

Rafters & Roof Structures

Note: This set of detailed instructions is provided for those not familiar with building the roof on the ground (one of Project Mercy's two methods). Skilled helpers will be available to assist as desired.)

Note: If your group has requested that your lumber be pre-cut, you can skip the cutting steps and just refer to the layout and assembly steps

Materials Needed

- Twenty-eight rafters
 - a. 22 Common
 - b. 4 Notched
 - c. 4 Barge
- Eight outlookers @ 45-5/8"
- Frieze Blocking
 - a. 12 @ 21-5/8"
 - b. 8 @ 22-5/8"
- Twelve 8-ft 2x4's
- 16d framing nails



Tools Needed

- Rafter Template (if rafters not pre-cut)
- Hammers
- Mitre saw or Circular saw (if components not pre-cut).
- Reciprocating saw or jig saw (if rafters not pre-cut)
- Tape Measure
- Pencil

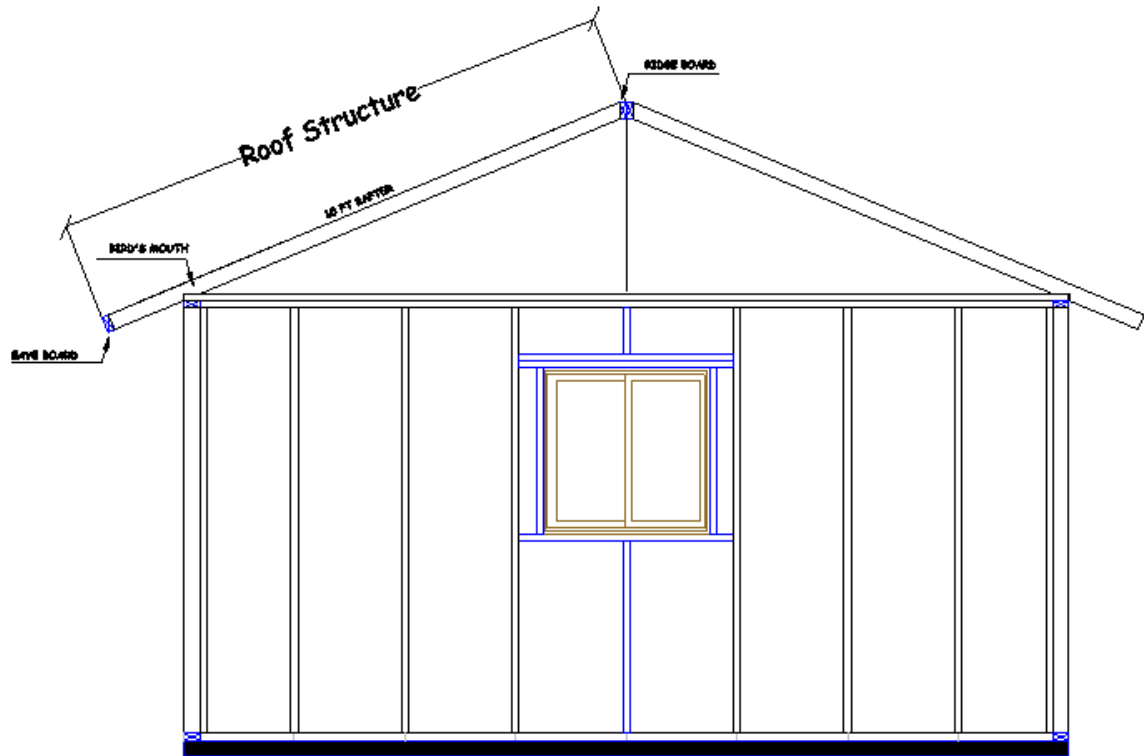
Most Common Mistakes

- Not nailing rafters flush with ridge and 3/4" down at eave.
- Not nailing blocking flush with rafter tops & at wrong angle.
- Not nailing rafters on layout.
- Nailing rafters upside down.

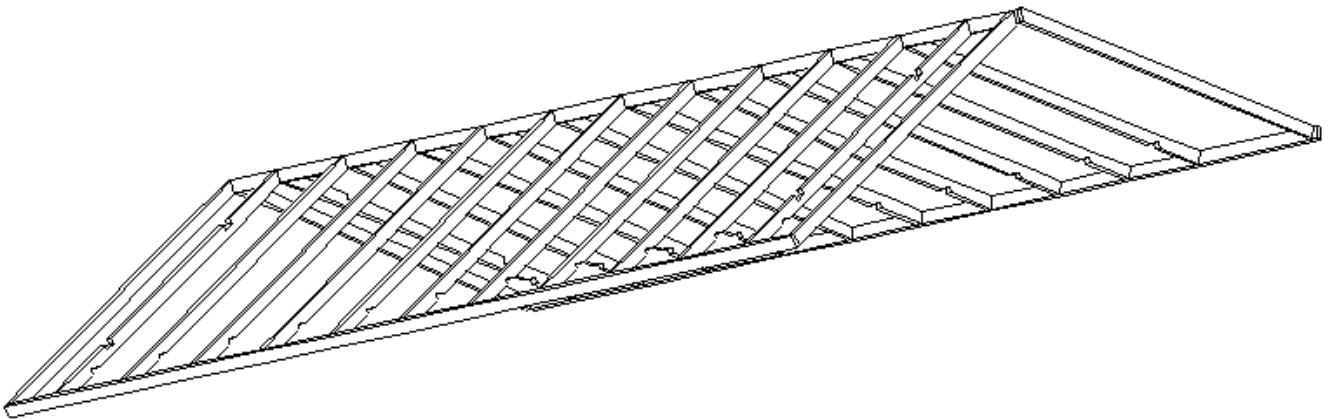


Introduction

The roof structure is built in six 8-ft segments to be combined at a later date on the house to form the roof. Put simply, the six roof assemblies, when lifted and mounted onto the tops of the long walls, create a sequence of wooden triangles that form the roof of a house. More precisely, they are assemblies consisting of a number of 10' long, rafters, held together in the roof structure by eave and ridge boards. Blocking is installed between the rafters to aid in attaching the roof structure to the walls. Three sets of two identical structures are built to create the triangular shape of the roof, each of which is lifted onto the top plates of the house's long walls separately, and joined together once is the proper location and securely nailed to the walls. These assemblies overhang the walls to form eaves. The rafter structure is designed to handle the various loads a roof will experience. Our rafters are made out of 2x4 framing lumber that are fastened together with 16-penny (3-1/4") nails.



Basic Roof Design



Pre-Construction

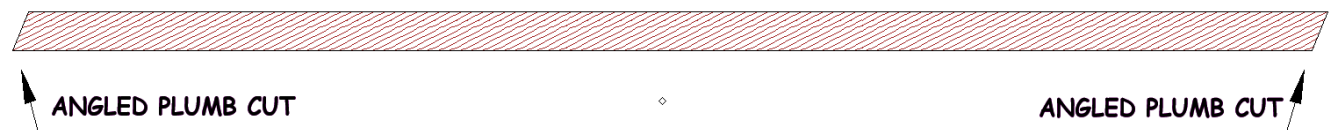
1. Locate an area away from other activities that is relatively flat and a minimum 10' by 12'. Preferably, two such areas are needed in order to work on the roof structures simultaneously. Once started it is difficult to move a roof structures until it is completed,
2. Once a work area has been identified, move all of the roof structure material to that area to avoid interference with other activities.

Rafter Layout and Cutting (rafters may be pre-cut)

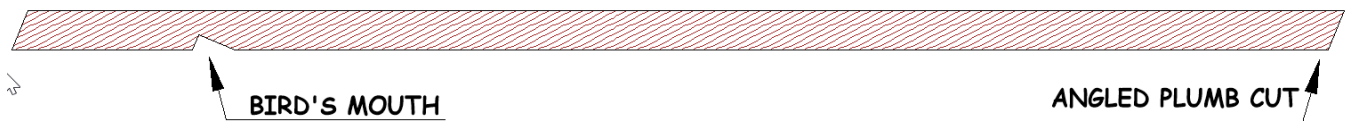
Rafters are laid out using a Rafter Template provided by the Project Mercy staff. Each of the six roof structures consists of 5 rafters in various configurations and each receives an angled (plumb) cut at each end.

The following cuts are made for each roof segment.

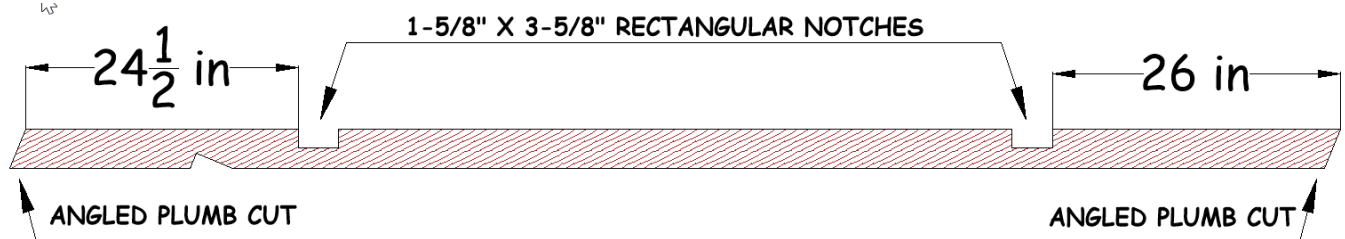
Barge rafters form the ends of the roof and extend beyond the walls forming an overhang. Cut angled plumb cuts on each of the 8 Barge rafters and set aside.



Each of the remaining rafters receives an additional notch cut called a 'Bird's Mouth'. When installed on the walls, the bird's mouth rests on the top plate of the wall, providing a nailing surface for the rafter into the top plate. These are referred to as Common rafters.



Four of the rafters that have the bird's mouth cut each receive two additional 3-5/8" x 1-5/8" rectangular notches that are used to support the overhang extension of the roof at the front and back of the house. Utilize the measurements in the diagram below to lay out these notches.



Cutting the Rafters

Rafters are normally cut using a skill saw (circular saw), although the angled plumb cuts can alternatively be cut using the miter saw.



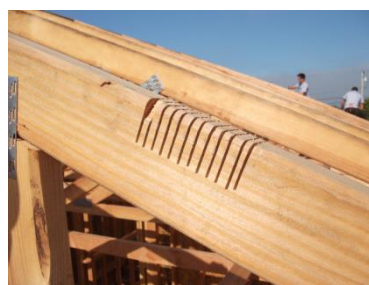
If the rafters have not been pre-cut for you, cut the angled plumb cut on 28 rafters. Once cut, set four of these boards aside as Barge rafters. These are the end boards of a single roof assembly and they receive no other cuts.

Make the two cuts for the bird's mouth in the remaining 24 rafters. Since these cuts are being made with a circular saw, the top (visible part of the cut) will be further advanced than the lower part of the cut (because of the curve in the blade). This can be compensated for by over-cutting (extending the cuts beyond the intersection of the two lines). However, this method further weakens the board at the location of the cut, it is preferable to stop the cuts at the intersection of the lines, and then use a reciprocating saw or jig saw to finish the cut. (see photos below)



Four of the rafters that have receive the bird's mouth cut receive additional rectangular notches. These notches can be cut in one of two methods.

Method 1: Stand the four boards on end and aligned so that the pencil marks for the two notches are directly opposite each other. Set the table of the skill saw to 1-5/8" and cut across the four boards at one of the pencil marks. (Note: this is a good time to check the depth of the cut with a tape measure to ensure you have properly set the table at 1-5/8".) Cut across the boards at the other pencil line. Once you've made these two boundary cuts, make multiple cuts across the boards between these two boundary cuts at approx. 1/2" spacing. Repeat these steps for the second rectangular notch.



Lay the boards flat and tap the cut areas with a hammer. The 1/4" - 1/2" pieces should break out easily. Clean the bottom of the notch with the reciprocating saw or jig saw and test the depth with a scrap piece of 2 x 4 lumber.

Method 2: The alternative method is to cut the notch with a skill saw. Lay the rafter flat and cut along the two shorter lines first and then us a plunge cut (Lifting the back end of the saw table above the line and slowly lowering the running blade into the wood.) Overcuts beyond the line intersections are unavoidable with this technique, but minimize the overcuts as much as possible. Using a reciprocating saw or jig saw to finish the cuts in the same manner as the bird's mouth cut described above which will help minimize overcuts.

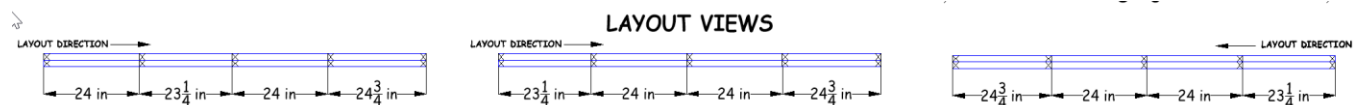
Eave & Ridge Board Layout and Cutting

The roof assembly is formed by nailing rafter ends to an eave board and ridge board oriented at right angles to the rafters. The spacing of the rafters is defined by the lay out (pencil marks) on a pair of eave and ridge boards.

Lay two of the 8-foot 2x4's on edge and temporarily nail them together using 8 penny nails. The nails should be started at an angle in the center of on one of the boards and driven about half way in such that the nail point penetrates the second board, holding the two boards firmly together. One nail should be located about 8" from each end and if needed because the boards are bowed, one in the approx. center of the board between those two nails. Don't use any more nails than are necessary to hold the two boards securely together and remove any bows between them.



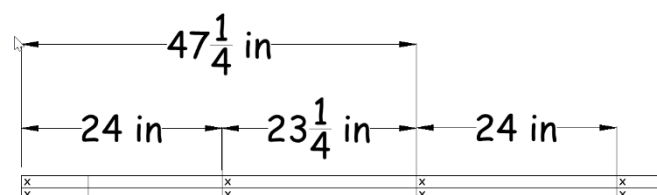
The layout of the roof segments differs depending on which segments are being built. See the roof diagram and mark the layouts.



Hook a tape measure to the end of the board set identified as layout direction and place a pencil mark at the first measurement on the diagram. Reposition the tape measure on the first line and place another pencil mark the second measure on the diagram. Continue this process for the remaining two rafters. Extend these marks straight across the two boards at a right angle, and mark an X at the end of the board and on the correct side of each line. (a speed square, if you have one, can be used to quickly draw straight lines.)



Instead of repositioning the tape each time, you can just add the dimensions together and simply mark that cumulative value on the boards.





Set this set of boards aside and repeat the layout on the second set of boards.



Alternatively, you can mark two sets of boards at one time since you will need two segments of each type by aligning both sets together. Although this method is quicker, care must be taken to keep the ends aligned and the two set of boards held tightly together in order to avoid marking errors. Also, note that the left and right side roof segments are mirror images of each other, and can be marked together as well.

Roof Structure Rafter Assembly

Assembly and nailing of the roof structure can begin once the lay out is complete of at least one segment and the rafters have been cut.

Remove the temporary nails from one set of eave and ridge boards and separate them by about 10 feet on the ground, keeping them roughly parallel to each other.



If saw horses are available, placing the 8-ft ridge board across the horses and nailing the rafters to the ridge board (which will be at an angle) from a standing position is easier on the back.

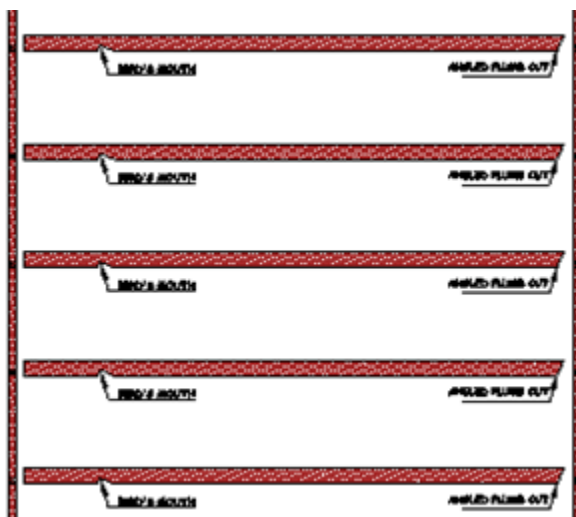
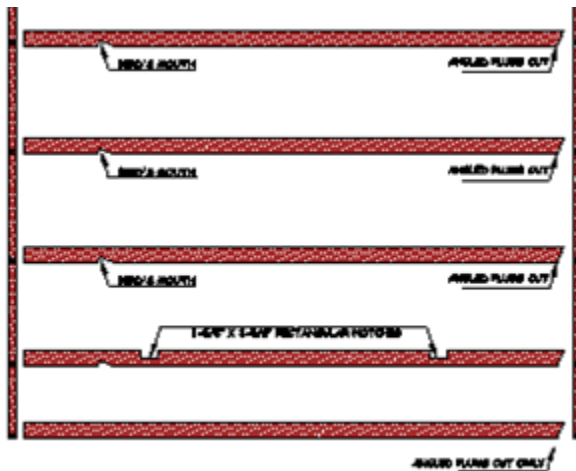
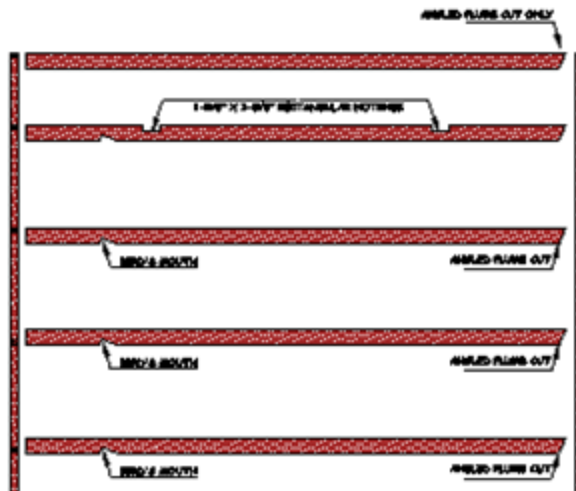
Caution: Do not pick up the one of the separated ridge/eave boards previously marked and turn around. This will change the orientation of the marks. Simply pick up one of the boards (one person on each end) and walk it forward about 10 feet.



Lay the rafters in between the eave and ridge boards, roughly in the location of each X on the boards. For the outer rafter segments, the outside board on one end receives a rafter with only the plumb cut (barge rafter). The second board in receives a rafter with the extra rectangular notches in them. All the remaining rafters (with angled plumb cut and bird's mouth, called common rafters fill in the empty spaces between the two ends.

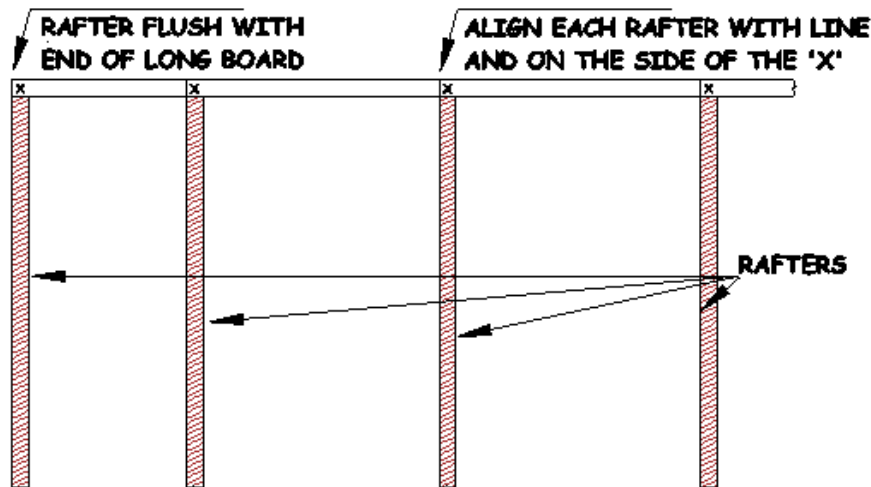
For the two inner rafter segments, all rafters are common rafters.

Project Mercy Construction Manual

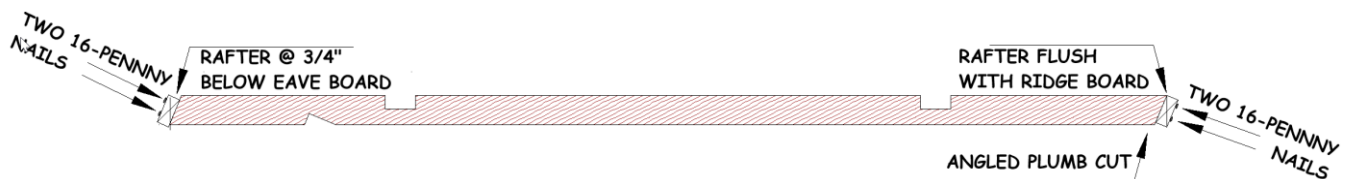


Each rafter end is nailed to the eave board and ridge board with two 16 penny (large) nails, one above the other.

Note: it is important to align the rafter so that one edge is on a previously drawn lay out line, and the rafter on the side with the X. It is equally important that the top of the rafter and top of the ridge board are flush with each other. The eave board should be dropped 3/4" below the rafter tail.



Position each rafter with the tops (side that will receive the sheathing) up. That means the angled end of the rafter (with the plumb cut) will be oriented with the longest edge up and the shorter bottom edge towards the center of the roof structure. The second rafter in from the ends with the rectangular notches, should be facing up with the notches visible on top.



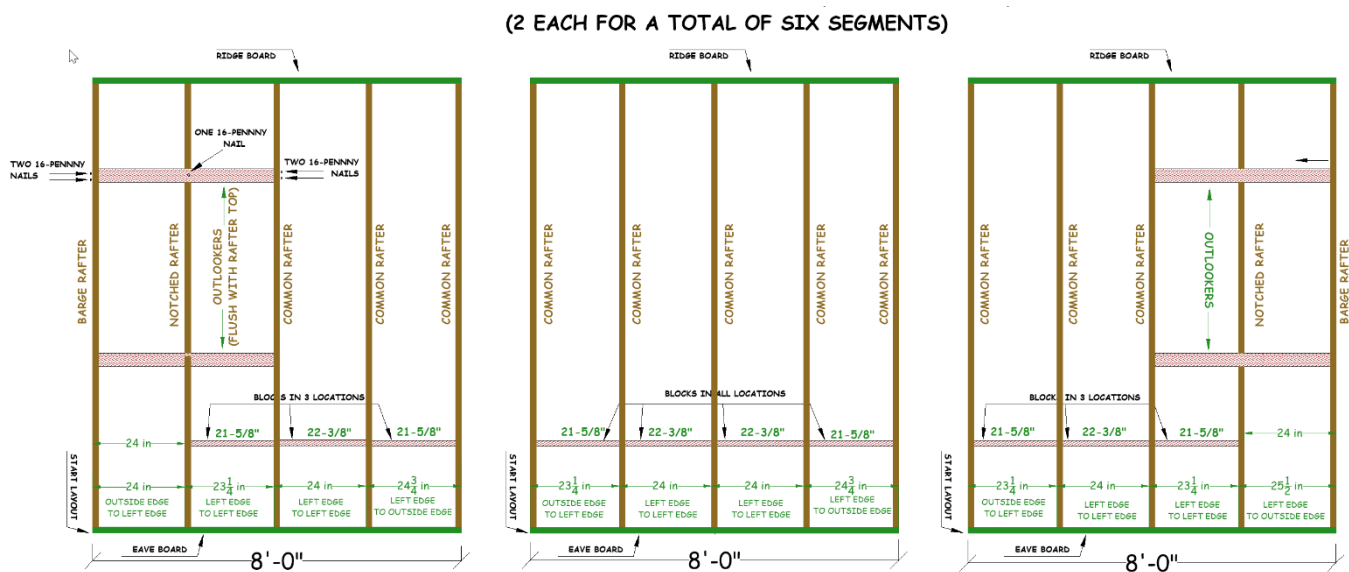
Tip: It is easier and less error prone to nail all the rafters to the ridge board first, especially when multiple volunteers are nailing. This will prevent people trying to move both ends of a rafter at the same time and will result in a more coordinated build. Starting with the angled ridge board also eliminates the possibility of nailing a rafter upside down.

Frieze Blocks and Outlooker Installation

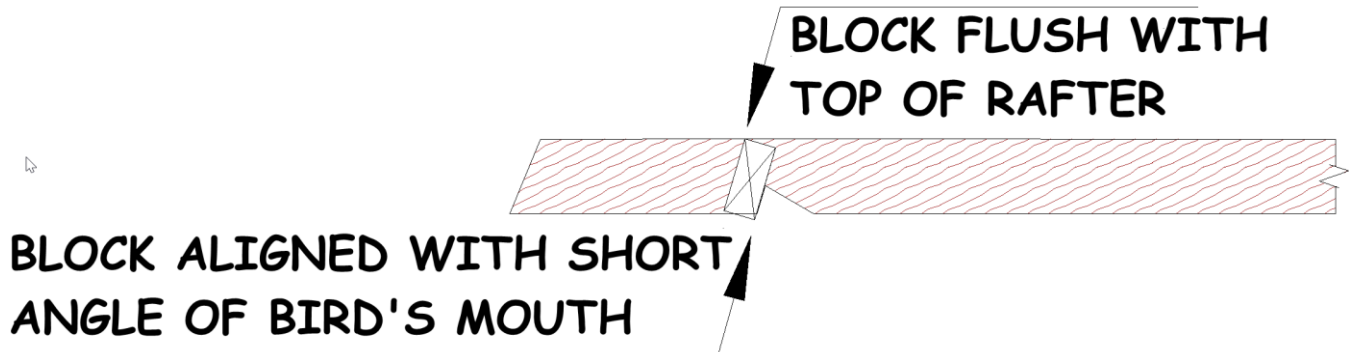
Frieze Blocks

Frieze blocks (short pieces of 2x4's) are placed between each rafter except for the outer rafter on either end. The purpose of this blocking is to allow solid nailing of the roof structure to the walls of the building.

There are two sizes of blocks: 21-5/8" and 22-3/8 inch. The size of the blocks should be written on each pre-cut block. If not pre-cut the blocks out of 8-ft 2x4's and install according to the roof diagram.

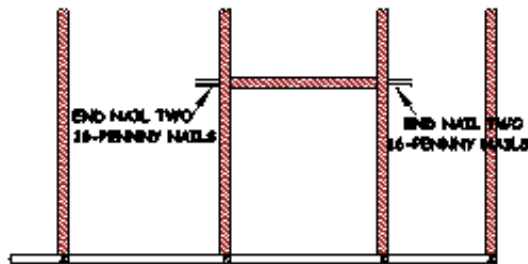


Blocks should be oriented at an angle between the rafters, aligned with, and at the same angle as, the short cut on the bird's mouth. Ensure that the top of the block is flush with the top of the rafter.

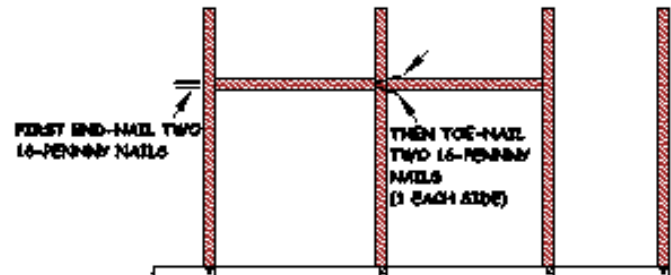




Tip: It is easiest to work sequentially from each end of the roof segment. The first block can be end nailed on each end. Each subsequent block can be end nailed on the side away from the previous block but has to be toe-nailed on the other end. (End nailing is easier to accomplish than toe-nailing). The center block will then have to be toe-nailed on both ends. Starting blocking at random locations will result in more toe-nailing.



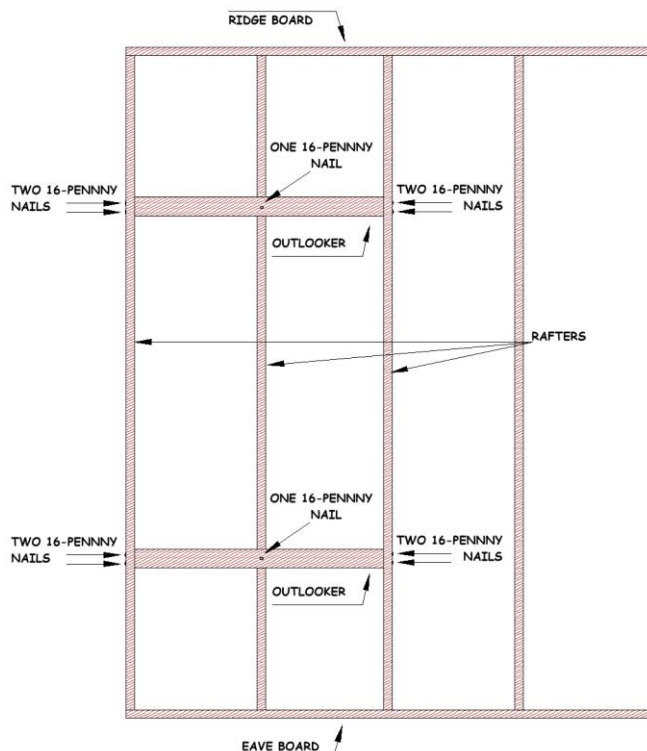
First Block



Subsequent Blocks

Outlookers

Four 45- 5/8" 2x4's are installed at right angles to the rafters between the 1st and 3rd rafters on the ends. These outlookers (or lookouts) cross the 2nd rafter and fit into the rectangular notches cut earlier. Their purpose is to provide some additional strength for the portion of the roof that extends beyond the plane of the walls. The outlookers should be end nailed with two 16 penny nails through the first and third rafter, flush with the top of the rafter. A single 16 penny nail should be face nailed through the top of the outlooker and into the 2nd notched rafter.



Painting

Once all nailing is complete, the roof assembly is ready for painting. However, it will have to be flipped over so that the top of the roof structure is facing down (bird's mouths facing up). Be careful when flipping the roof segments because they can be a bit heavy and unstable.



Get some scrap 2x4 pieces from the cut crew and elevate roof assembly off the ground by several inches to make it easier to paint. Paint the roof segments with the white Kilz primer.



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Congratulations, the roof structures are complete & ready for installation on the walls!

