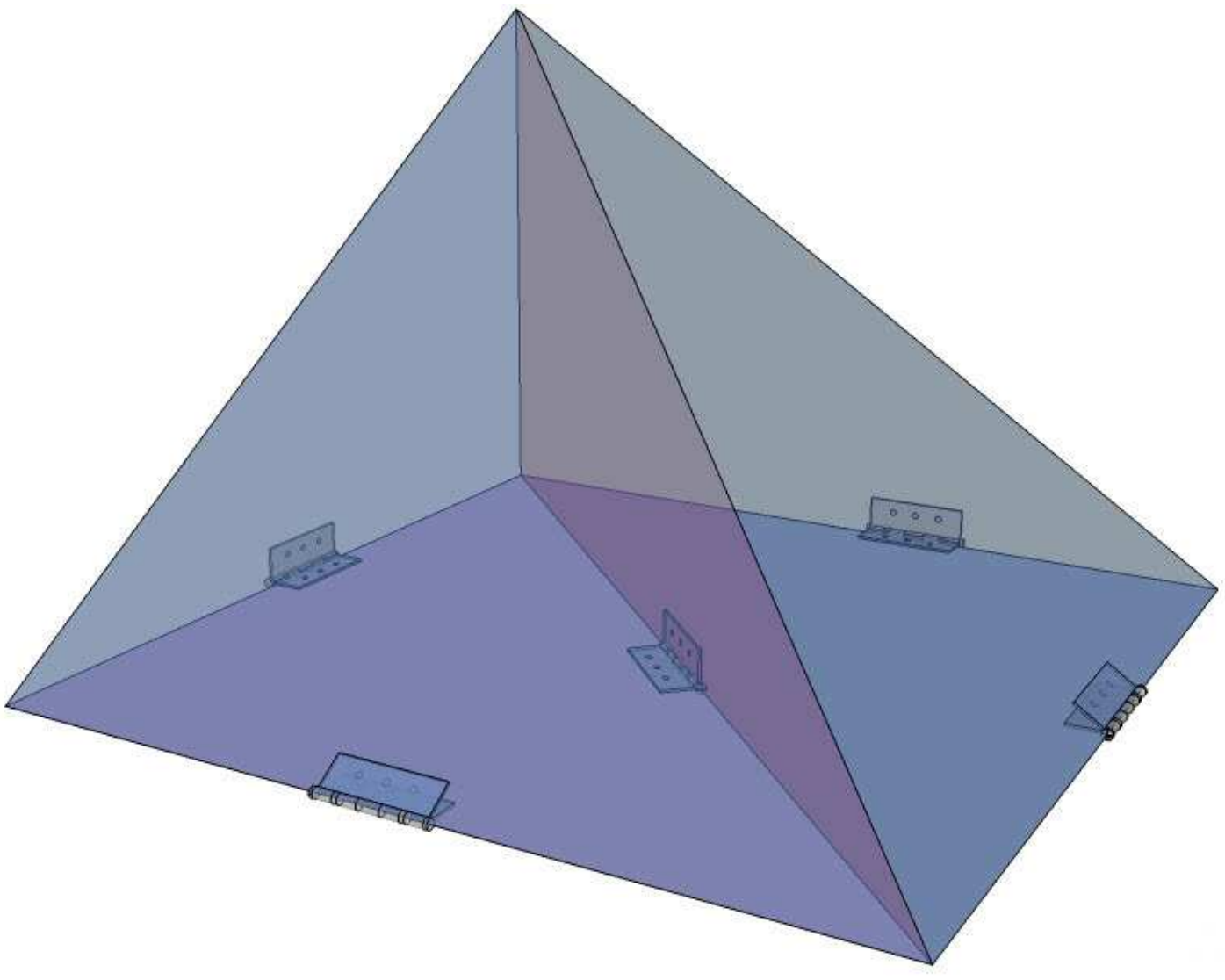
ATP Presents
Complex Roof Layout

North American carpenters have used several techniques to cut rafters over the last 300+ years. Protestant Huguenots and others trained in traditional carpentry came to Canada and America in the 1600's. Skills they brought: lofting timbers over lay lines with plumb bobs, English and French Scribe, the art of the line, and German Shiften geometry were common. However, the framing square manufacturers in the early 1800's sold carpenters framing squares that required the carpenter to know very little about traditional roof framing geometry. Carpenters were efficient at cutting rafters for simple roofs with the new framing square, however the geometric base of roof framing was set aside in pursuit of production. Many books were published to preserve the skills of the traditional carpenter and many were left to gather dust. The framing square is still a solid measuring and layout tool but the power of the carpenter is found in the underlying geometry that can be brought to the timbers via that square.

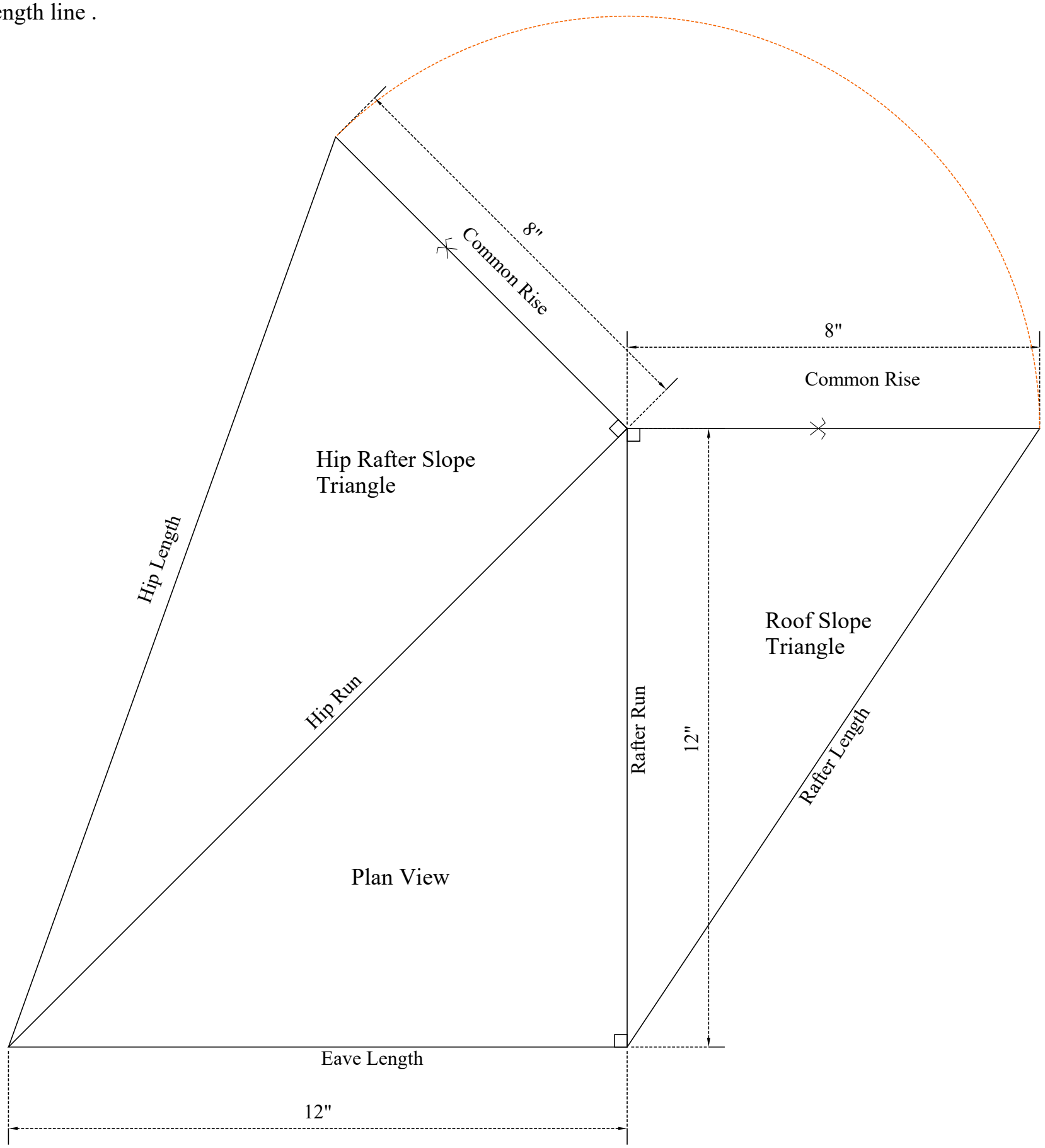
Complex roof framing layout can be accomplished by using unrelated right triangles but we will start with related triangles. With a basic understanding of folding roof planes, drafting based on plumb lines and dimensions taken from a plan view drawing the mental process of laying out various parts of complex roofs becomes clearer. This process is called developed drawing. The goal of developed drawings is to discover the true length and shape of geometry that is presented in plan view in a related auxiliary view.

Awareness of the different planes of roof kernels is the beginning of a study of the underlying geometry in complex roof layout. The folding roof plane drawings in this document form the basic geometric roof framing kernels that should be studied. Mastery of the drawing techniques requires practice, the math that is represented by the geometry requires even more effort.



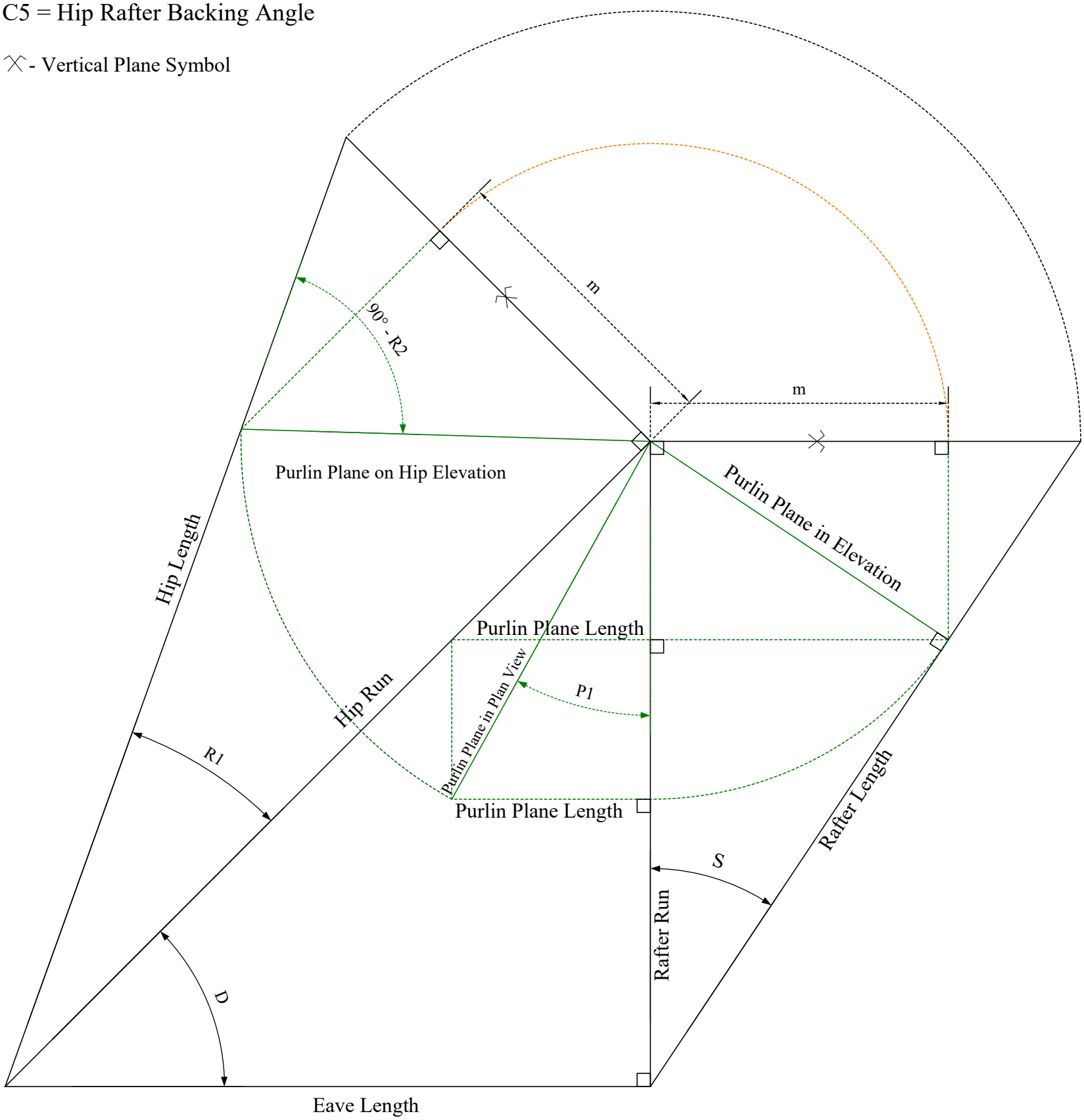
TFG - Roof Framing Kernel Geometric Development
Drawing out the roof framing kernel on a 48"x48" sheet of plywood using the framing square:

Start your drawing for an equal pitched 8:12 roof with a plan angle of 45°. The two sides of the plan view drawing, Eave Length & Rafter Run, will be 12" in length. Finish the plan view triangle by drawing the Hip Rafter Run line. Next draw in the Roof Slope Triangle by drawing the 8" Common Rafter Rise line perpendicular to the Common Rafter Run Line. Then draw the Rafter Length line to finish the Roof Slope Triangle. The Rafter Length line will be the length of the profile-common rafter for 12" of run in plan view. Draw an 8" line perpendicular to the Hip Rafter Run line. Finish the drawing by drawing the Hip Rafter Length line .



S = Roof Slope Angle
D = Plan Angle
R1 = Hip Rafter Slope Angle
P2 = Jack Rafter Bevel
P7 = Roof Sheathing Angle
P1 = Purlin Miter Angle
R2 = Hip Rafter Purlin Housing Angle & Square Tail Hip Rafter Miter
C1 = SBBA for Purlin Miter Line, Hip Rafter Square Tail Miter Line
C5 = Hip Rafter Backing Angle

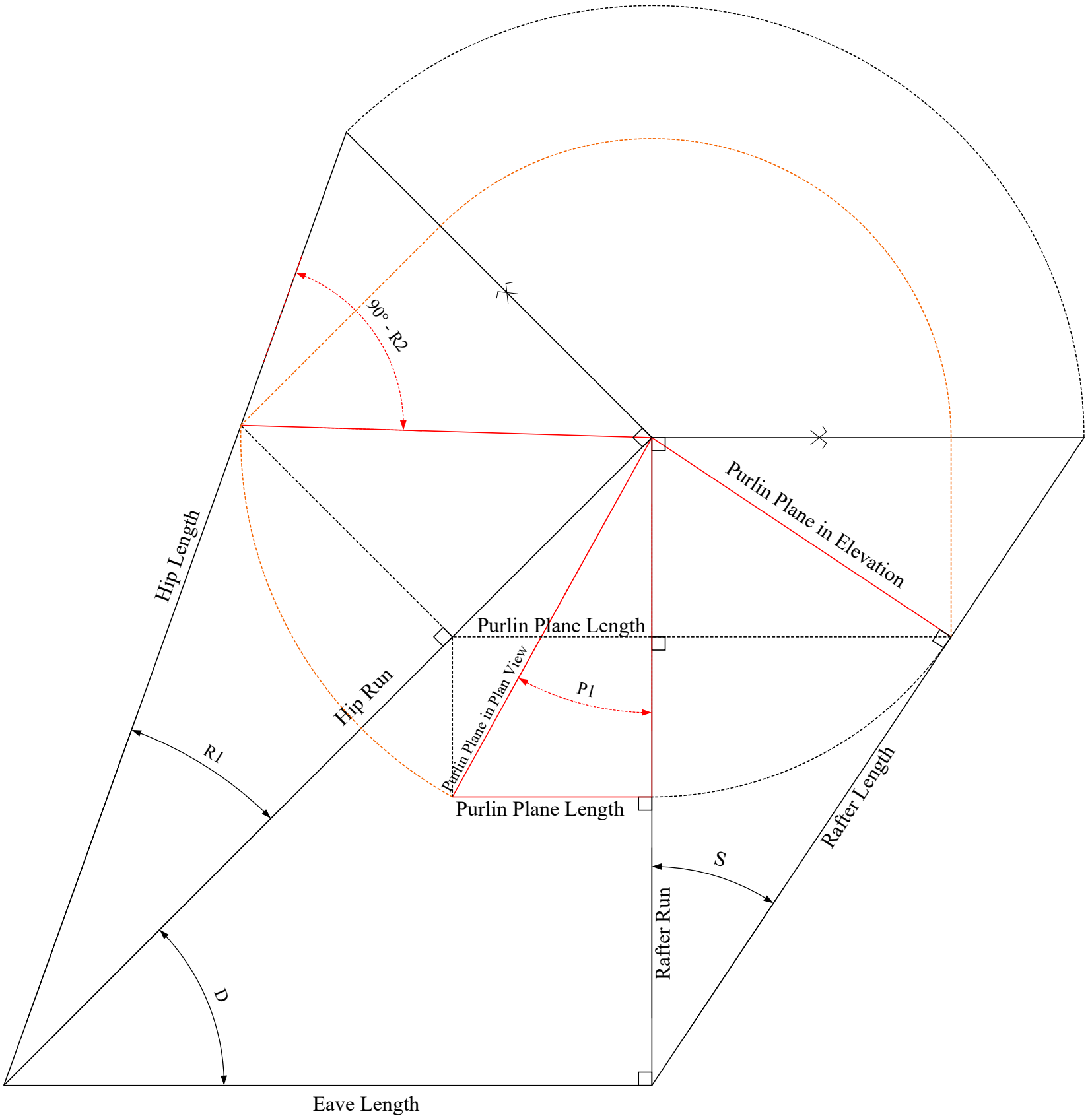
⟊- Vertical Plane Symbol



Add the Purlin Miter Angle P1 geometric development to your drawing. Also, add the hip rafter purlin housing angle geometric development as shown. For the angle 90° - R2.

S = Roof Slope Angle
D = Plan Angle
R1 = Hip Rafter Slope Angle
P2 = Jack Rafter Bevel
P7 = Roof Sheathing Angle
P1 = Purlin Miter Angle
R2 = Hip Rafter Purlin Housing Angle & Square Tail Hip Rafter Miter
C1 = SBBA for Purlin Miter Line, Hip Rafter Square Tail Miter Line
C5 = Hip Rafter Backing Angle

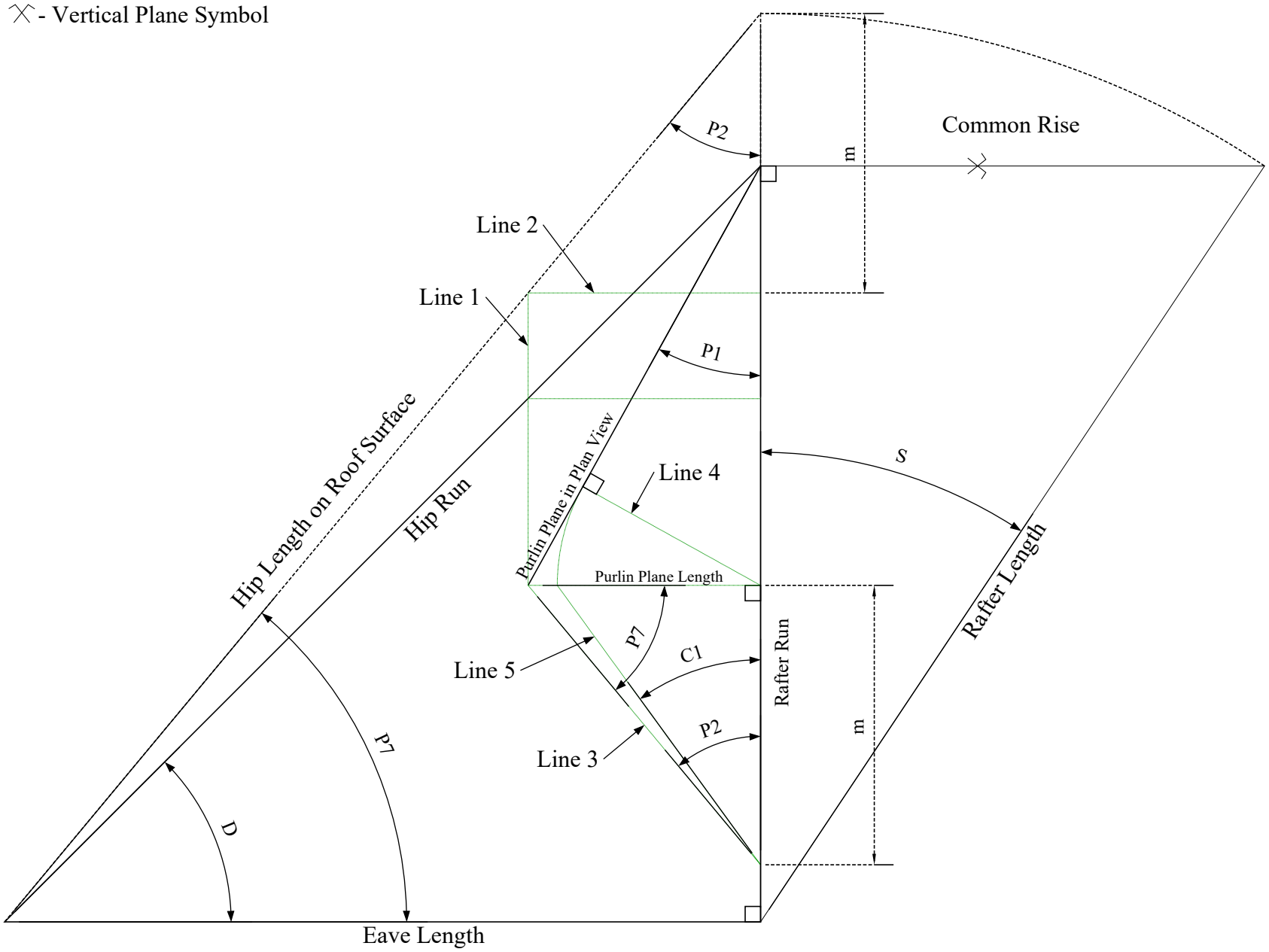
⟋- Vertical Plane Symbol



Alternate method of developing the hip rafter purlin housing angle geometrically for the angle 90° - R2.

S = Roof Slope Angle
D = Plan Angle
R1 = Hip Rafter Slope Angle
P2 = Jack Rafter Bevel
P7 = Roof Sheathing Angle
P1 = Purlin Miter Angle
R2 = Hip Rafter Purlin Housing Angle & Square Tail Hip Rafter Miter
C1 = SBBA for Purlin Miter Line, Hip Rafter Square Tail Miter Line
C5 = Hip Rafter Backing Angle
SBBA = Saw Blade Bevel Angle

- Vertical Plane Symbol



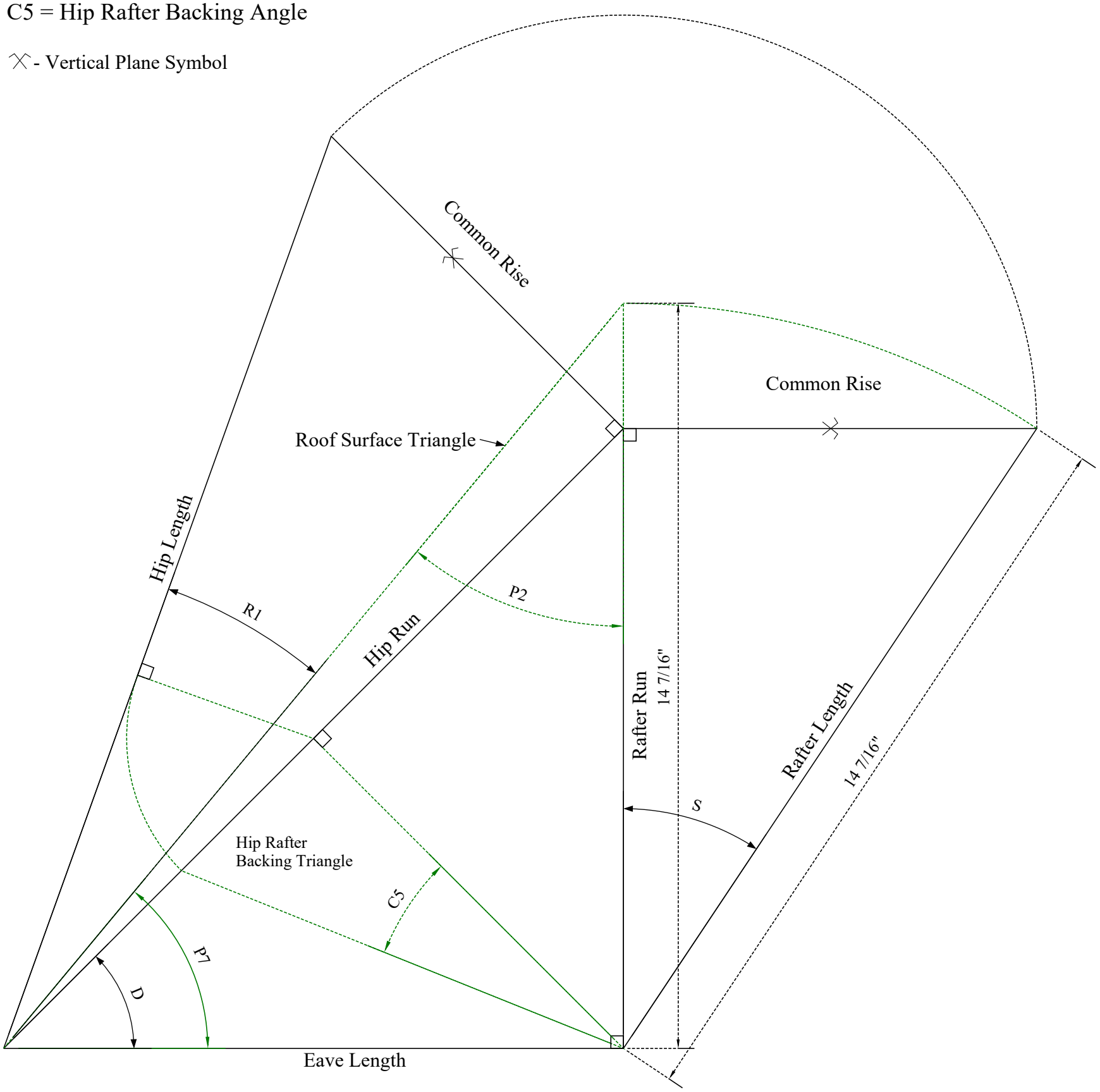
C1 SBBA method: use dimension "m" to develop the geometry for the saw blade bevel angle C1.

Start the drawing by drawing lines 1&2. Take the dimension "m" and mark off this length on the Rafter Run line below the Purlin Plane Length line. Draw line 3 back to the Purlin Plane Length line.

Draw line 4 perpendicular to the Purlin Plane in Plan View line. Swing an arc from the intersection of line 4 & the Rafter Run to the Purlin Plane Length line. Then draw line 5. The purlin saw blade bevel angle C1 is used to cut the purlin miter angle line on the side of the material perpendicular to the roof surface, AKA the upslope or downslope face.

S = Roof Slope Angle
D = Plan Angle
R1 = Hip Rafter Slope Angle
P2 = Jack Rafter Bevel
P7 = Roof Sheathing Angle
P1 = Purlin Miter Angle
R2 = Hip Rafter Purlin Housing Angle & Square Tail Hip Rafter Miter
C1 = SBBA for Purlin Miter Line, Hip Rafter Square Tail Miter Line
C5 = Hip Rafter Backing Angle

⟡ - Vertical Plane Symbol



Roof Surface geometric development for Jack Rafter Bevel Angle P2, Purlin top cut & Roof Sheathing Angle P7. Swing an arc centered at the intersection of the Eave Length and Rafter Run using the Rafter Length as the radius from the top of the common rise to an extension of the common run. This develops the roof surface triangle folded down over plan view.

Next draw in the Hip Rafter Backing Triangle. Draw a line perpendicular to the Hip Rafter Run line as shown. Draw a line perpendicular to the Hip Rafter Length line back to the perpendicular line that intersects at the Hip Rafter Run line. Swing an arc from the intersection of the perpendicular lines back to the hip rafter run line to develop the hip rafter backing triangle.

S = Roof Slope Angle
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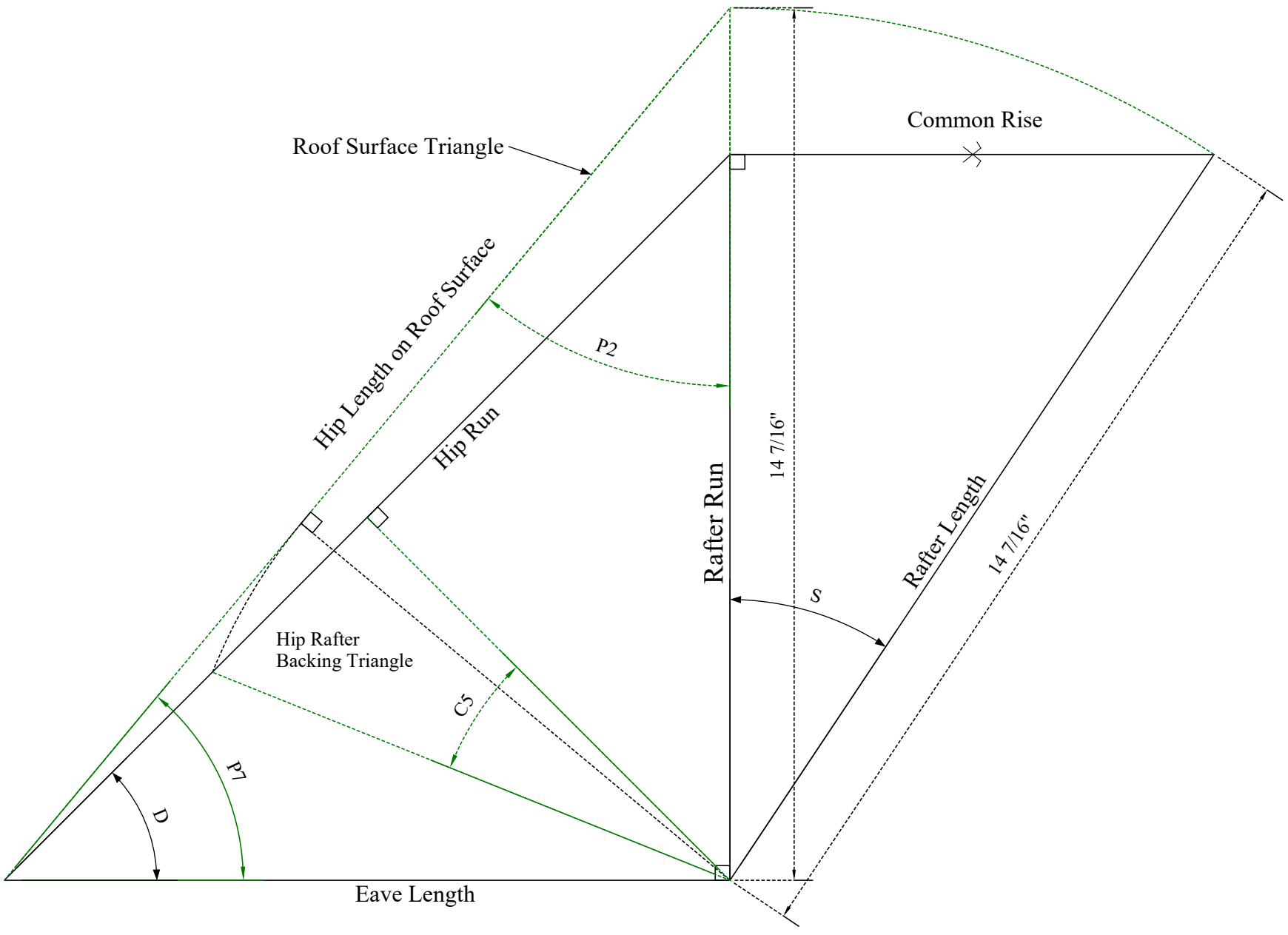
R1 = Hip Rafter Slope Angle
P2 = Jack Rafter Bevel
P7 = Roof Sheathing Angle
P1 = Purlin Miter Angle
R2 = Hip Rafter Purlin Housing Angle & Square Tail Hip Rafter Miter
C1 = SBBA for Purlin Miter Line, Hip Rafter Square Tail Miter Line
C5 = Hip Rafter Backing Angle

- Vertical Plane Symbol

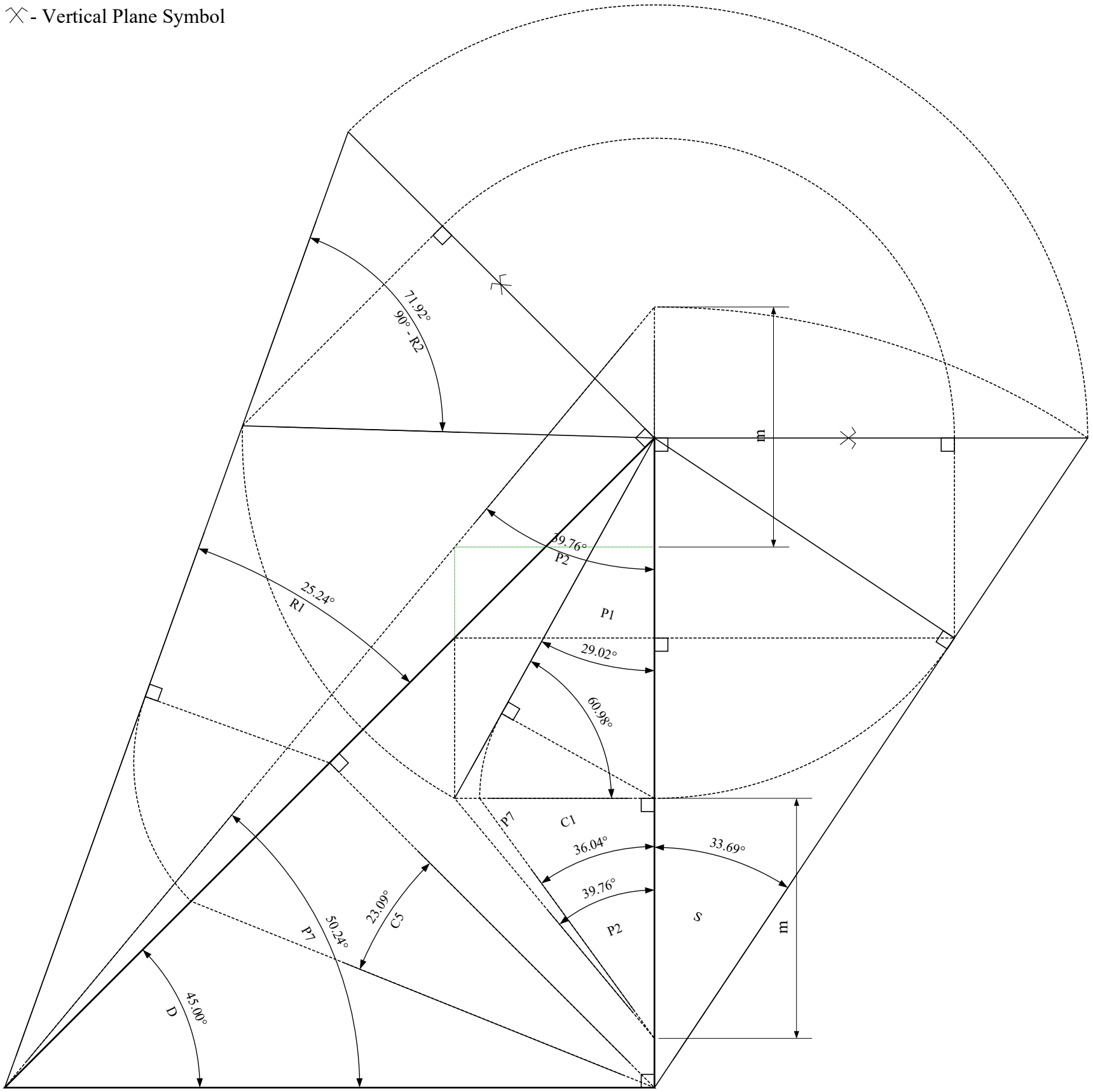


ALTERNATE METHOD of developing the Hip Rafter Backing Triangle from the Roof Surface Triangle. From the intersection of the eave length and rafter run draw a line perpendicular to the hip rafter run line and draw a line perpendicular to the Hip Length on Roof Surface line. Swing an arc with the center point of the arc at the intersection of the Eave Length and Rafter Run using the perpendicular line on the Hip Length on Roof Surface line back to the Hip Run line.

TFG - Roof Framing Kernel geometric development for the purlin miter angle and the SBBA for purlins and square tail hip rafters. This geometric development can be developed with just a framing square. This works on all plan angles with equal pitched roofs or unequal pitched roofs.

S = Roof Slope Angle
D = Plan Angle
R1 = Hip Rafter Slope Angle
P2 = Jack Rafter Bevel
P7 = Roof Sheathing Angle
P1 = Purlin Miter Angle
R2 = Hip Rafter Purlin Housing Angle & Square Tail Hip Rafter Miter
C1 = SBBA for Purlin Miter Line, Hip Rafter Square Tail Miter Line
C5 = Hip Rafter Backing Angle

- Vertical Plane Symbol



Irregular Hip Roof Development

Standard geometric roof framing kernel with a unit rise of 12", fig. 1. By drawing out the roof framing kernel on a sheet of plywood or paper the mental process of visualizing the folding roof planes, fig. 2, is enhanced.

Draw the base of the roof framing kernel with the rafter elevations then develop the hip rafter slope triangle based on the unit of rise of 12", as seen in fig. 3. This technique that follows works for all unequal pitched roofs, as well as eaves that are not at 90°.

fig. 1

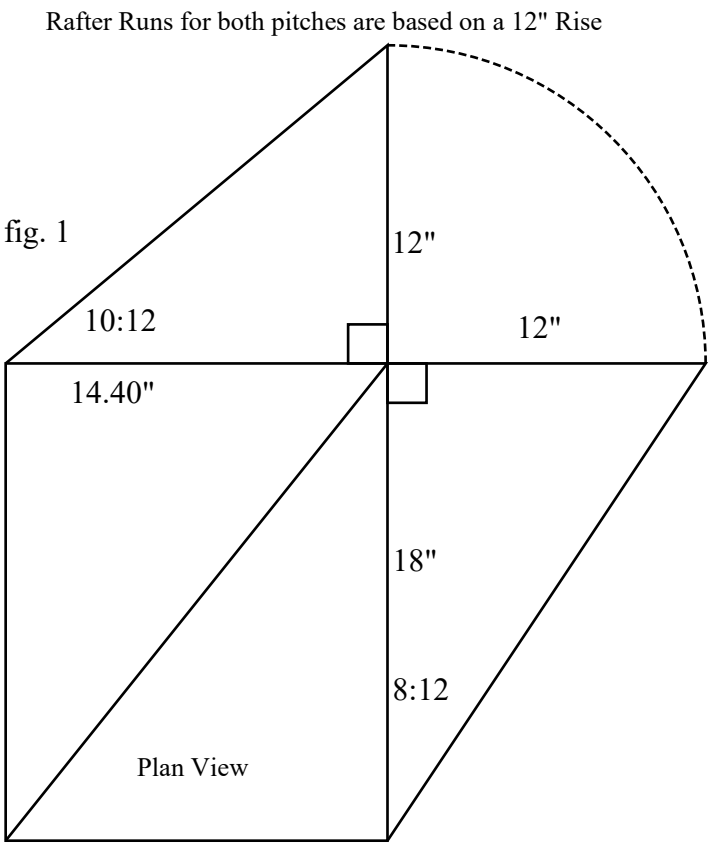


fig. 3

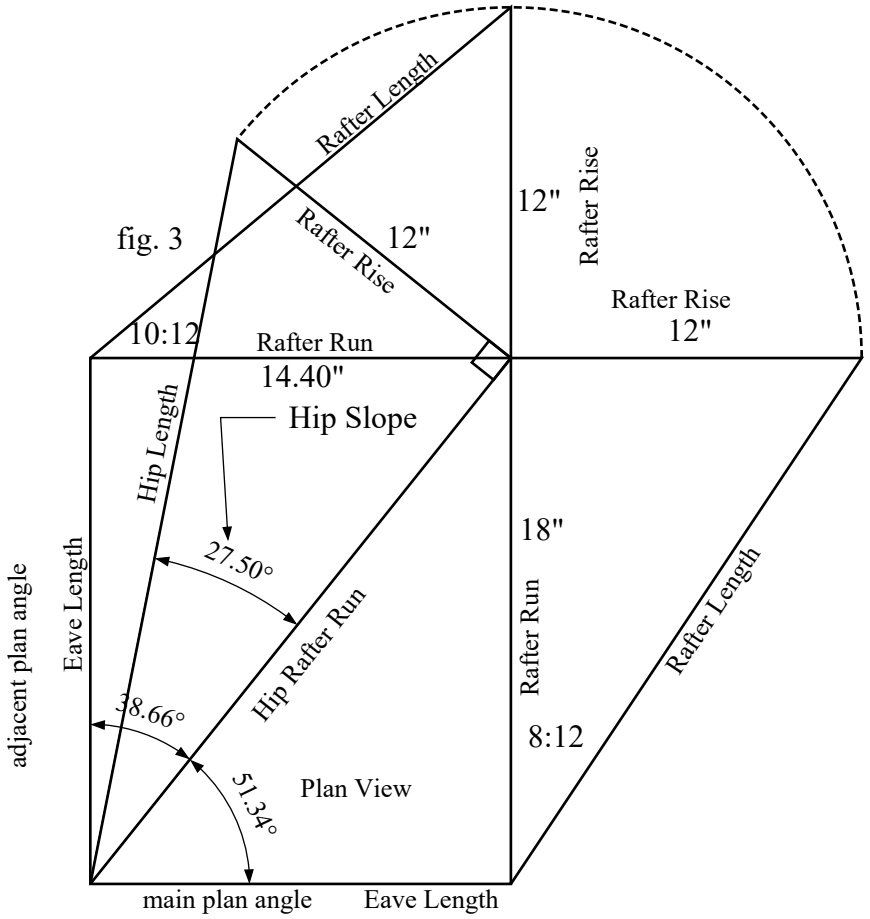
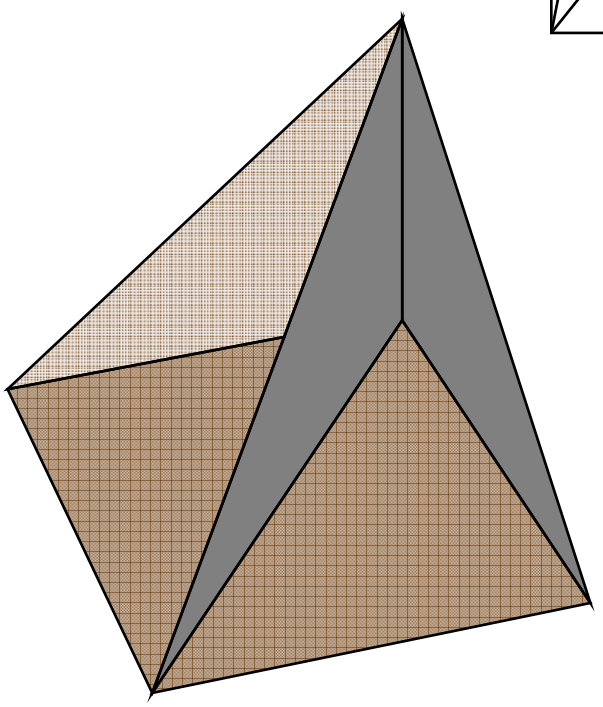


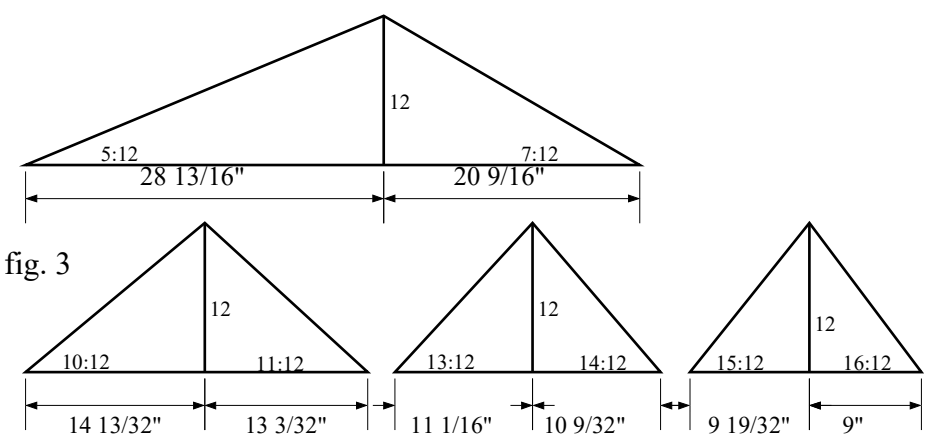
fig. 2



Unit Run for 12" Rise
formula 12 ÷ (pitch÷12)

4/12 Pitch Unit Run = 36"
5/12 Pitch Unit Run = 28.80 - 28 1316"
6/12 Pitch Unit Run = 24"
7/12 Pitch Unit Run = 20.57143 -- 20 9/16"
8/12 Pitch Unit Run = 18"
9/12 Pitch Unit Run = 16"
10/12 Pitch Unit Run = 14.40 -- 14 13/32"
11/12 Pitch Unit Run = 13.09091 -- 13 3/32"
12/12 Pitch Unit Run = 12"
13/12 Pitch Unit Run = 11.07692 -- 11 1/16"
14/12 Pitch Unit Run = 10.28571 -- 10 9 32"
15/12 Pitch Unit Run = 9.60 -- 9 19/32"
16/12 Pitch Unit Run = 9"

fig. 3



Irregular Hip Roof Development

The next step in developing the geometry for the roof framing kernel is to fold out the roof surface planes. The roof surface planes are right triangles consisting of Eave length, Rafter length and Hip length for the common rise of 12". With the roof surface developed you can take actual lengths and angles of the roof sheathing geometry, jack rafter side cut angles and purlin top cut angles.

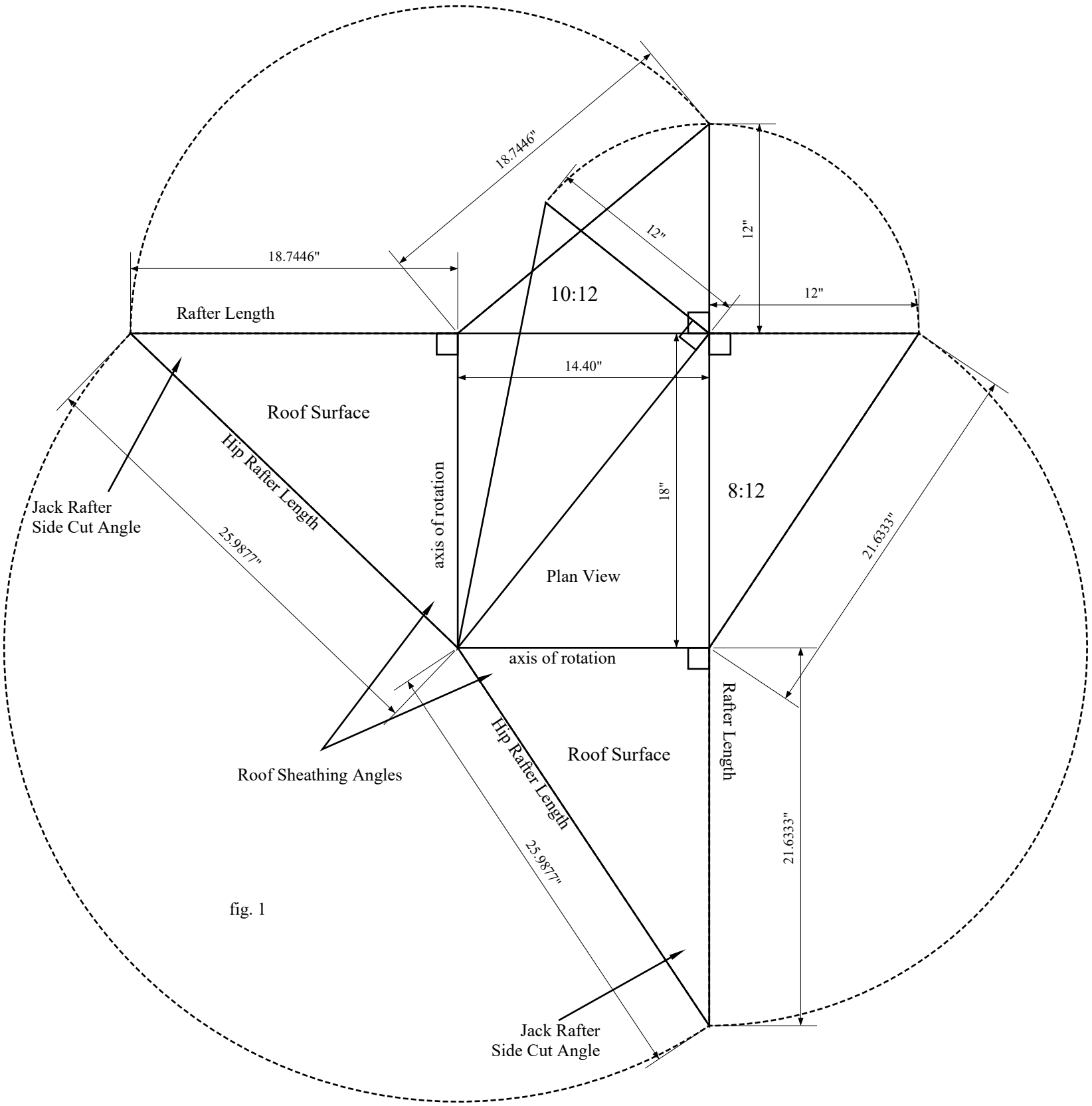
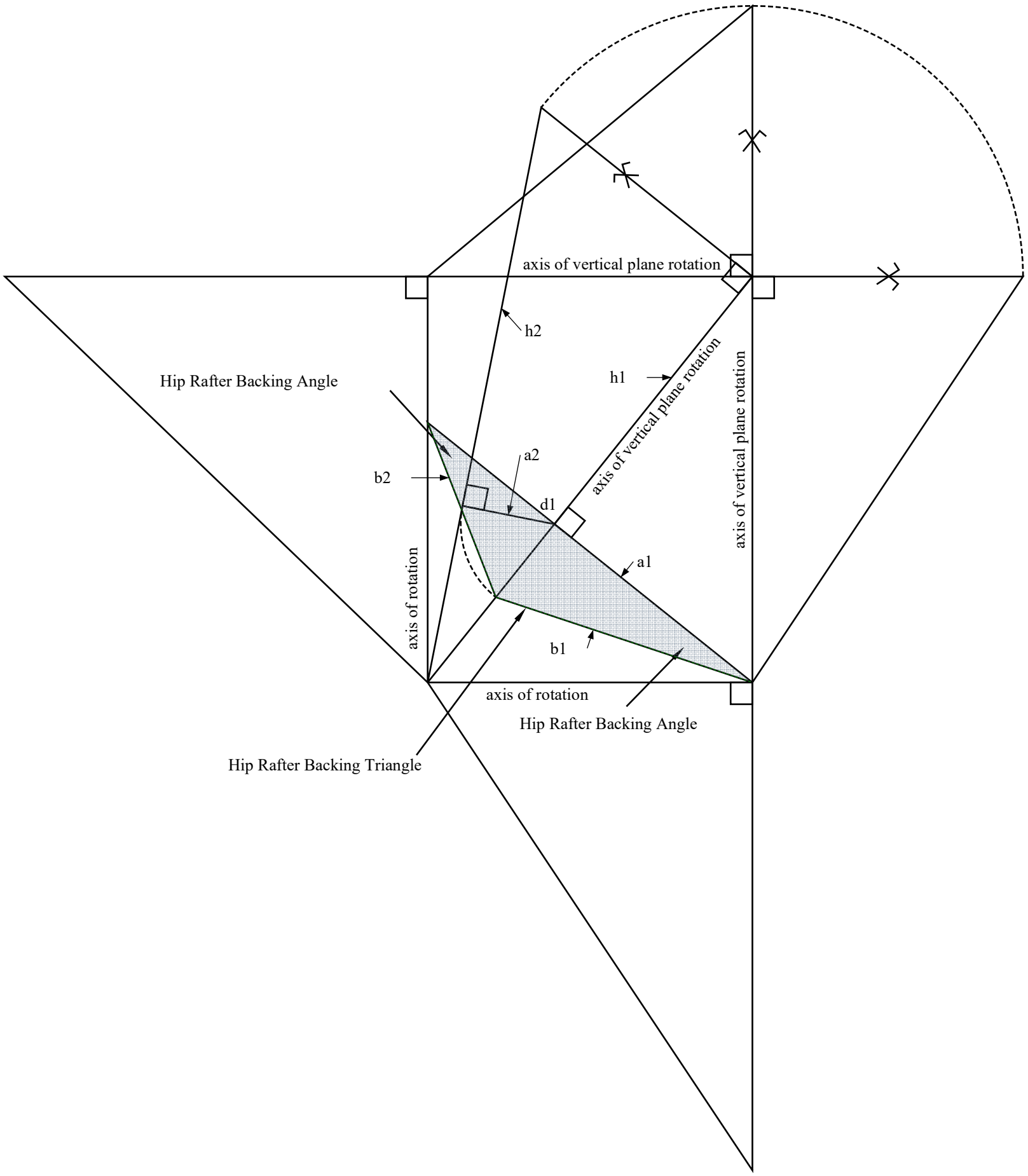


fig. 1

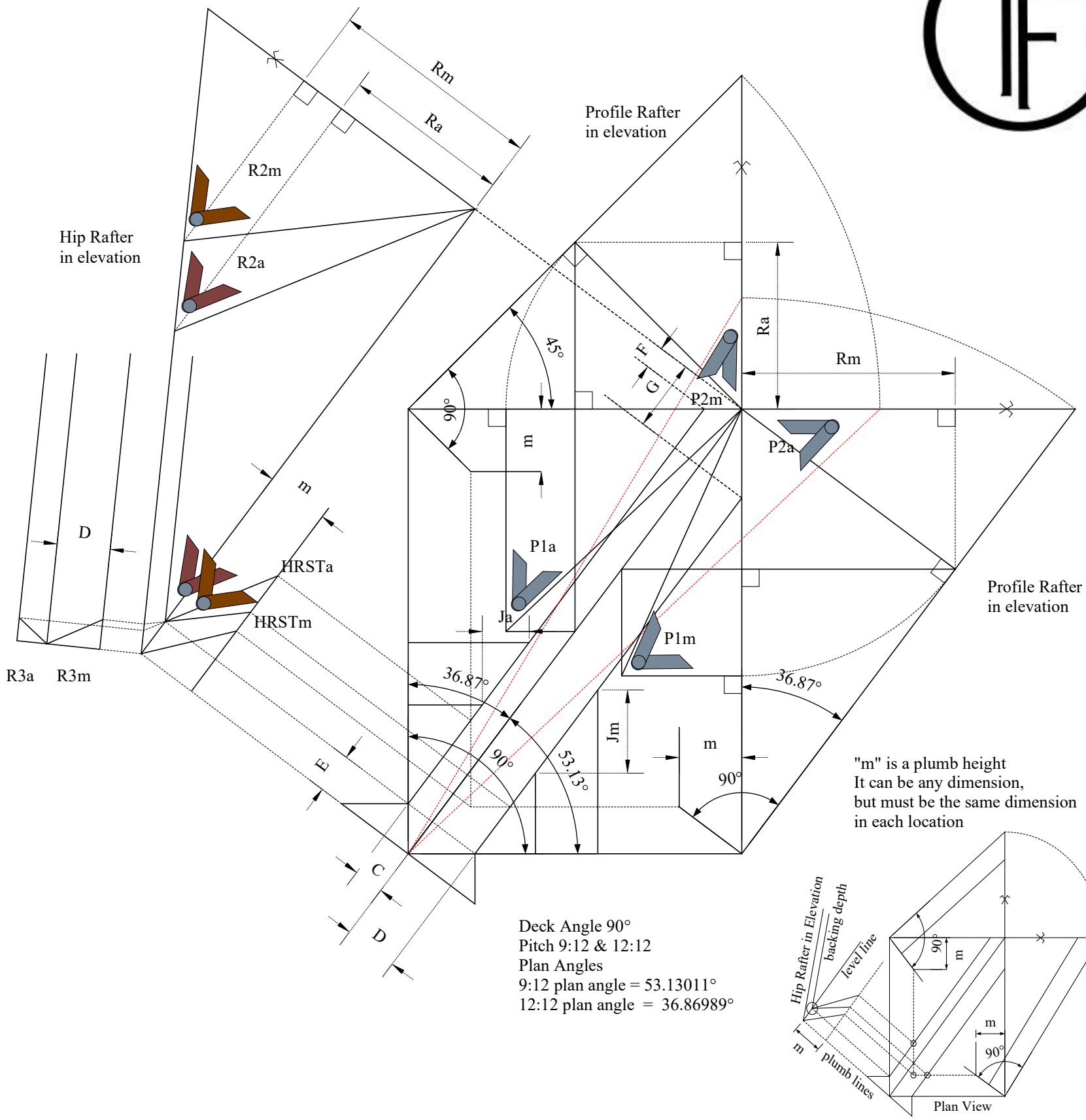
Irregular Hip Roof Development

The next step in developing the geometry for the roof framing kernel is to develop the hip rafter backing triangle. Draw line a1 perpendicular to the hip rafter run line h1 and extend it to the eave lines. From the point where a1 crosses hl draw line a2 perpendicular to the hip rafter slope line h2. Swing an arc with the radius equal to a2 from point d1 to the line h1. Then draw lines b1 and b2 from the intersections of line a1 and the eave lines. Each section of this shaded triangle will be the hip rafter backing angle for that side of the roof.

- Vertical Plane Symbol



Irregular Hip Roof Development



This drawing is a combination of French art du trait and German Shiften. Start the drawing with a plan view of the hip rafter, drawing the hip rafter shift-offset for equal height shoulders. Then draw the profile rafters in elevation using the same height for the rise of the rafter. Next, draw the hip rafter in elevation using the same rise.The hip rafter purlin housing angles are drawn using the French technique and the hip rafter witches cut on the hip rafter tail is drawn using the German technique. This drawing should be the base for all your geometric roof plans in plan view. The most important parts of this drawing are the plumb lines. The drawings do not have to be full scale in length, however the width of the hip rafter and jack rafters must be drawn to the correct width. This drawing is about 48" x 48".

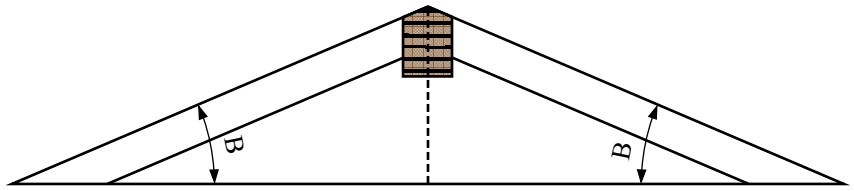
In this geometric drawing the purlin rafter miter angles on the stick-timber are P1m and P1a. The purlin rafter top bevel cut angle can be laid out using the roof sheathing angle P7 or 90° - P2m and 90° - P2a. R2m and R2a are the hip rafter purlin housing angles on the stick-timber. The angles to cut the hip rafter for square tail alignment on the hip rafter, HRSTm and HRSTa, are the same angles as the hip rafter housing angles, because the tails are at 90° to the roof surface plane. You can use either technique to develop the hip rafter square tail alignment cut. However, by developing the plumb lines for HRSTm and HRSTa they develop the hip rafter top bevel angles R3m and R3a on an unbacked hip rafter.

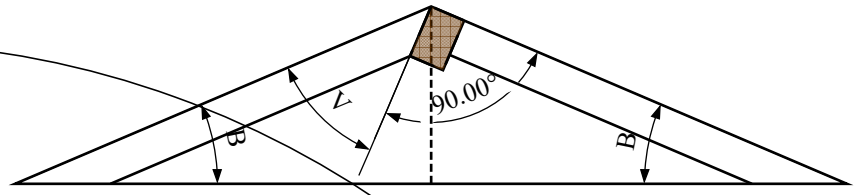
The TFG - Roof Framing Kernel geometric development is a geometric base development that can be used to develop all of the roof framing angles geometrically. The roof framing angles are based on these three angles.

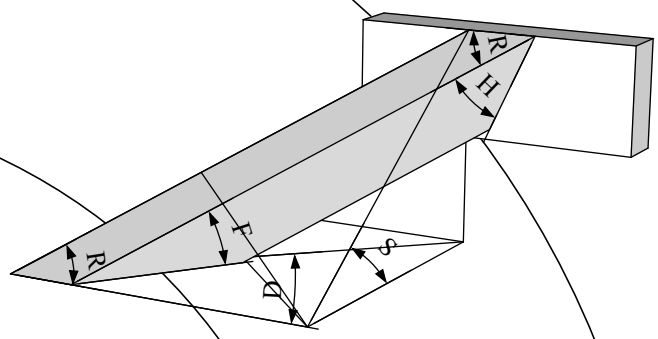
1: Hip Rafter Backing Angle
2: Valley Sleeper Layover Bevel Angle
3: Roof Surface - Sheathing Angles.

All of the roof framing angles we use are based on these three angles. For plumb hip rafters, the hip rafter backing angle and roof sheathing angles define the cut on the timber. For canted rafters, the valley sleeper layover bevel angle and roof sheathings angle define the cuts on the timber for canted rafters. This descriptive geometric drawing below only works on equal pitched roofs with a deck angle of 90°. However, the saw blade bevel angle can also be developed geometrically for each of the miter angles by using the roof sheathing angle in a folding roof framing drawing.

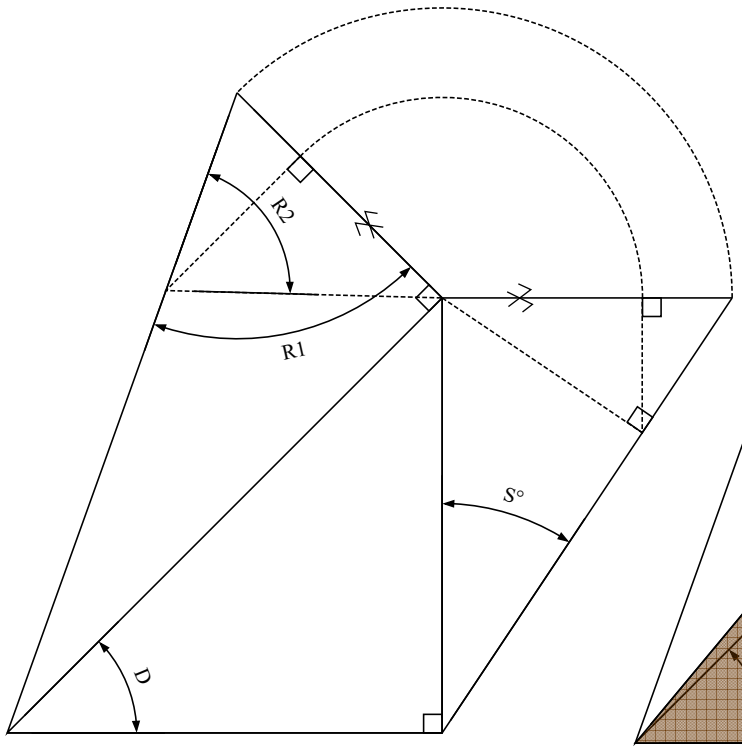
B= Plumb Hip Rafter Backing Angle
V = Valley Sleeper Layover Bevel Angle
S = Roof Slope Angle
D = Plan Angle --45°
R1 = Plumb Hip Rafter Head Cut Angle
R2 = Plumb Hip Rafter Purlin Housing Angle
R = Roof Surface - Roof Sheathing Angle
C = Jack Rafter Top Bevel Angle
JM = Jack Rafter Plumb Cut
JC = Jack Rafter Lower Claw Angle
PM - Purlin Miter Angle on Stick
PC = Purlin Lower Claw Angle
R = Purlin Top Bevel Angle
H = Canted Hip Rafter Head Cut
F = Canted Hip Rafter Foot Cut
JCC = Jack Rafter Miter Angle on Canted Hip Rafter
PCC = Purlin Miter Angle on Canted Hip Rafter
DJC = Jack Rafter Lower Claw Angle on Canted Hip Rafter
DPC = Purlin Lower Claw Angle on Canted Hip Rafter
SBBA = Saw Blade Bevel Angle



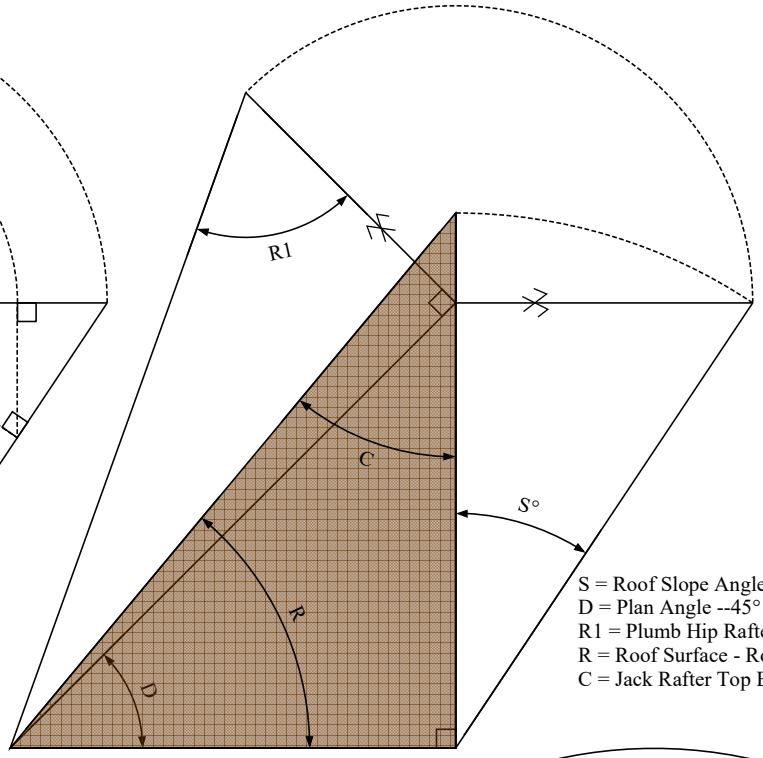




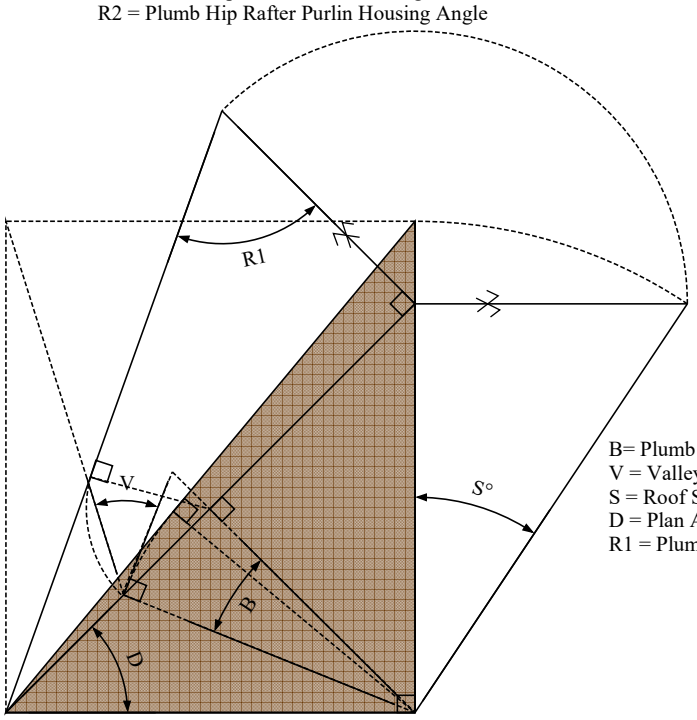
Canted Hip Rafter
Rotated into Roof Surface Plane



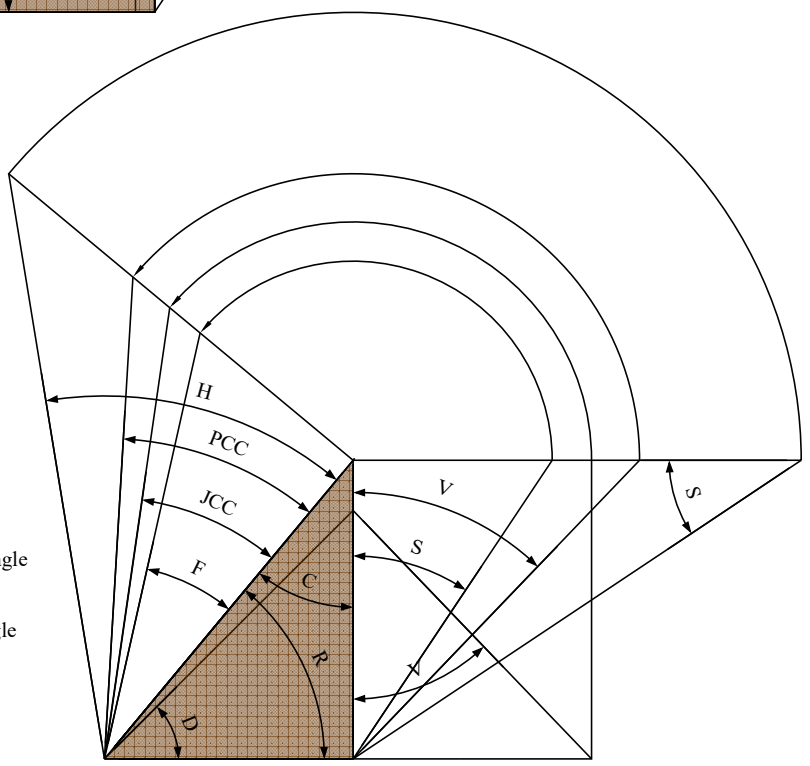
S = Roof Slope Angle
D = Plan Angle --45°
R1 = Plumb Hip Rafter Head Cut Angle
R2 = Plumb Hip Rafter Purlin Housing Angle



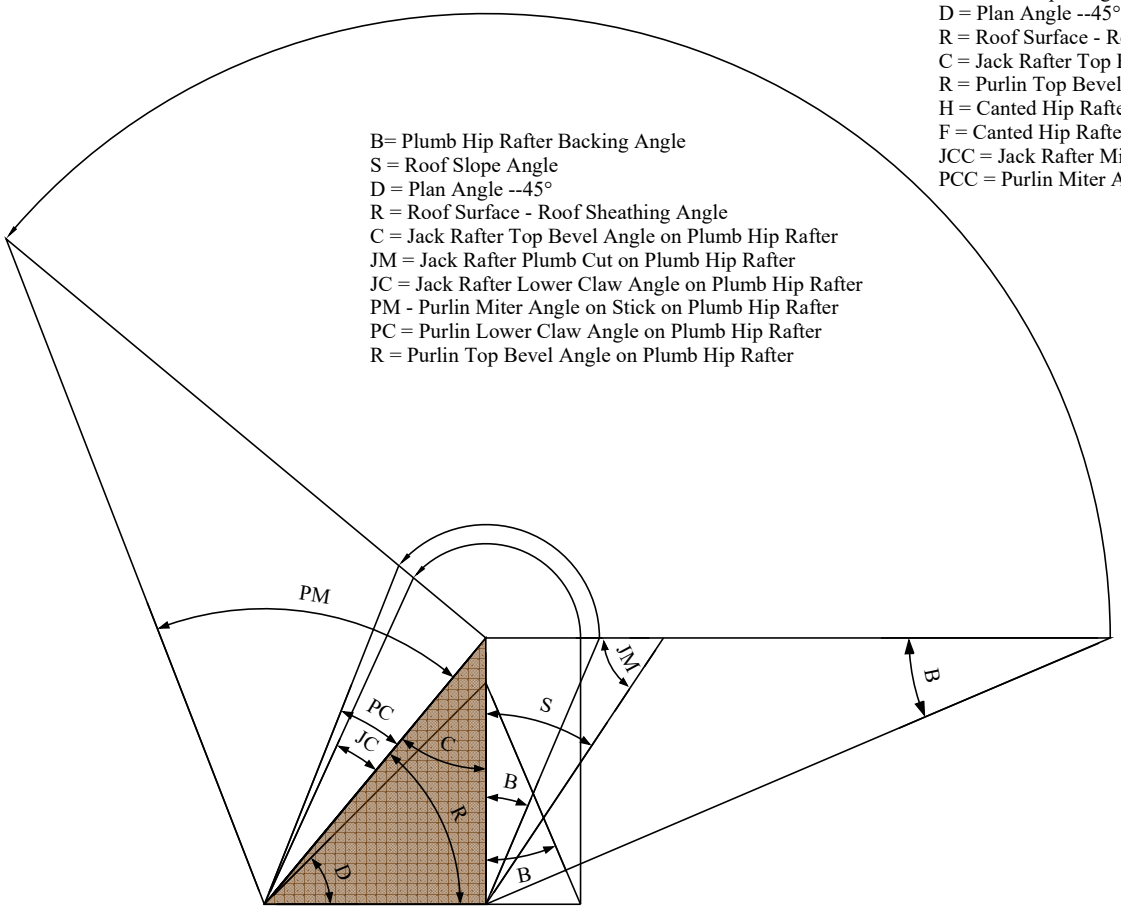
S = Roof Slope Angle
D = Plan Angle --45°
R1 = Plumb Hip Rafter Head Cut Angle
R = Roof Surface - Roof Sheathing Angle
C = Jack Rafter Top Bevel Angle



B= Plumb Hip Rafter Backing Angle
V = Valley Sleeper Layover Bevel Angle
S = Roof Slope Angle
D = Plan Angle --45°
R1 = Plumb Hip Rafter Head Cut Angle

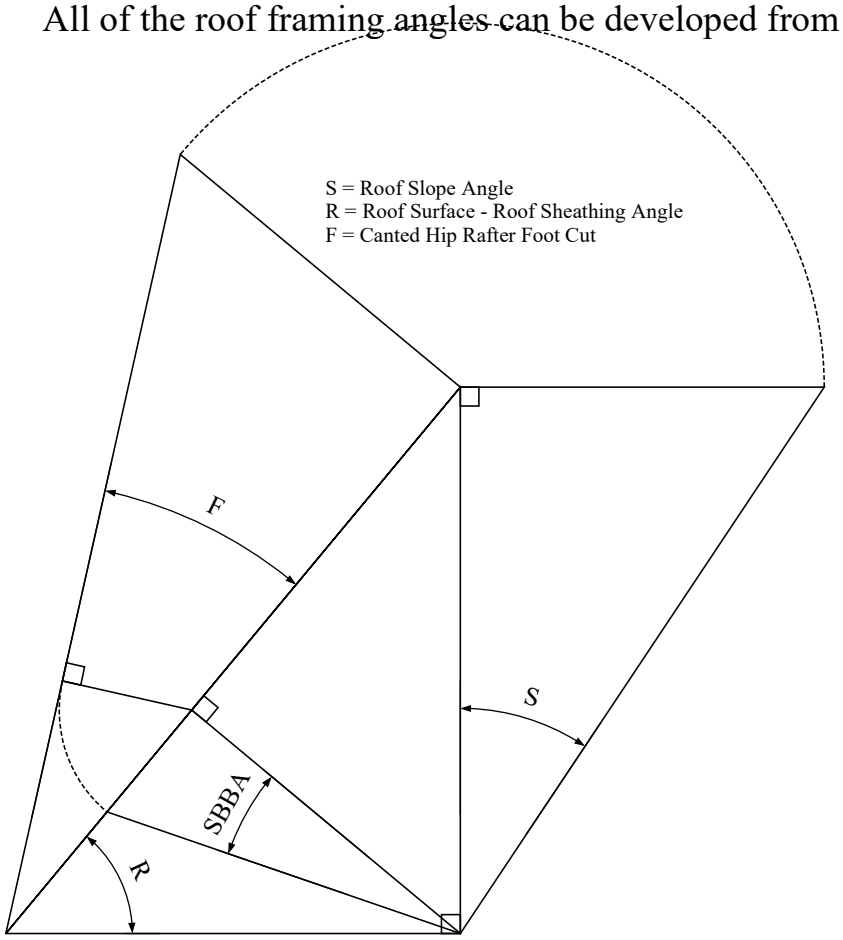


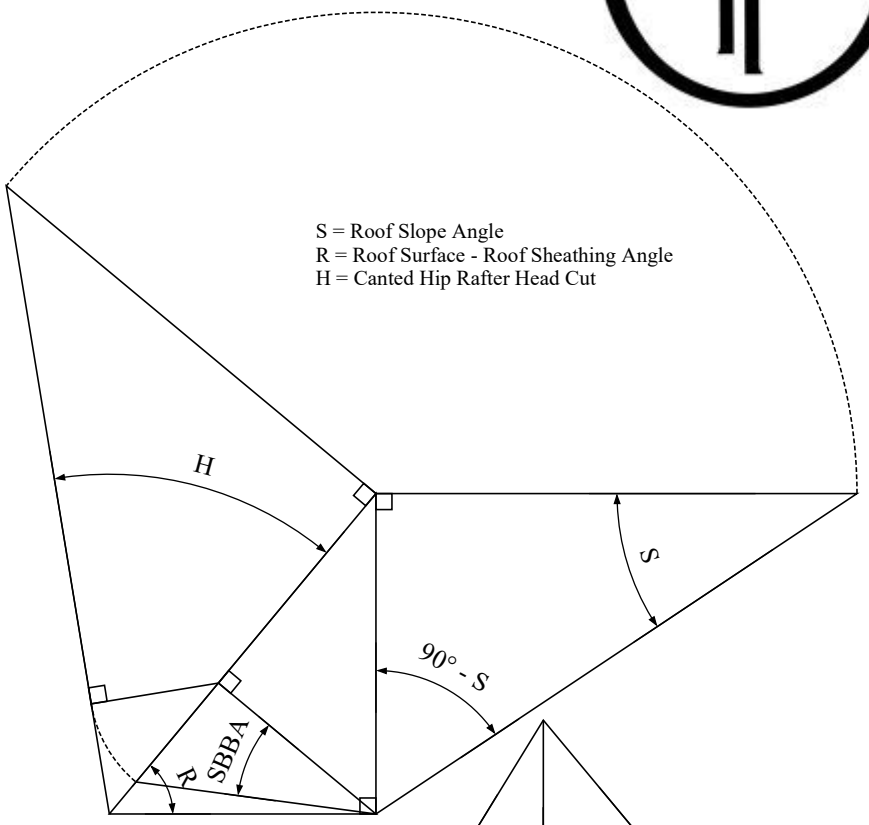
V = Valley Sleeper Layover Bevel Angle
S = Roof Slope Angle
D = Plan Angle --45°
R = Roof Surface - Roof Sheathing Angle
C = Jack Rafter Top Bevel Angle
R = Purlin Top Bevel Angle
H = Canted Hip Rafter Head Cut
F = Canted Hip Rafter Foot Cut
JCC = Jack Rafter Miter Angle on Canted Hip Rafter
PCC = Purlin Miter Angle on Canted Hip Rafter

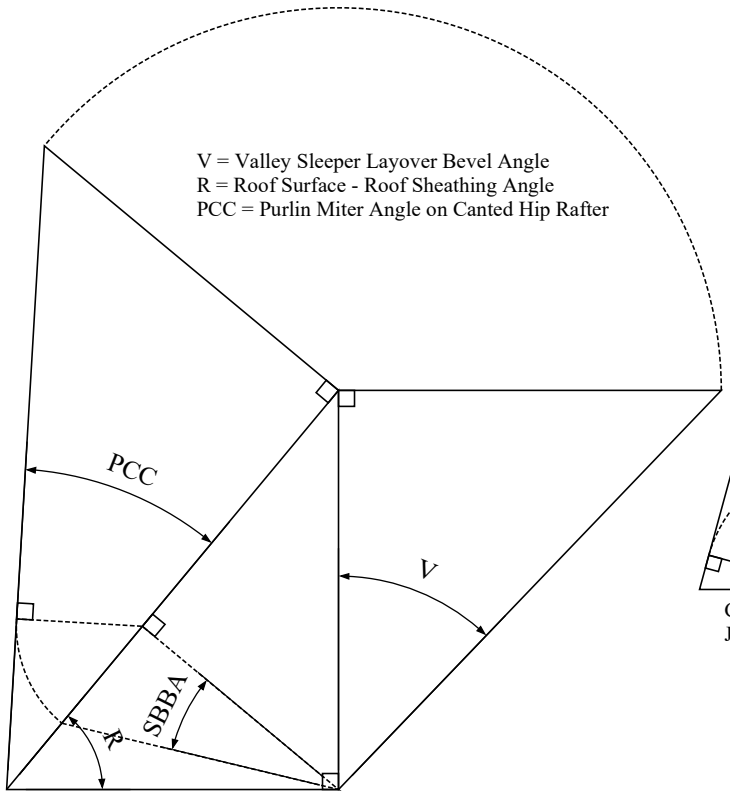


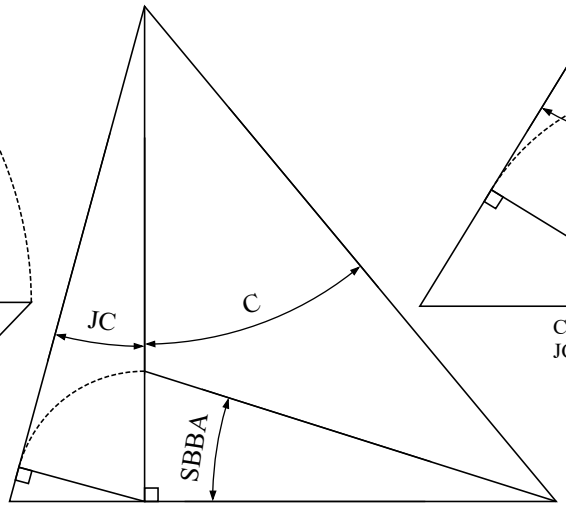
B= Plumb Hip Rafter Backing Angle
S = Roof Slope Angle
D = Plan Angle --45°
R = Roof Surface - Roof Sheathing Angle
C = Jack Rafter Top Bevel Angle on Plumb Hip Rafter
JM = Jack Rafter Plumb Cut on Plumb Hip Rafter
JC = Jack Rafter Lower Claw Angle on Plumb Hip Rafter
PM - Purlin Miter Angle on Stick on Plumb Hip Rafter
PC = Purlin Lower Claw Angle on Plumb Hip Rafter
R = Purlin Top Bevel Angle on Plumb Hip Rafter

All of the roof framing angles can be developed from 3 triangles for regular plan and pitch roofs

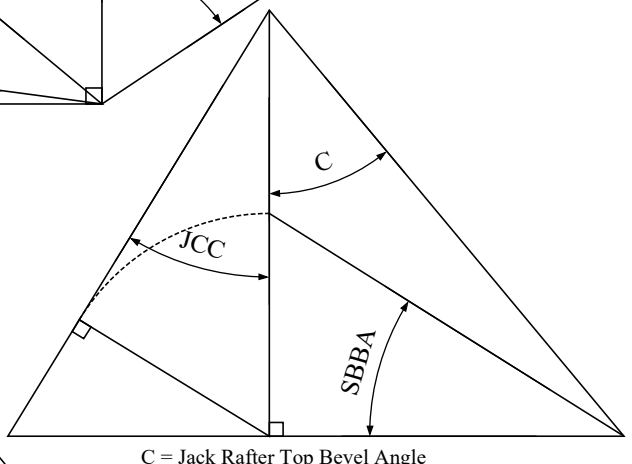




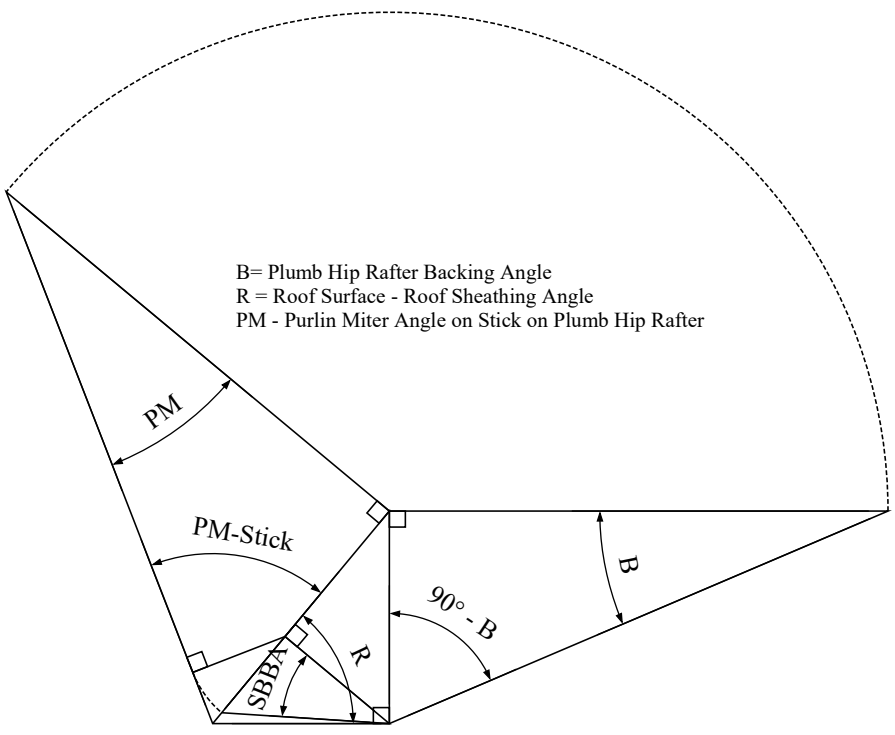


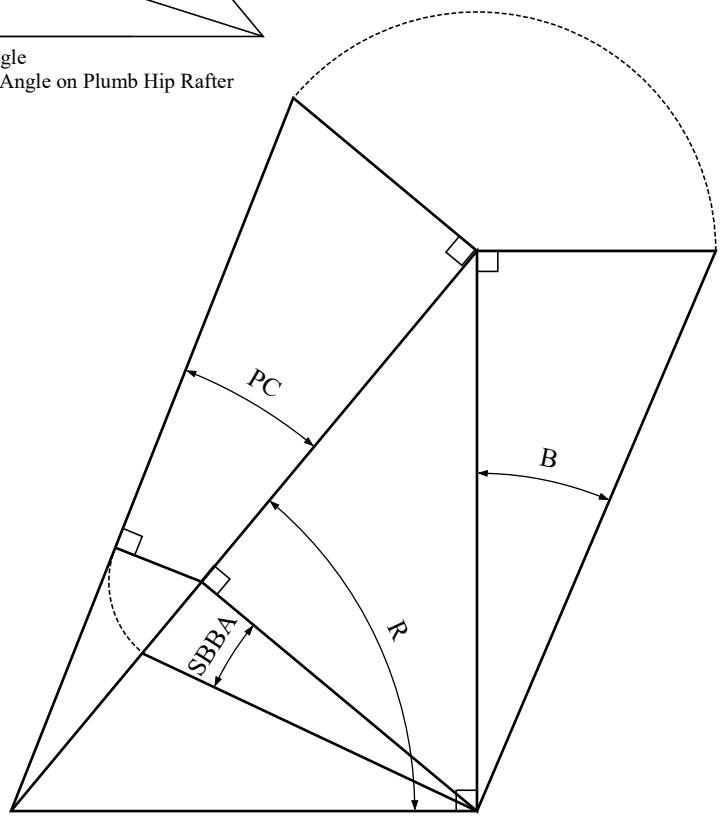


C = Jack Rafter Top Bevel Angle
JC = Jack Rafter Lower Claw Angle on Plumb Hip Rafter



C = Jack Rafter Top Bevel Angle
JCC = Jack Rafter Miter Angle on Canted Hip Rafter





B= Plumb Hip Rafter Backing Angle
R = Roof Surface - Roof Sheathing Angle
PC = Purlin Lower Claw Angle on Plumb Hip Rafter