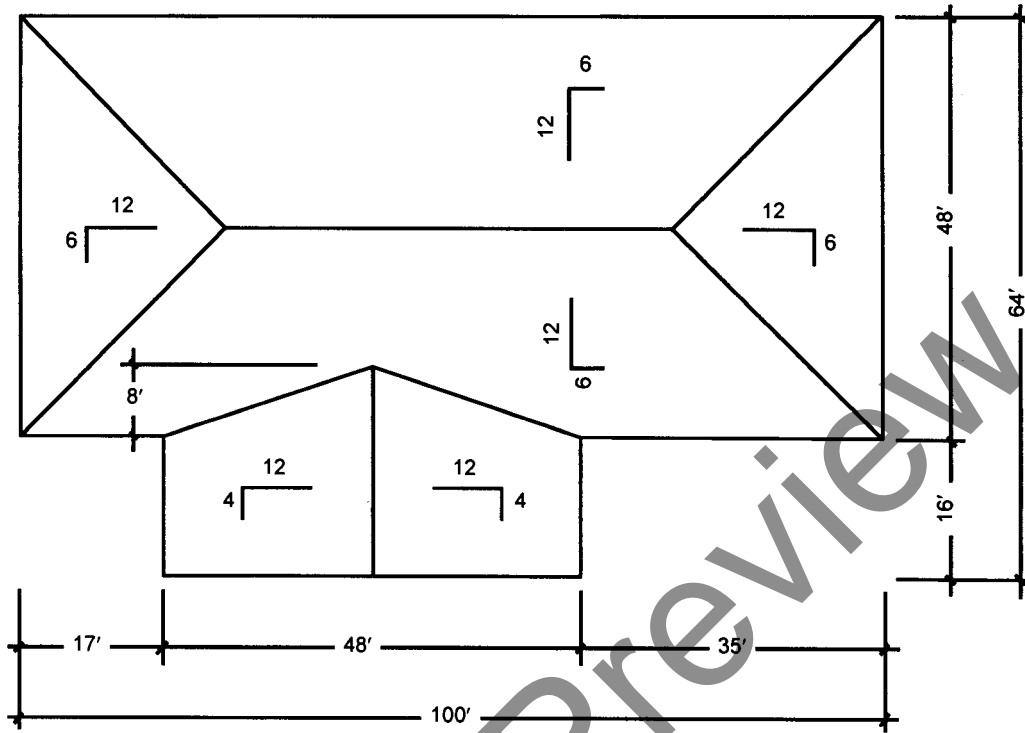


Figure 1-23 Roof with varied slopes

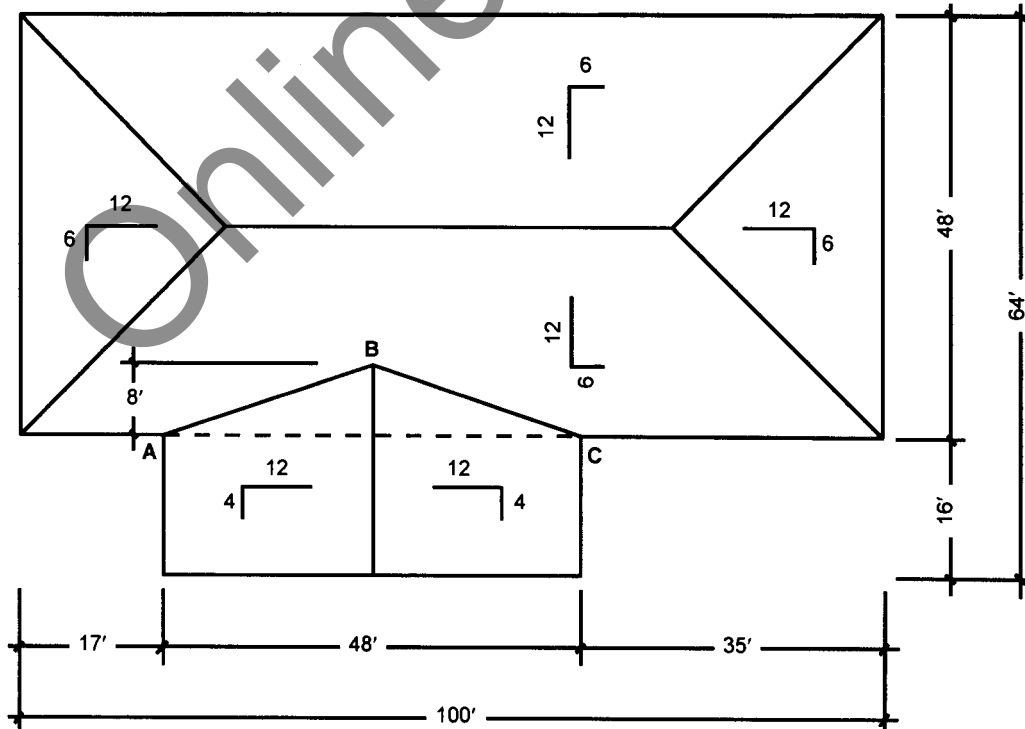


Figure 1-24 Sectioning the roof plan

Step 4: Repeat Step 2 for the 4 in 12 section:

$$\begin{aligned}\text{Net Roof Area (4 in 12)} &= 960 \text{ SF} \times 1.054 \\ &= 1,012 \text{ SF}\end{aligned}$$

Step 5: Add together the two net areas:

$$\begin{aligned}\text{Total Net Roof Area} &= 5,152 \text{ SF} + 1,012 \text{ SF} \\ &= 6,164 \text{ SF}\end{aligned}$$

Roof Overhangs, Hips and Valleys

When you calculate the net area of a roof, be careful you don't omit the roof overhang that extends beyond the walls of the building. (See Figure 1-25.) Also watch for overhangs at interior gable end walls on multi-level roofs like the one in Figure 1-26, and on dormers.

You also need accurate measurements for hips and valleys, which require a variety of roofing materials. Again, refer to Figure 1-19 for conversion factors you can use to calculate the actual lengths for hip and valley rafters. Use the slope factors in column 3 if the hip or valley rafter dimensions are based on the run. Use column 4 if measurements are taken from the plan length. See Figure 1-27.

If the hips and valleys are framed conventionally at a 45-degree angle to the outside walls, you can calculate the plan length with this formula:

$$\begin{aligned}\text{Plan Length (Hip or Valley)} & \\ = 1.414 \times \text{Run} & \quad \text{Equation 1-14}\end{aligned}$$

▼ **Example 1-14:** Assume a roof slope of 10 in 12, then find the actual length of any hip rafter for the roof in Figure 1-20.

In this illustration, the run of the hip rafter is 10 feet. Refer to column 3 in Figure 1-19 and you see the conversion factor for a 10 in 12 slope is 1.642.

$$\text{Rafter length} = 10' \times 1.642 = 16.42 \text{ linear feet}$$

You can also use the formula above to calculate the plan length based on the run, then use the factor from column 4 in Figure 1-19 to get the actual length:

$$\text{Plan length} = 1.414 \times 10' = 14.14 \text{ linear feet}$$

$$\text{Rafter length} = 14.14 \times 1.161 = 16.42 \text{ linear feet}$$

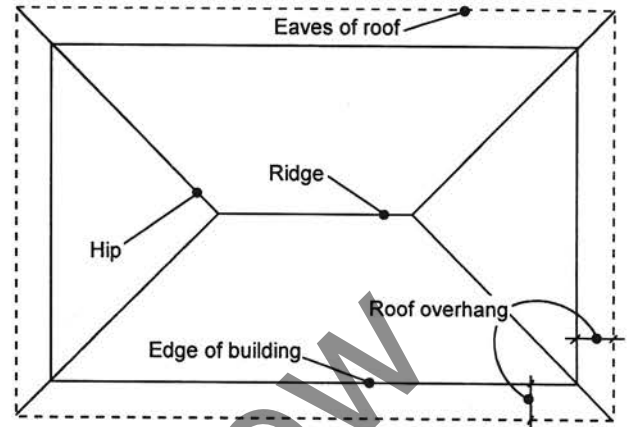


Illustration by Tami Atcheson

Figure 1-25 Roof overhangs

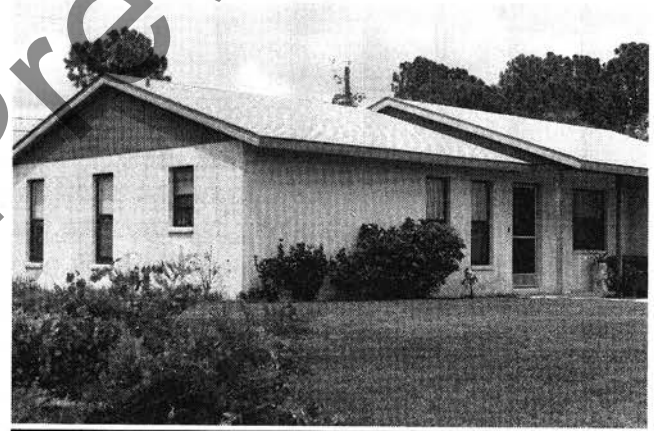


Figure 1-26 Multi-level roof overhang

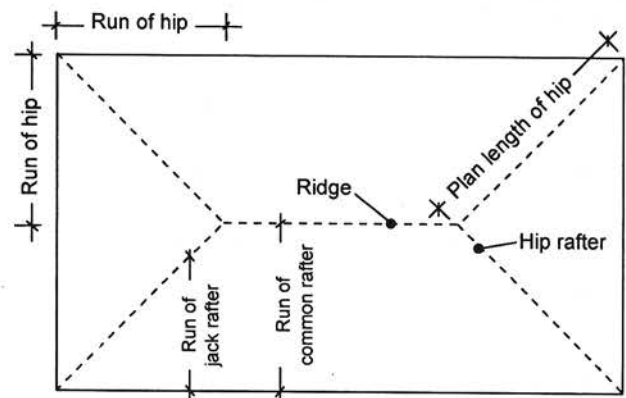


Illustration by Tami Atcheson

Figure 1-27 Lengths of hip rafters

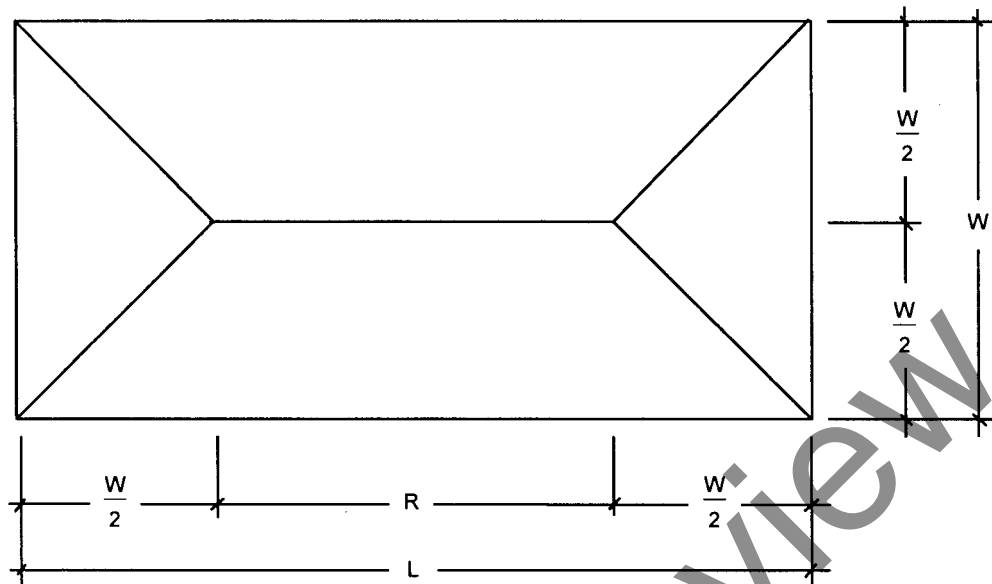


Figure 1-28 Ridge length

Now, what if a building is built with roofs of unequal slopes, such as the one shown in Figure 1-23? You can find the actual length of a valley where the roofs intersect by multiplying the run of the low-sloping roof by the appropriate factor from the table in Appendix B.

▼ **Example 1-15:** Determine the actual length of each valley of the roof diagrammed in Figure 1-23. The run of the low-sloping roof is 24 feet.

So the actual valley length (using the factor from Appendix B) is:

$$\text{Valley length} = 24' \times 1.247 = 29.93 \text{ linear feet}$$

Length of Ridge (Hip Roofs)

Refer to Figure 1-28. If you assume that the hips are conventionally framed, you find the ridge length on a hip roof with:

$$\text{Ridge} = L - \left[2 \times \left(\frac{W}{2} \right) \right] = L - W$$

Equation 1-15

where L equals the length of the roof, and W is the width.

▼ **Example 1-16:** Determine the ridge length of the roof diagrammed in Figure 1-20.

$$\text{Ridge} = 40' - 20' = 20 \text{ linear feet}$$

You can't do the example problems in later chapters if you don't know the formulas in this chapter. Don't go on until you're sure you know how these equations work and how to apply them.

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| Prices subject to change without notice | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |