

# home

stick-framed vs. truss roof components

pitch & slope

roof shapes & components

roof frame components

estimating gable roof materials

estimating hip roof materials

estimating intersecting roof materials

valleys & frieze blocking

roof openings

exposed eaves

information resources



# framing

roofs: stick method

In some markets, trusses have replaced stick-framed roofs, but not everywhere—the decision is still a balancing act between cost and flexibility. Like wall panels, the savings in using trusses come from the fact that they go up quickly, which offsets the cost of making them. But the cost differential shrinks as the roof gets more complex and in some cases, it may even be cheaper to stick frame.

Why are roof trusses common and wall panels aren't? Because every framer knows how to build a wall. Stick-framing a roof is much more difficult, and sometimes takes years to learn.

You don't need to know how to stick frame a roof to supply materials, but you do need to know the concepts, terms, and procedures in stick framing whether you sell sticks or trusses.



The terminology is different, but the framing components in a roof are the same for both trusses and sticks.

The framing assembly consists of three parts: The sloped members that form the basic structure are called rafters in a stick frame, or the top chord in a truss.

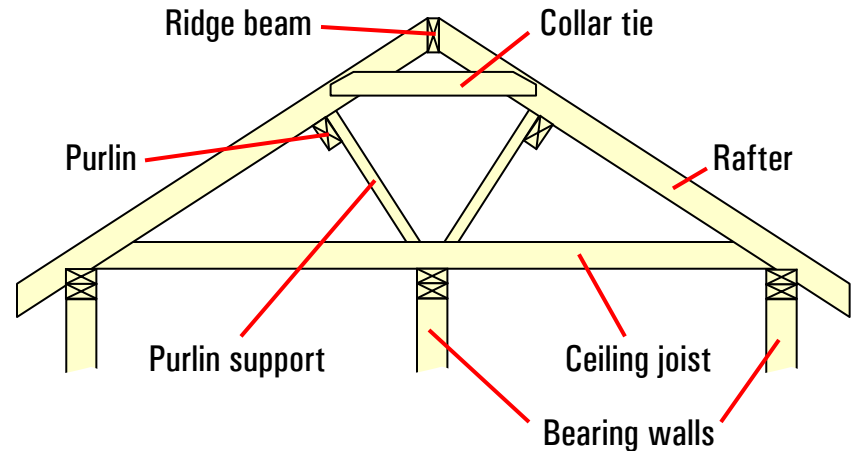
Rafters and top chords exert outward force and need to be tied together at the base. In a stick frame, ceiling joists hold the rafters together. In a truss, that member is called a bottom chord.

Top chords in a truss are supported along their length by struts. In a stick frame, purlins and purlin supports serve the same purpose.

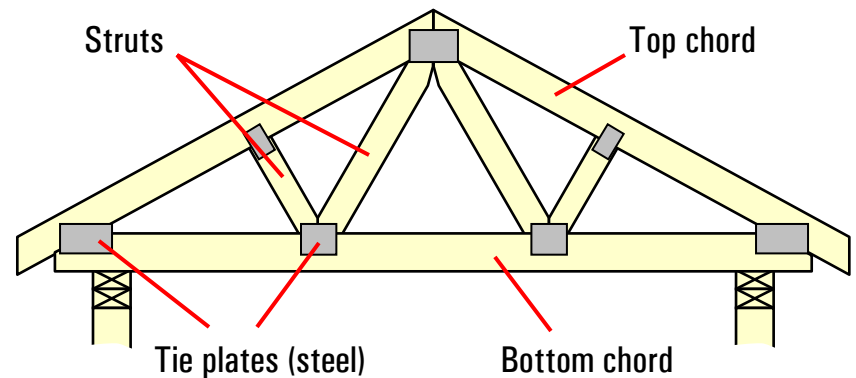
In a stick frame, the rafters are secured to a ridge beam or ridge board at the top.

## Stick-framed roof parts vs. roof truss

### Stick-framed roof



### Truss roof



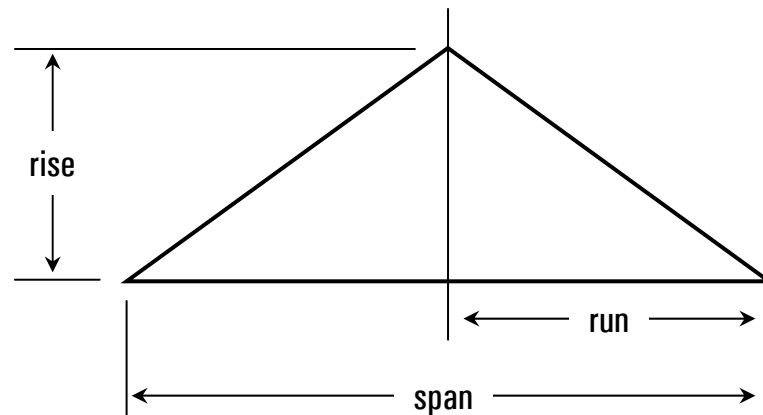
The first key question in roof framing is the length of the rafters. To find the length, you need to know the slope of the roof.

Slope is expressed as a ratio between the horizontal dimension from eave to center point, called the *run*, and vertical dimension from eaves to peak, called the *rise*. A roof with a 6:12 slope rises 6" for every 12" of run.

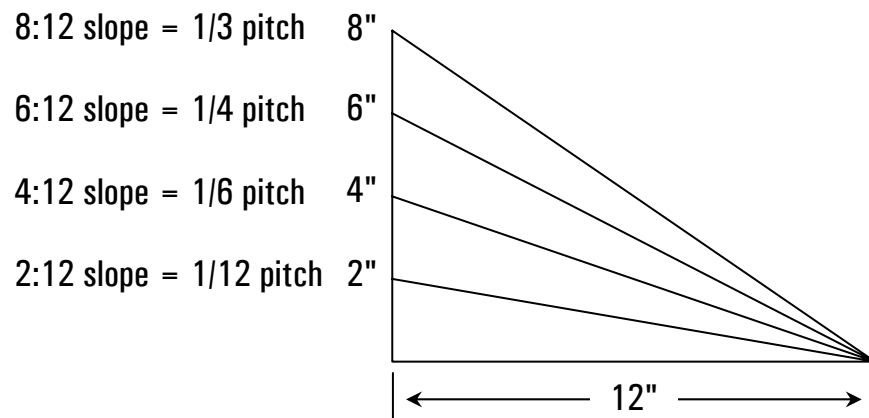
Roof slopes are specified in the building plans. They typically range from 4:12 to 16:12, but can be practically anything.

Some people use the terms slope and pitch interchangeably. Pitch is actually a fraction that describes the height vs. the *span*, or horizontal dimension from eave to eave. A 6:12 slope equals a 1/4 pitch: The rise is 6 and the span is 24 ( $12 \times 2$ ).  $6/24 = 1/4$ .

### Roof terms



### Slope vs. pitch



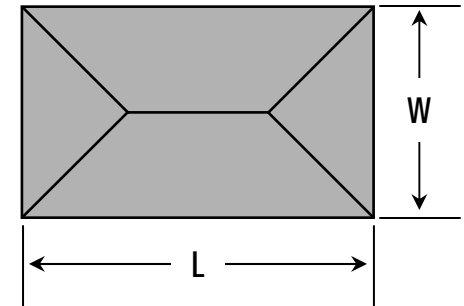
Once you know the slope, you can calculate the length of the rafters from *slope factors* that are published for each slope. You multiply the horizontal dimension by the slope factor to find the sloped length.

Where do slope factors come from? Here's the theory: Think of the roof as two right triangles butted together. In any right triangle, the hypotenuse (sloped side) squared is the sum of the base (horizontal side) squared plus the altitude (vertical side) squared. It's called the Pythagorean Theorem after [Pythagoras](#), the Greek mathematician who worked it out around 400 B.C.

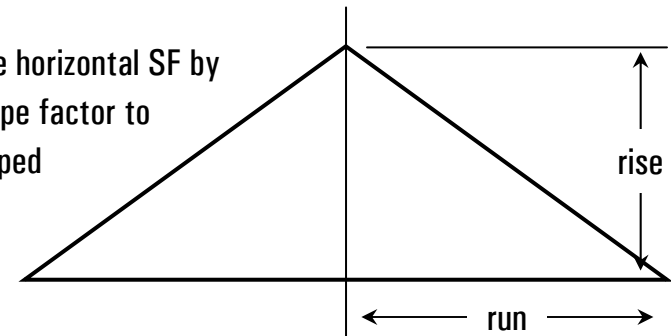
You could calculate rafter lengths this way, but it'd be time-consuming to do it on every project. That's why slope factors were worked out and published in reference tables.

### Roof slope factors

- 1) Multiply the length (L) by the width (W) to find the horizontal square footage.



- 2) Multiply the horizontal SF by the roof slope factor to find the sloped square footage.



	<u>Slope</u>	<u>Factor</u>	<u>Slope</u>	<u>Factor</u>
If the slope is an odd number, use the next higher slope (e.g., 8:12 if the roof is 7:12)	4:12	1.054	12:12	1.414
	6:12	1.118	14:12	1.537
	8:12	1.202	16:12	1.667
	10:12	1.302		

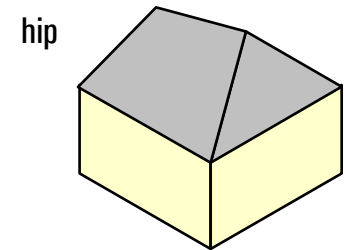
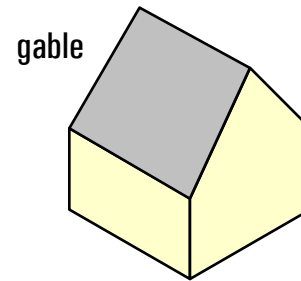
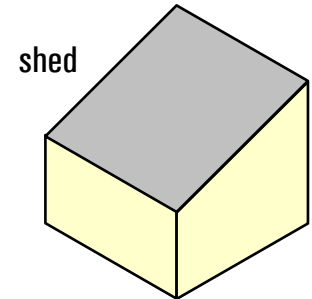
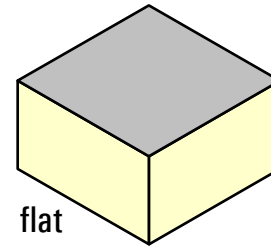
There are four basic roof shapes: flat, shed, gable, and hip. Others are based on those four. A gambrel roof is a gable roof with two slopes; a mansard roof is a hip roof with two slopes.

Most roofs combine two or more shapes, for example, a hip roof with intersecting gables or two shed roofs offset to create a clerestory roof.

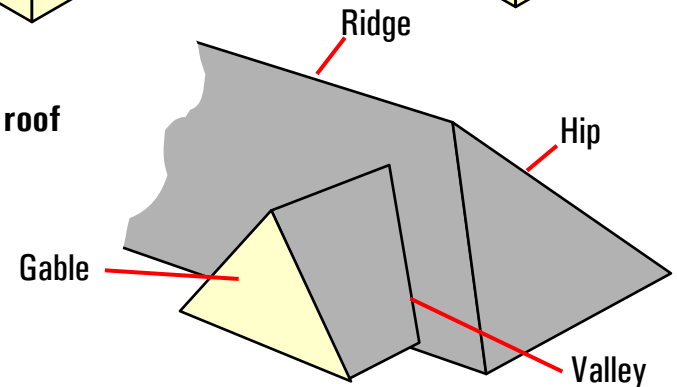
Flat roofs are common primarily in hot climates where snow loads aren't a factor. They're not flat—they have a slight slope, typically 1/4:12 to 1/2:12, to shed water. The rafters double as ceiling joists, with insulation in the cavities.

The roof sheathing is typically covered with rigid foam panels, either foil-faced to reflect heat, or asphalt-impregnated to serve as a base for hot-mopped asphalt roofing.

### Basic roof shapes



### Parts of a roof



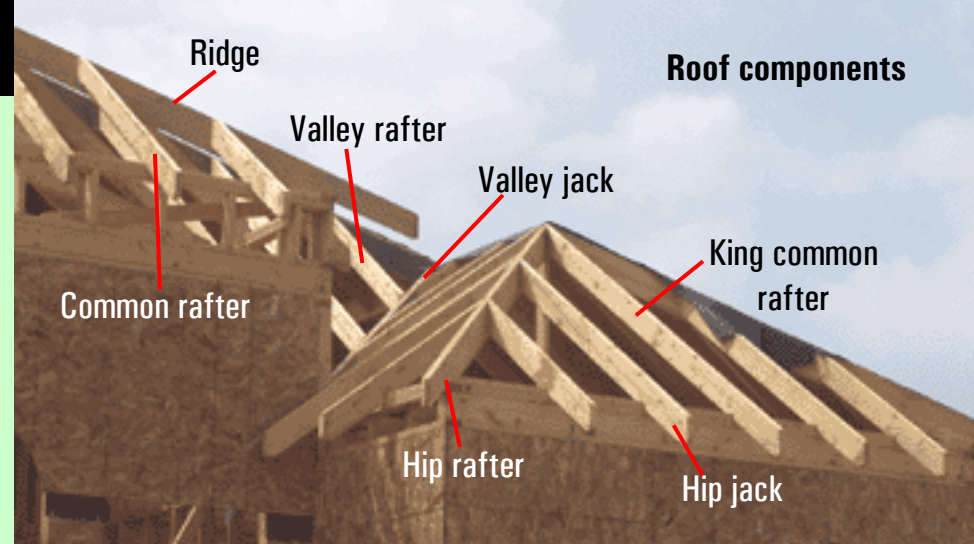
Rafters have different names depending on how they're used.

A **common rafter** is any rafter that runs from the ridge beam to the top plates of the walls at a right angle. **Hip and valley rafters** run diagonally from the ridge to the top plates.

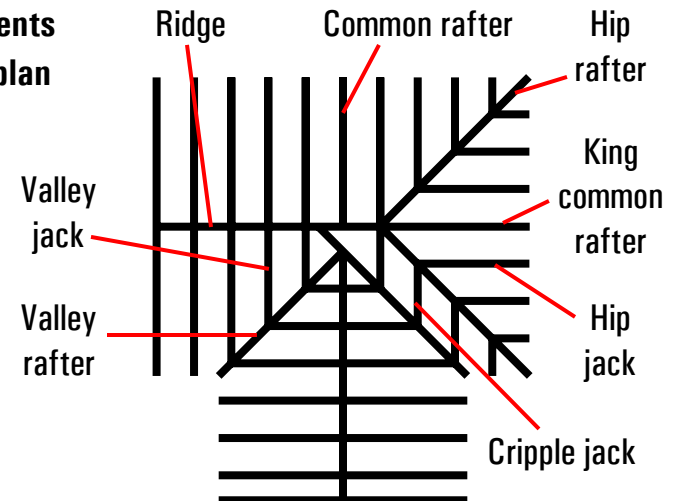
**Jack rafters** run to the ridge or the wall, but not both. Valley jacks run from the ridge to a valley rafter; hip jacks run from a wall to a hip rafter.

**Cripples** or cripple jacks connect hip and valley rafters. Like cripples in a wall frame, they provide a nailing base but don't carry loads.

You'll also run into regional terms such as king commons (common rafters that butt to the ends of the ridge). You'll pick them up as you go; the key thing is to keep the basic functions in mind.



Roof components in a framing plan



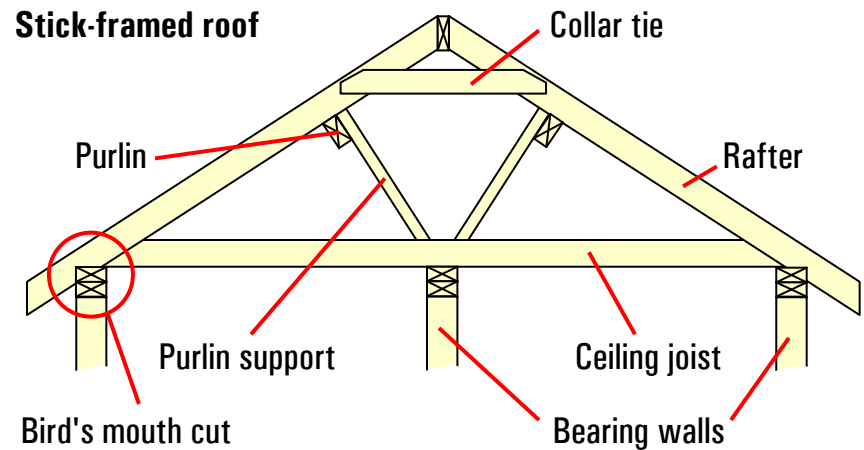
Rafters may be 2x6s to 2x12s; the size is determined by standard span tables. 2x6 is the most common size, and you can use them even if they won't span the full distance by supporting them at midspan with 2x4 purlins and purlin supports running to an interior bearing wall.

Because the top ends of the rafters are cut at an angle, the ridge and hips need to be one size wider—e.g., 2x8s with 2x6 common rafters.

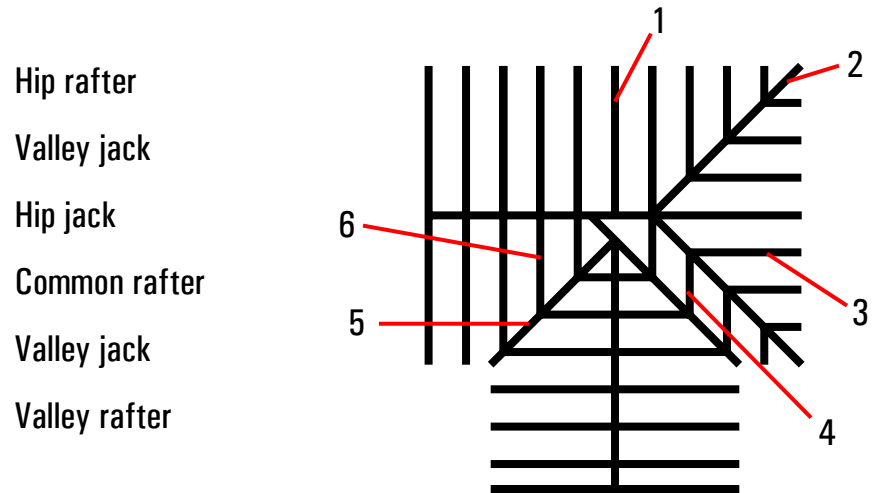
To sit firmly on the top plate, a “bird’s mouth” is cut into each rafter. The seat cut matches the slope; the heel cut is at a right angle to the seat cut.

Ceiling joists resist outward force at the bottom of the assembly. 2x4 collar ties serve the same purpose near the top. They're placed 4' apart in the upper 1/3 of the assembly.

### Stick-framed roof



**Test your knowledge.** Enter the corresponding number from the framing plan next to each roof frame component.



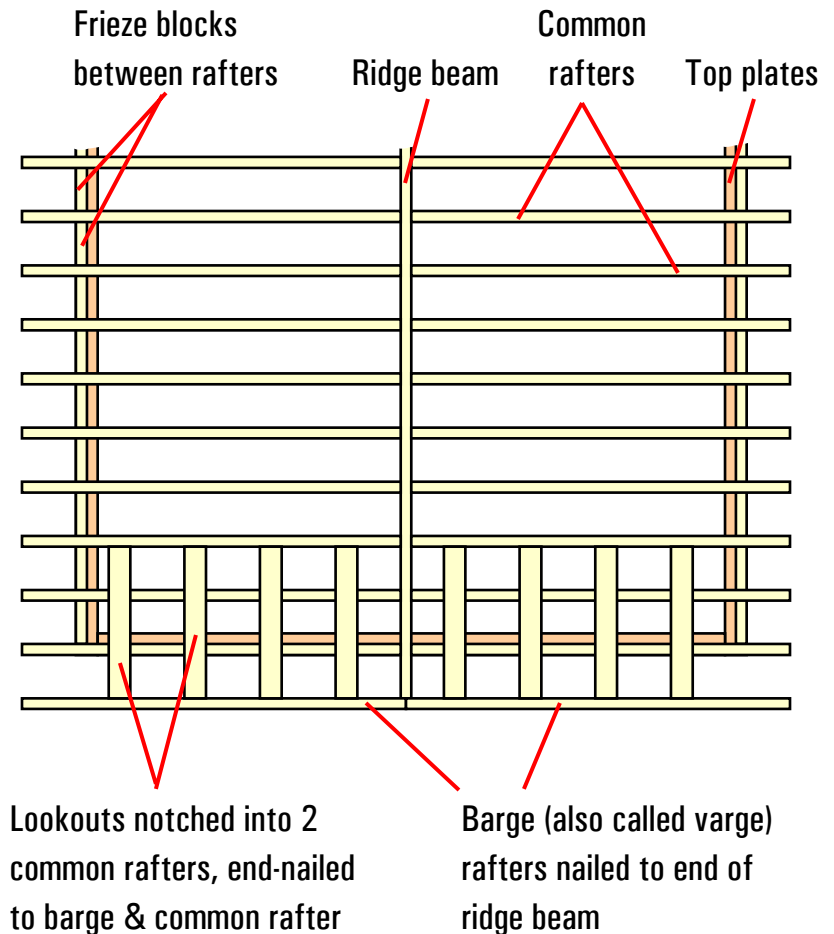
Rafters are typically spaced 24" o.c., but you'll see 16" spacing, too. On a gable roof, barge rafters (or verge rafters) at either end extend beyond the roof to provide an overhang.

They're secured to the first two common rafters with 2x4 lookouts 16" or 24" o.c. There are a number of ways to fasten them; typically, you notch the common rafters to maintain a smooth surface.

Frieze blocking goes between the rafters at the top plates, to keep them from shifting or rotating. It's 2" stock one size narrower than the rafters to allow for ventilation (e.g., 2x4s with 2x6 rafters).

Rafters are typically fastened to the ridge beam with joist hangers, then toenailed and secured with hurricane ties to the top plates of the walls.

### Gable roof components (plan view)



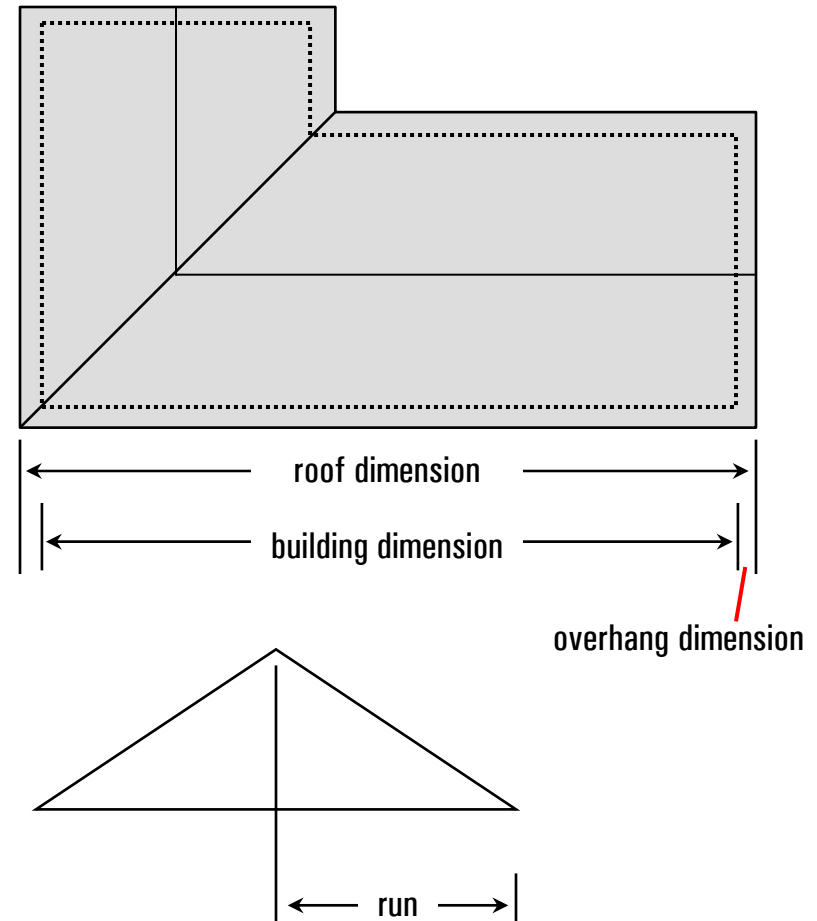
**Gable roofs.** Estimating materials for a gable roof is simple. There's one trick: Use the roof dimensions (wall to wall plus the overhang on each side), not the building dimensions alone.

**Ridge.** The roof length equals the LF of ridge material you need. Sell long lengths in 4' multiples so splices will be centered between a pair of rafters, and be sure and ship straight pieces.

**Rafters.** To find the length, multiply the run (roof width  $\div$  2) by the appropriate slope factor, then round up to the nearest standard lumber length.

Here's how to calculate the number of rafters:

- 16" o.c.:  $(\text{Roof length} \times 0.75) + 1 = \text{Qty. per side.}$   
 $\text{Qty. per side} \times 2 = \text{Qty. (both sides)}$
- 24" o.c.:  $\text{Roof length} + 2 = \text{Qty. (both sides)}$



**Collar ties.** To find the length, divide the span by 3. Since you need collar ties every 4', divide the roof length by 4 to find the quantity, then fit them into standard lumber lengths.

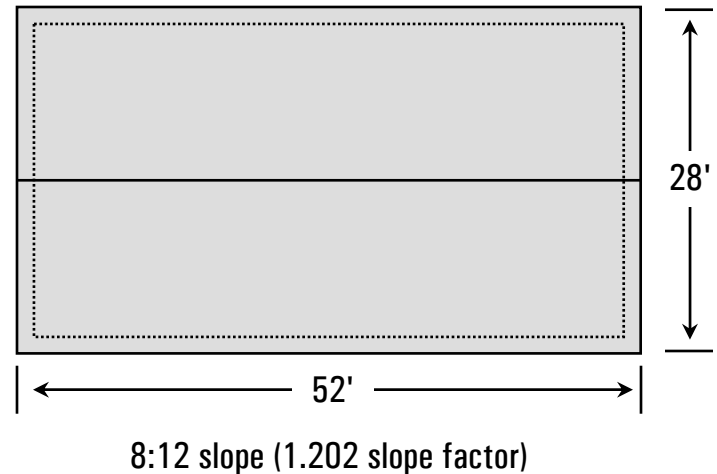
**Lookouts.** Lookouts are 4' long. Since they're placed 24" o.c., the rafter length equals the number you need for each *pair* of barge rafters.

**Frieze blocking.** Multiply the roof length by 2 to find the LF you need. You can ship any length.

**Sheathing.** It'll typically be 7/16" OSB. Panels are staggered 4' apart perpendicular to the rafters with an 1/8" gap for expansion.

To estimate, find the horizontal SF of the roof, then multiply by the slope factor to find the sloped SF. Add 5% for simple roofs or 10% for cut-up roofs, then divide by 32 to find the number of 4x8 panels.

**Test your knowledge.** Calculate the framing components for the gable roof below (plan view), and mark the correct answer.



1. Common rafter length
 

14'	16'	18'	20'
-----	-----	-----	-----
2. Total number of rafters 24" o.c.
 

40	54	80	108
----	----	----	-----
3. Total number of 4x8 - 7/16" sheathing panels
 

46	55	58	64
----	----	----	----

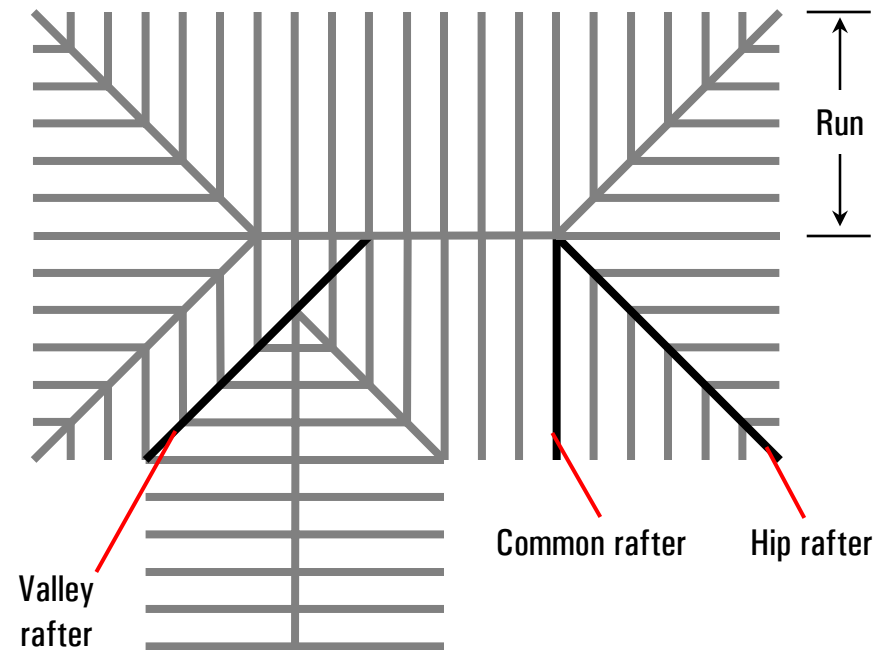
**Hip roofs.** There's no question that framing a hip roof takes special skills. But estimating materials for a hip roof is much easier.

Most hips and valleys run at a  $45^\circ$  angle to the ridge and rafters. When they do, the ratio of the hip to common rafter lengths is 17:12 (don't worry about why—it's Pythagoras again).

In theory, that means you can find the lengths of hip and valley rafters by finding the common rafter length, then multiplying by 1.42 ( $17 \div 12 = 1.4167$ ). It's easier just to multiply by 1.5, then round up to the nearest standard lumber length.

Sometimes you'll see hips at less than  $45^\circ$ , typically on short roofs where the ridge line would be short and look odd. If so, the hip rafters will be a little shorter. Use the same technique you use for  $45^\circ$  to calculate the length.

**Finding hip and valley rafter lengths.** Multiply the run by the slope factor to find the length of the common rafters. Then multiply by 1.5 to find the length of the hip and valley rafters.

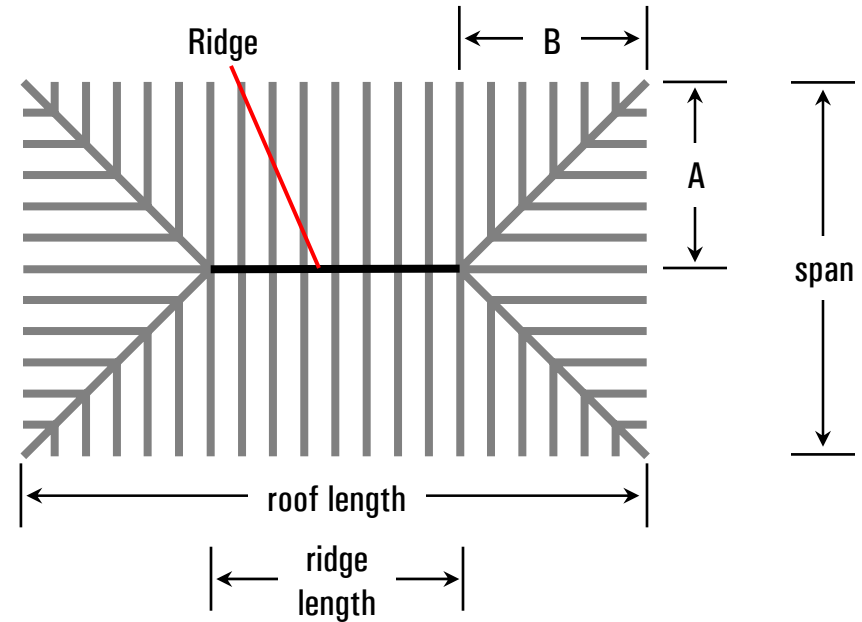


**Ridge.** The ridge beam on a hip roof doesn't run full length—it just runs between the hip rafters. If the hip is 45°, the hip rafters “project” into the building the same dimension as the run ( $A = B$ ). To find the ridge length, subtract the span ( $\text{Run} \times 2$ ) from the roof length.

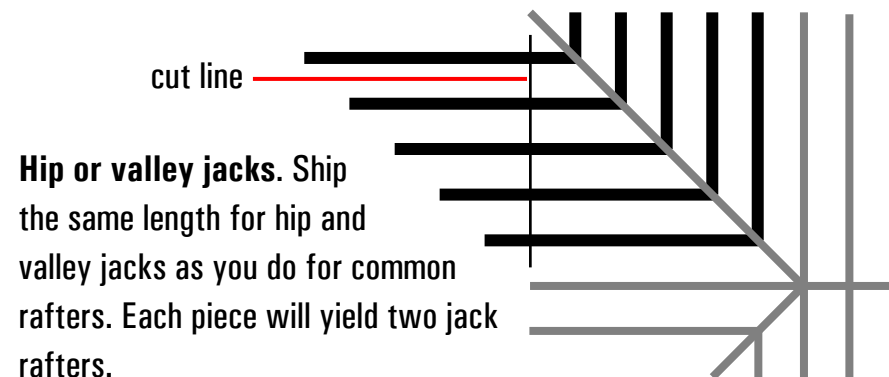
**Rafters.** You'll need 4 hip rafters, of course. The rest are easier than they look on the plan.

Because hip jacks “step down” in length as you work your way from the ridge to the wall, the cut end from the longest jack can be used for the shortest one; scrap from the second-longest is used for the second-shortest, and so on.

What it means is that you can estimate rafters the same as you do for a gable roof. First find the length, then use your gable roof formulas to find the number of rafters you'll need.



$$\text{Roof length} - \text{span} = \text{Ridge length}$$



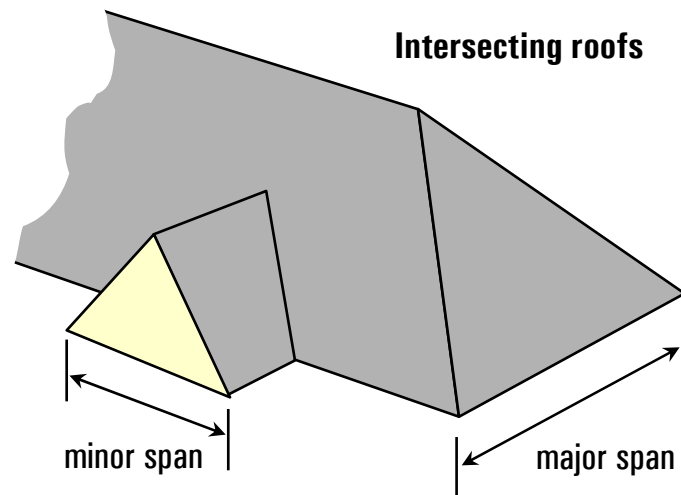
**Hip or valley jacks.** Ship the same length for hip and valley jacks as you do for common rafters. Each piece will yield two jack rafters.

Intersecting roofs get a little trickier, and how you estimate materials depends on how they'll be framed.

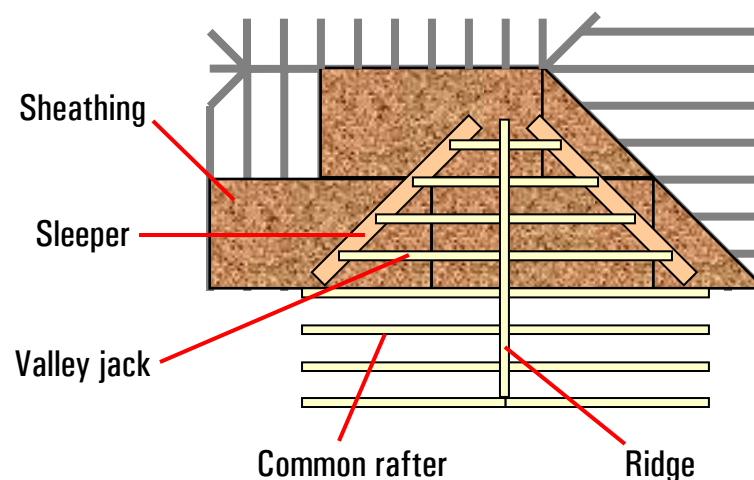
The height of the ridge depends on the span of each section of the building. If the spans are equal, you simply butt one ridge beam into the other, then run valley rafters at a 45° from the point where they meet

But when one section is narrower than the other, the ridge on the minor span will be below the ridge on the major span. There are a number of ways to frame it.

The easiest is a blind or California valley. You sheathe the main roof, then build the intersecting roof over it. You don't use valley rafters but you do need 1x8 sleepers as a nailing base for the valley jacks.



### A blind (California) valley

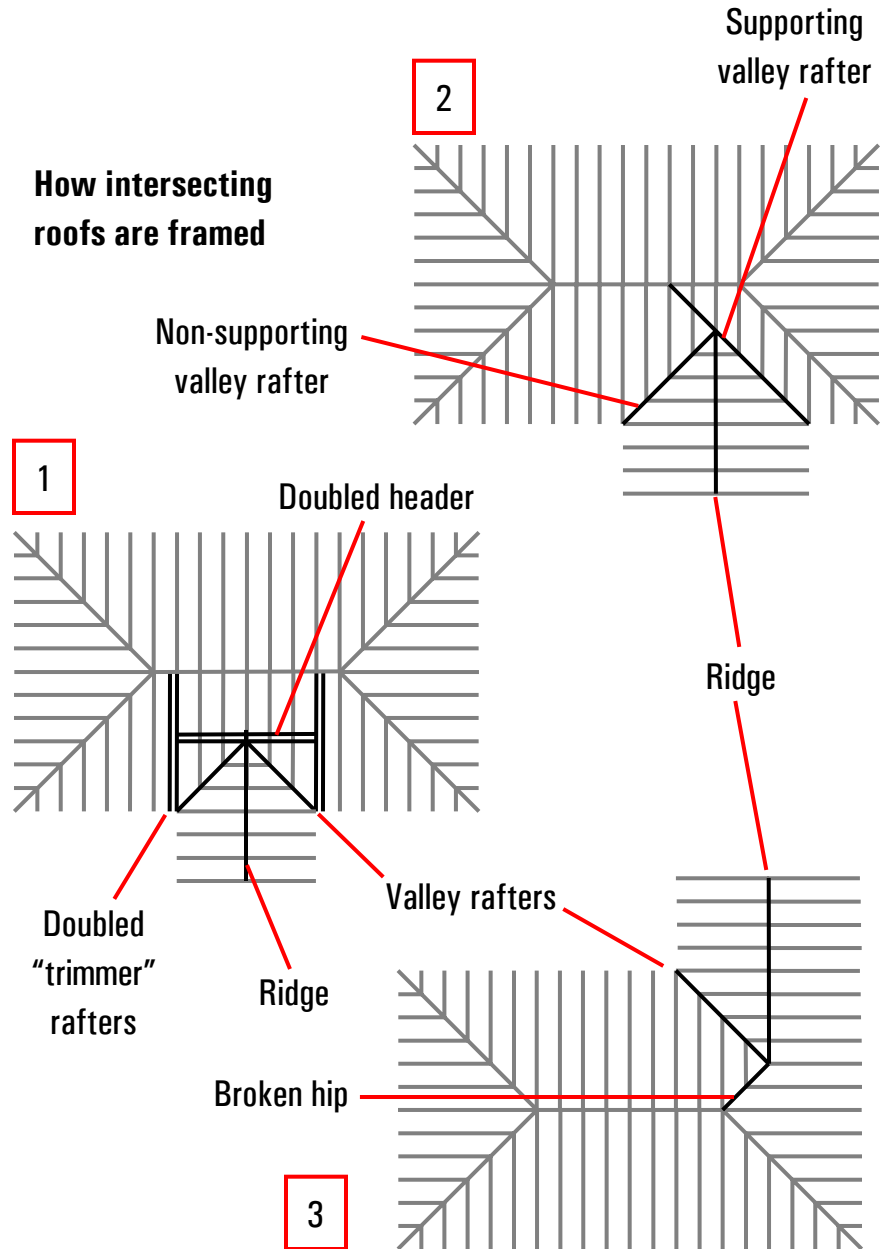


If the intersecting portion of the structure will be living space, you can't use a blind valley; the framing needs to be integrated.

With T-shaped structures, there are two methods: First, you can run a doubled header on the main roof, then hang the intersecting roof framing from it (1). Keep in mind that the header has to be one size wider than the rafters, since the rafters will be cut at an angle.

The second method is to use a supporting valley rafter on the main roof, then hang the intersecting ridge beam and a non-supporting valley rafter from it (2).

On an L-shaped structure, the ridge on the intersecting roof butts into the hip rafter, called a "broken hip," on the main roof (3).



When you estimate, the quirky stuff is all in the area where the intersecting roof ties to the main roof. The best way to handle it is to get the easy stuff out of the way, then do the tough parts.

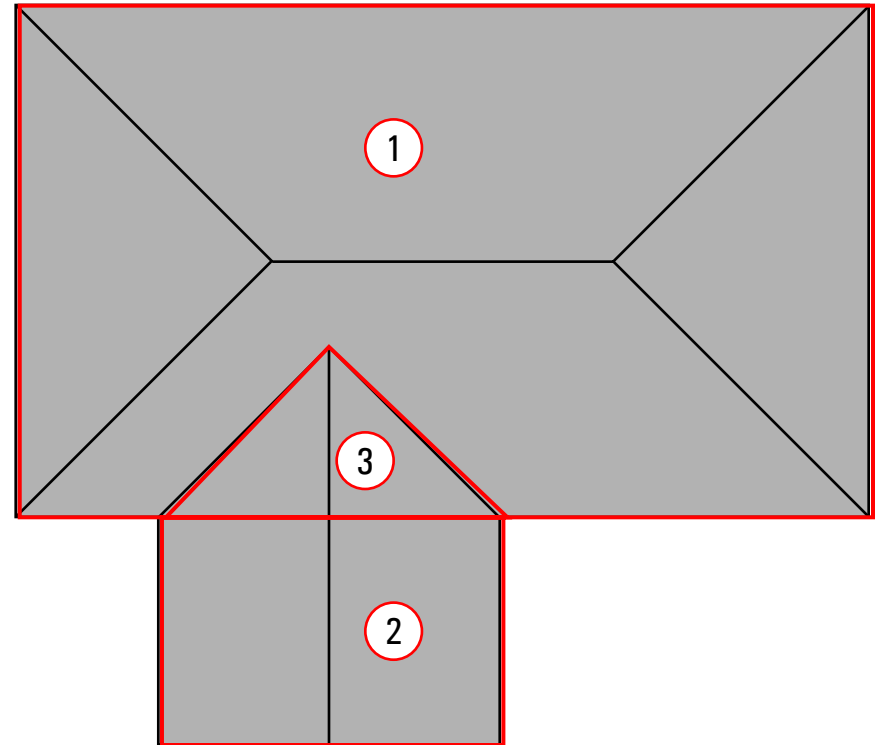
First, estimate the main roof (1) as if there was no intersecting roof, using the methods above.

To estimate the intersecting roof, you'll need the dimension from the main roof to the end of the intersecting roof, as well as the width of the section and the full length of the ridge beam.

Next, estimate the portion that projects from the main wall (2) as if it was a freestanding structure. Finally, estimate the area over the main roof (3).

If the framing will be integrated, you won't need valley jacks; the excess material from the main roof will be enough to cover what you need.

### Estimating an intersecting roof



- 1) Estimate the main roof like a freestanding hip roof.
- 2) Estimate this portion of the intersecting gable roof as if it was a freestanding structure.
- 3) Estimate additional materials for the intersecting area.

You will need to add framing to the main roof, however: a doubled header if that's how you're framing, or supporting and non-supporting valley rafters.

With a headered valley, the length of the header is the same as the width of the roof section. Multiply by two to double it, and add two common rafters on the main roof so they can be doubled at the ends of the header.

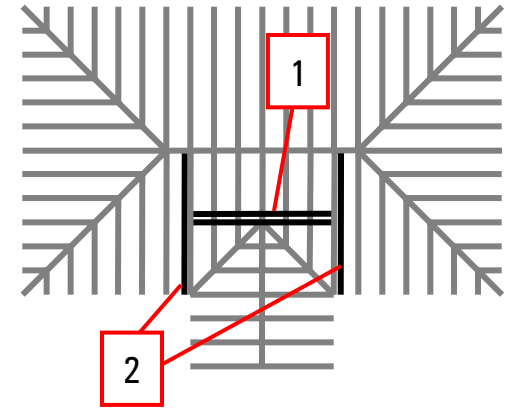
On a T-shaped roof, add two rafters the same length as a hip rafter on the main roof (common rafter length  $\times 1.5$ ) for the supporting and non-supporting valley rafters.

On an L-shaped roof, you don't need to add any extra rafters—the hip rafter from the main roof will cover both the broken hip and the valley rafter on the intersecting roof.

### Additional framing you'll need for intersecting roofs

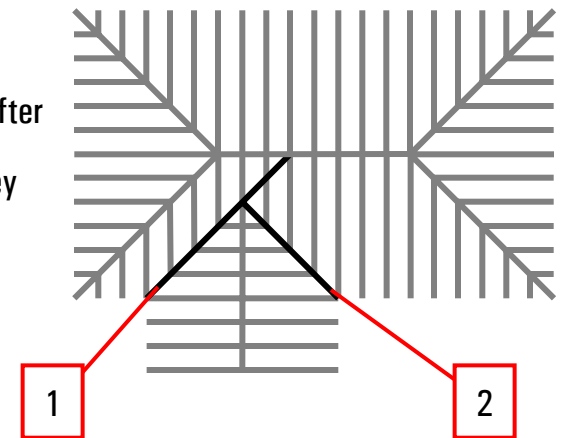
Headered valley:

1. Doubled header (1 size wider than rafters)
2. Two extra common rafters for trimmers



Raftered valley:

1. Supporting valley rafter
  2. Non-supporting valley rafter
- length = hip rafters



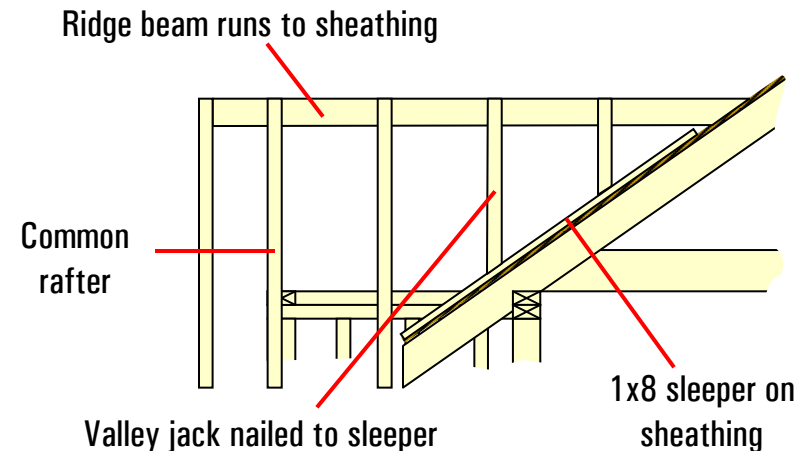
If you'll be framing a blind valley, you'll need valley jacks and 1x8 sleepers. The material you sell for valley jacks will be the same length as the common rafters on the intersecting roof.

To find the quantity, first find the length of that portion of the roof that falls over the main roof. Then divide by 2 for 24" o.c. framing or multiply by 0.75 for 16" o.c. rafters.

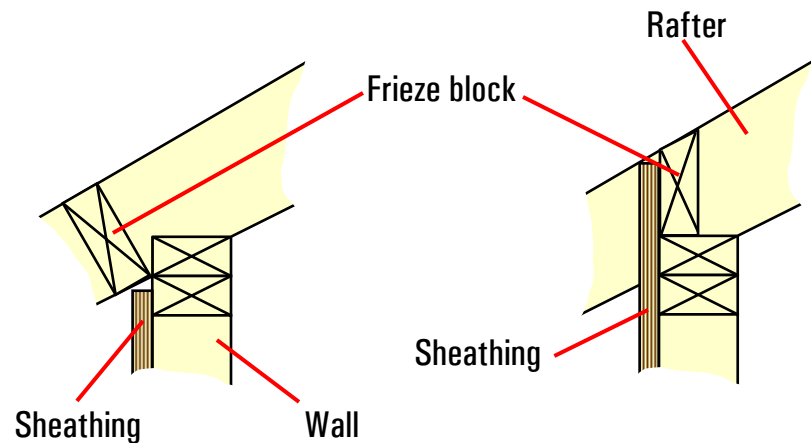
To find the length of the 1x8 sleepers, multiply the common rafter length by 1.5. Don't forget that you'll need two of them.

**Frieze blocking.** On a hip roof, you'll need frieze blocking all the way around, not just two sides. The perimeter LF of the building equals the LF you'll need. Since the blocks will be cut to less than 2', you can sell any length—and you can get rid of a few warped pieces.

### A blind valley (elevation view)



### Frieze blocking

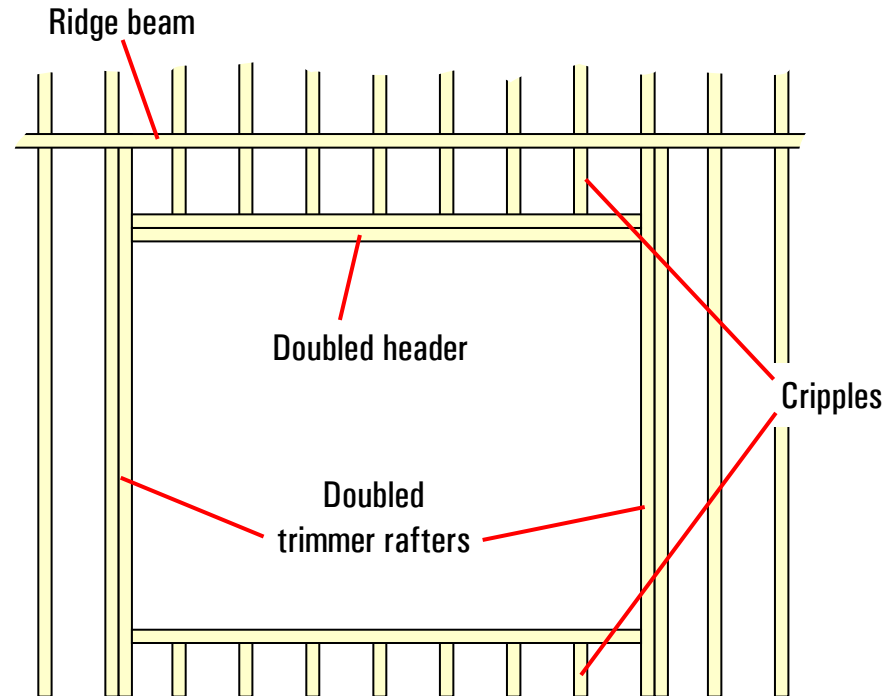


Openings in a roof frame are treated just like openings in a floor or a wall. They have to be headered to transfer the load to the rafters on either side. You'll also need to add trimmer rafters on either side of the opening.

Dormers are typically framed like any other roof opening: a doubled header at the top and, unless the dormer extends all the way to the outside wall, a single header at the base. You'll also need wall framing, of course; estimating specs are covered in BSCI's Wall Framing.

Headers for chimney openings and some skylights may be plumb, which means they need to be one size wider than the rafters. Skylight openings may also be splayed at the top; if so, they may require framing two sizes wider than the rafters.

### Roof openings (plan view)



Use a doubled header above the opening whenever you cut 3 or more rafters; if you only cut 1 or 2 rafters, use a single header.

Sometimes the eaves will be left exposed, so you'll sell 23/32" sheathing and use 1x6 or 1x8 T&G or shiplap boards around the perimeter of the roof to provide a finished appearance.

Estimate the panels as if you were going to cover the entire roof. To estimate the boards, you need to know the perimeter LF around the roof, the sloped width of the overhang, and the net coverage width of the boards.

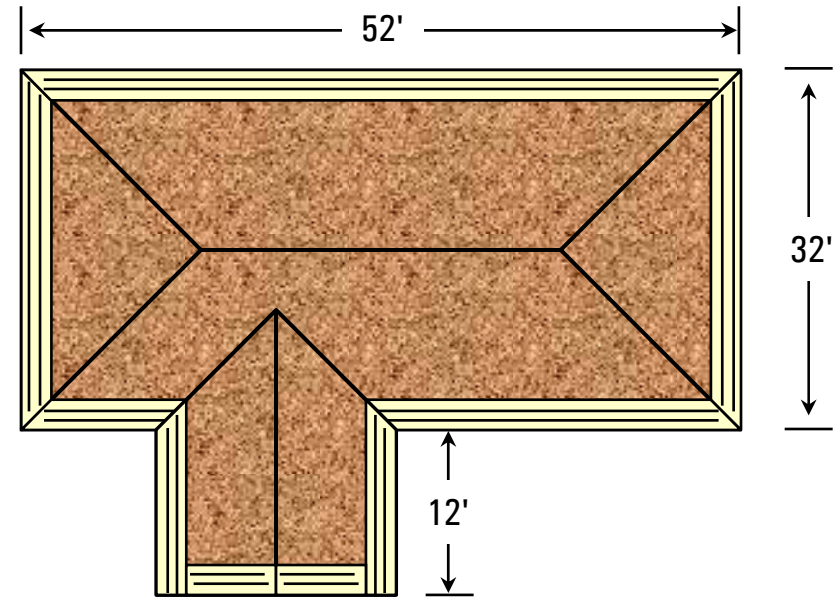
Take the perimeter LF off the plans. To find the sloped overhang width, find the horizontal width (in.) and multiply by the slope factor, then divide by 12 to convert it from inches to feet.

$$1) \text{ Perimeter LF} \times \text{Sloped overhang width} = \text{SF}$$

$$2) (\text{SF} \times 12) \div \text{Net coverage width} = \text{LF}$$

Multiply the LF by 1.1 to add a 10% waste factor.

### Exposed eaves



**Test your knowledge.** Find the linear feet of 1x8 T&G boards (7-1/8" net coverage width) you'll need for exposed eaves on the above plan, including a 10% waste factor.

The horizontal overhang width is 18" all around the building, and the slope is 8:12 (1.202 slope factor). Mark your answer below.

448 LF

526 LF

595 LF

640 LF

Roof framing may be the most complex part of building a home. While you won't be framing it yourself, the more you know, the more valuable you become to your customers.

If you're interested in exploring further, there are a number of excellent reference books that are well worth having close at hand when tough questions come up.

The books on the list at the right may be available at your local bookstore, but all of them are also available at Amazon.com.

### **Recommended books at Amazon.com.**

[Roof Framer's Bible](#), Barry Mussell. Reference tables and instructions for calculating the exact length and cutting specs for every component in a roof frame.

[Framing Roofs](#), Fine Homebuilding (ed.). A compilation of articles from Fine Homebuilding on advanced framing techniques.

[Graphic Guide to Frame Construction](#), Rob Thallon. Illustrated construction details covering the entire exterior of a wood-framed home.

[Roof Framing](#), Marshal Gross. Step-by-step explanation of how to frame simple and complex roofs.

[Building Construction Illustrated](#), Francis D. K. Ching. The ultimate reference book with detailed architectural drawings of virtually every component in residential construction.