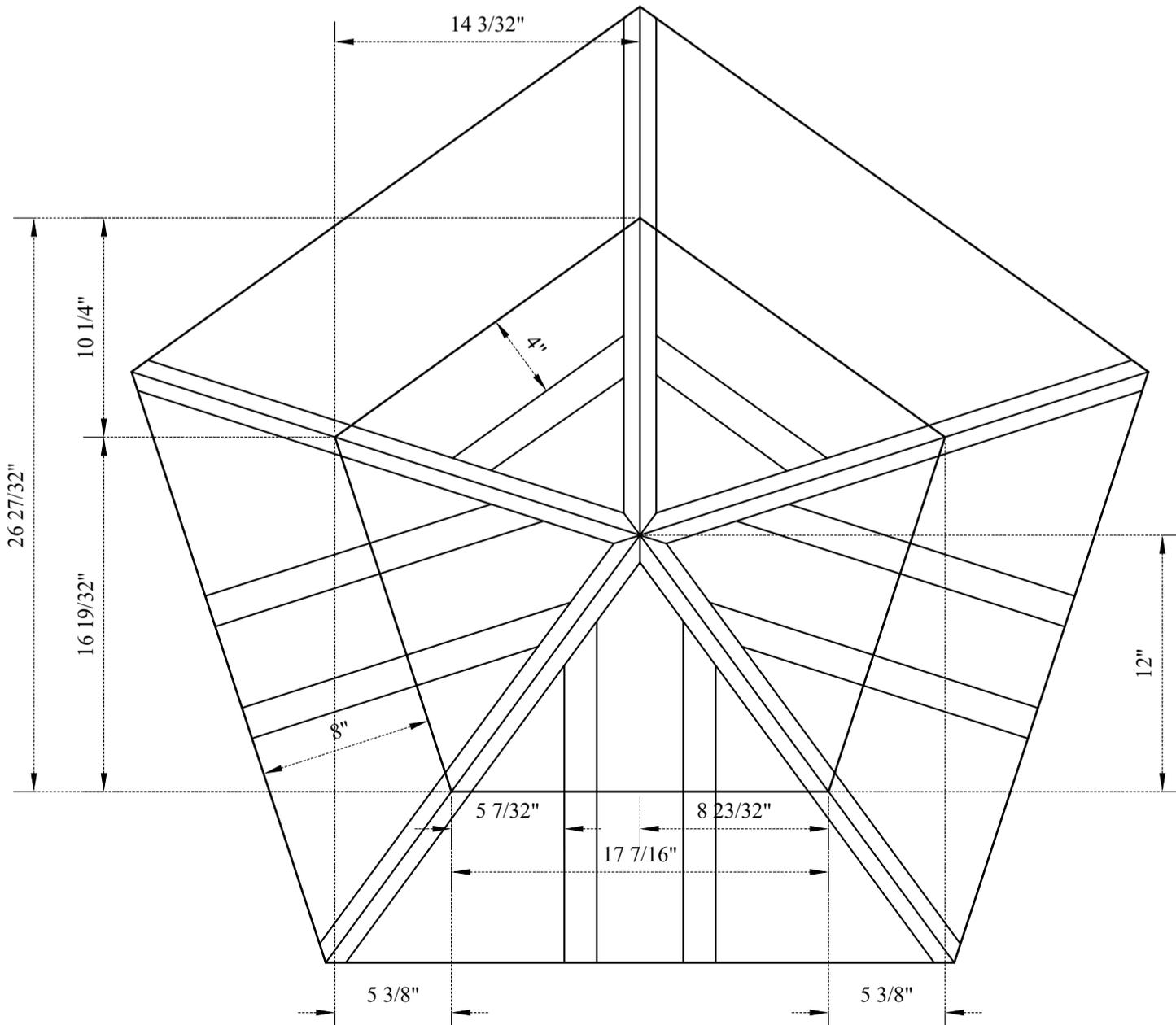
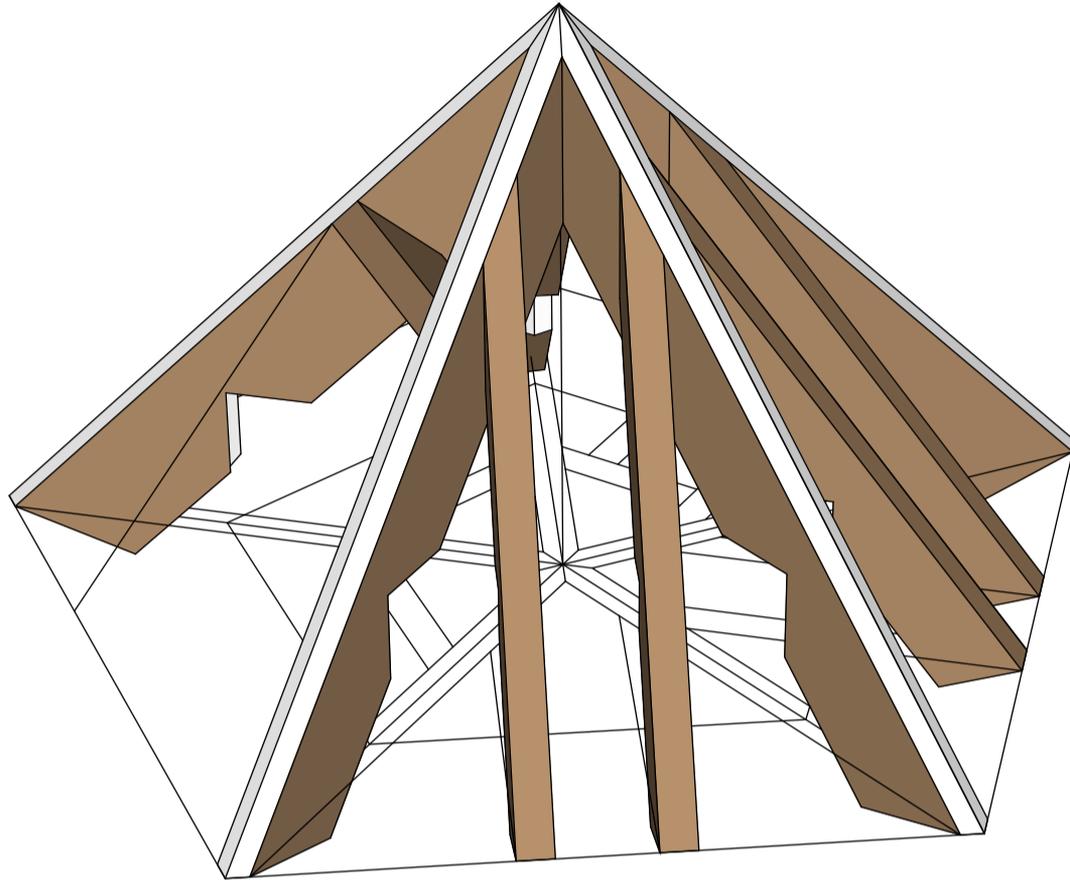


Level 3 Roof Cutter's Task Model

There will be five participants that cut and build each task model. Each participant is to layout and cut one hip rafter, one jack rafter, and one end of a purlin. Participants must print their name, with a felt tip pen, on each piece. Participants must have their instructor verify the rafters have all of the correct layout lines on the pieces before they are allowed to cut. Anyone who takes this exam at home must layout and cut all 5 hip rafters, 5 jack rafters and three purlins. Participants taking this exam at home must take pictures of all of their rafters before and after the rafters are cut. As a base for the model layout the plan view of this equal pitched pentagon roof on a sheet of plywood with an polygon edge length of $17 \frac{7}{16}$ ". The rafter tails will extend past the plywood base.

- Deck Angles = 108°
- Plan Angles = 54°
- Pitch 16:12, 53.13010°
- Profile Rafter Run = 12"
- Rafter Overhang Run = 8"
- Hip Rafter Material 2x6
- Jack Rafter Material 2x4
- Purlin Rafter Material 2x4
- Rafter Tail Slope = 75°
- HAP = 5"

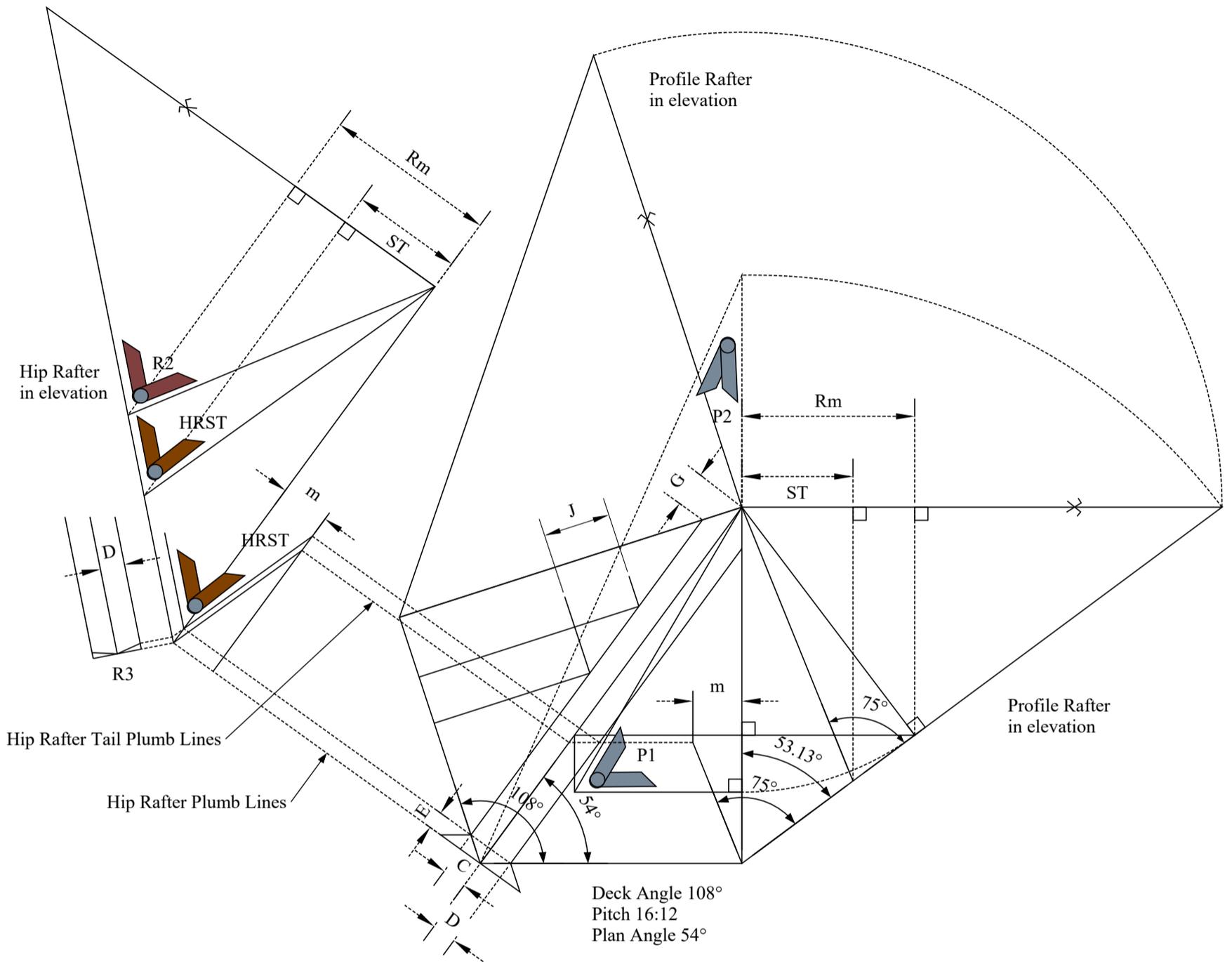


Level 3 Roof Cutter's Exam

R2 - Hip Rafter Purlin Housing Angle

R3 - Bevel Angle on the top edge of an unbacked hip rafter for square tail alignment

HRST - Hip Rafter Square Tail Miter Angle on the hip rafter
 Rm - The vertical dimension taken from the profile rafter, for the hip rafter purlin housing angle geometric development.
 m- This can be any dimension, however it must be the same dimension at the profile rafter and hip rafter



This developed 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 part 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.

In this geometric drawing the purlin rafter miter angles on the stick-timber are P1. The purlin rafter top bevel cut angle can be laid out using the roof sheathing angle P7 or 90° - P2. The angles to cut the hip rafter for 75° tails alignment on the hip rafter, HRST, are different then the hip rafter housing angles, because the tails are at 75° instead of 90° to the roof surface plane. The hip rafter top bevel angles R3, on an unbacked hip rafter, are developed using the same technique as with 90° rafter tails.

Level 3 Roof Cutter's Exam

This level 3 roof cutter's compound skills test can be solved with a combination of geometric drawings, trigonometry, framing square, or practical skills. Determine all of the dimensions and angles for this roof from the following information. These exams follow the WorldSkills carpentry competition layout format. The main focus of this exam is transferring plumb line dimensions from a plan view drawing to the timber that automatically develop the top bevel angles on the timber. The hip rafters and jack rafters must be completely laid out, as if you were going to cut the rafters with a handsaw. However, after the rafters are completely laid out you can cut the rafters with a handsaw, draw knife, hand plane or power tools. The hip rafters will have a minimum of 30 layout lines on the rafter. The jack rafter will have a minimum of 16 layout lines. You can use calculators(CMC) or 2D CAD drawings, but no iPhone or Android apps. You must be able to show graphic proof of your plumb line shift calculations. All plumb rafters must be laid-out using plumb lines from a plan view drawing.

The roof in this test is an Pentagon hip roof with a deck angle of 108° . The rafter tails will be level in the horizontal plane at the eave line and will be cut at 75° to the roof surface. The hip rafter tails will also be cut to align the hip rafter tail with the common rafter tails. The hip rafter will be edge beveled on each side of the hip rafter for roof plane alignment.

Deck Corner Angle = 108°

Main Pitch 16:12

Plan View building dimension $143 \frac{1}{8}"$ side wall length, king common rafter run is $116 \frac{1}{2}"$

Overhang run of $18"$

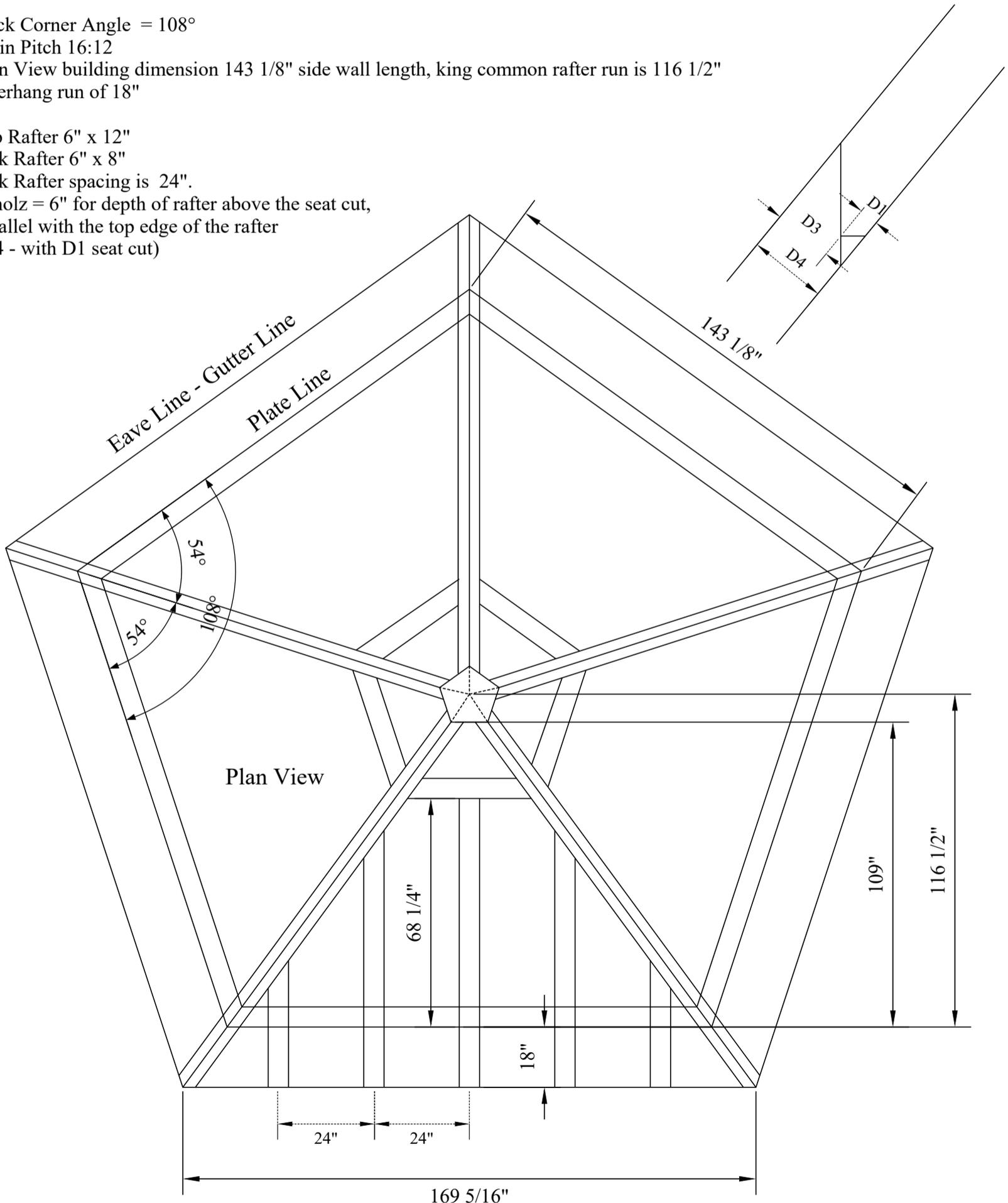
Hip Rafter $6" \times 12"$

Jack Rafter $6" \times 8"$

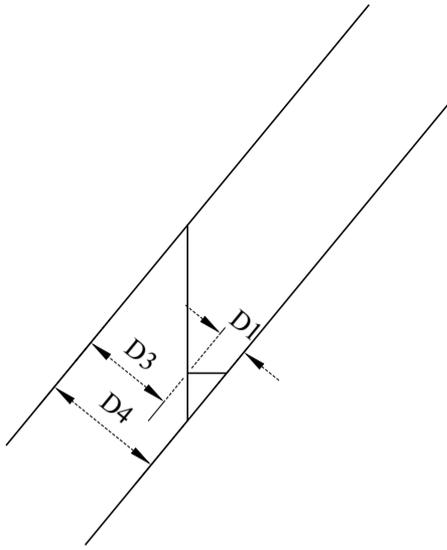
Jack Rafter spacing is $24"$.

obholz = $6"$ for depth of rafter above the seat cut, parallel with the top edge of the rafter

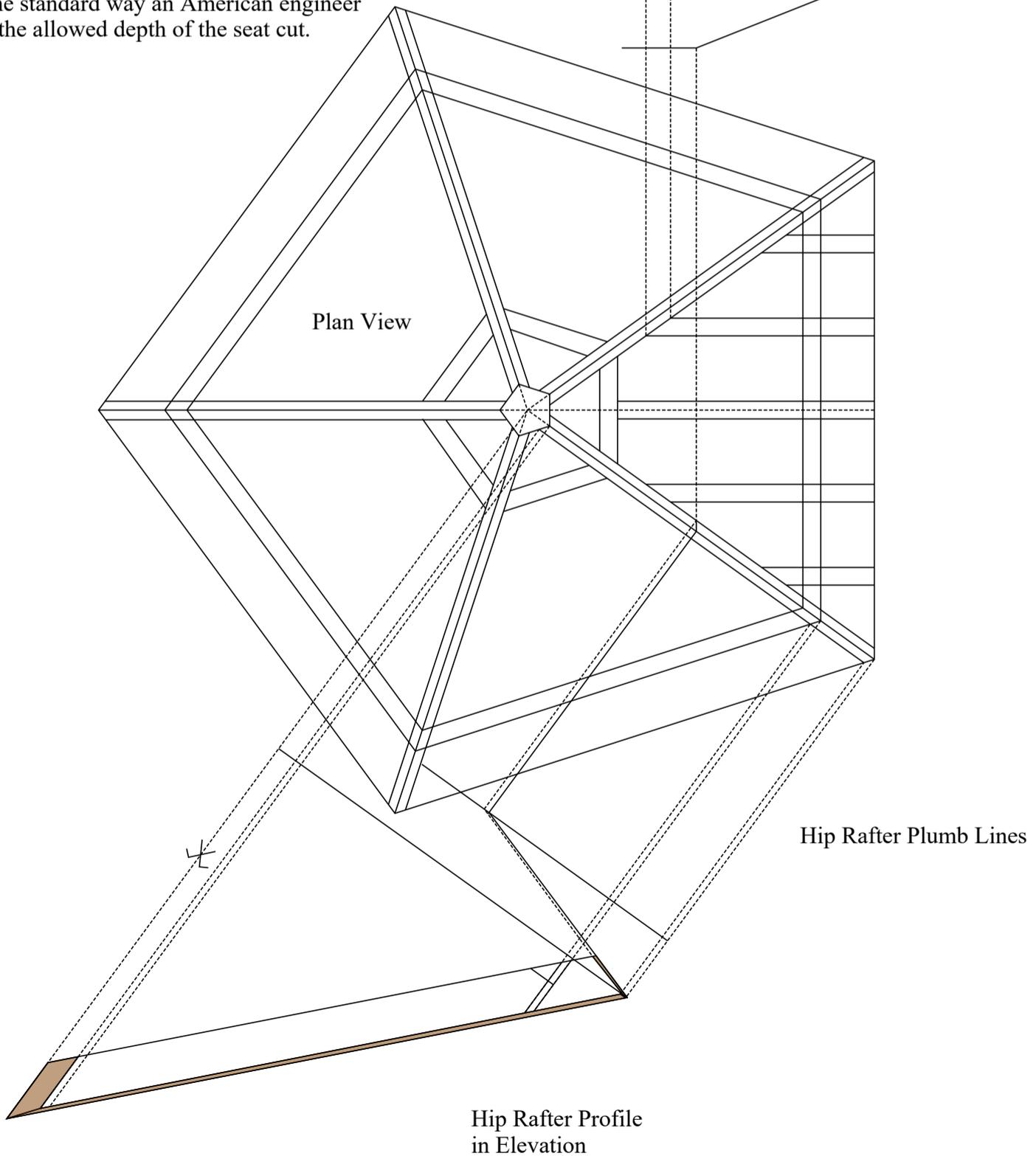
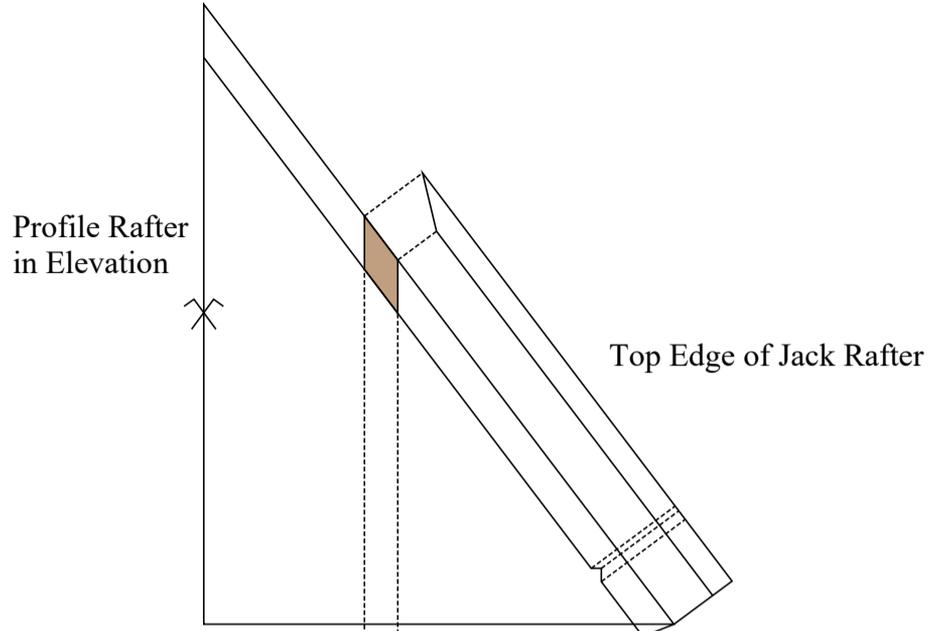
(D4 - with D1 seat cut)



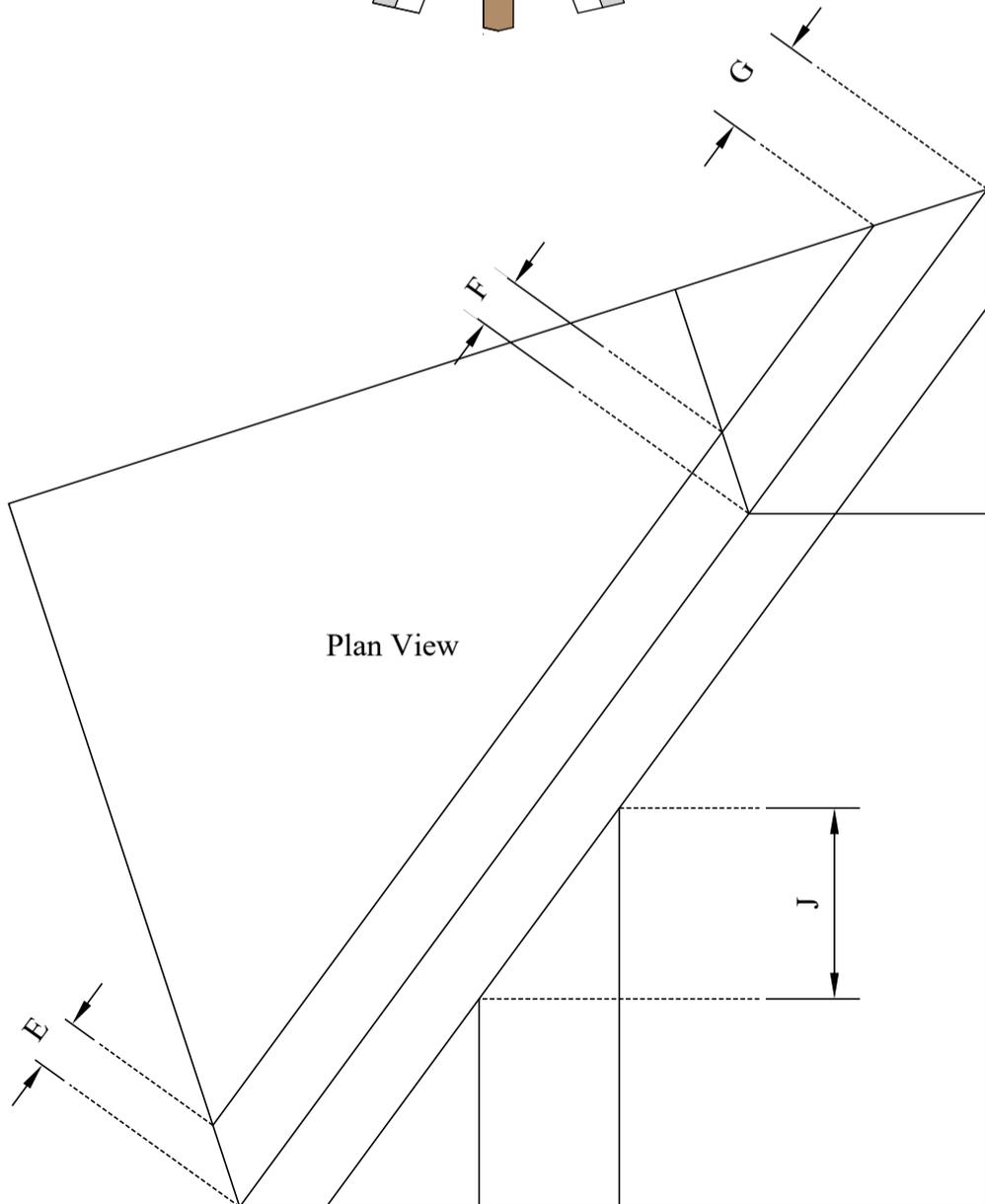
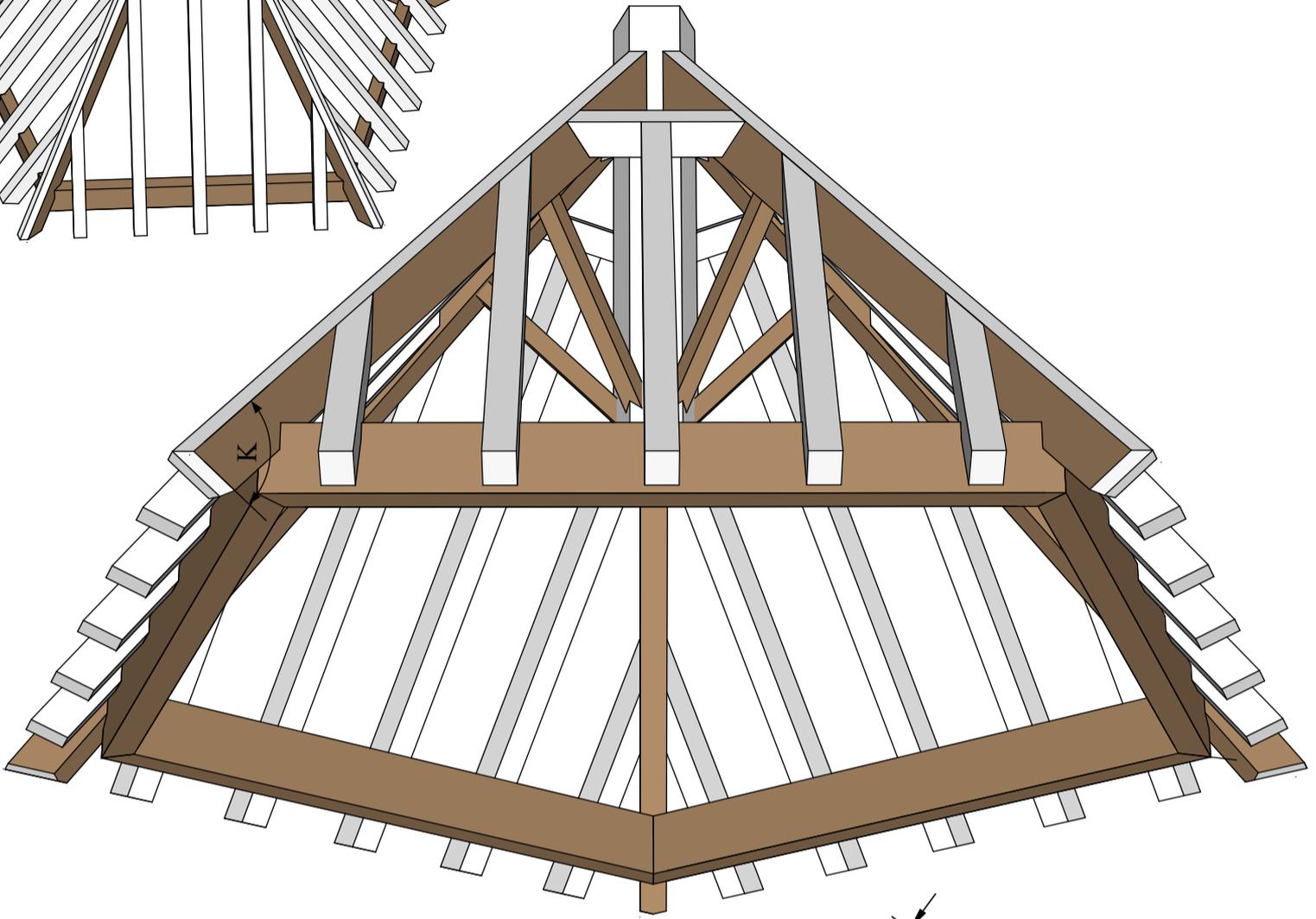
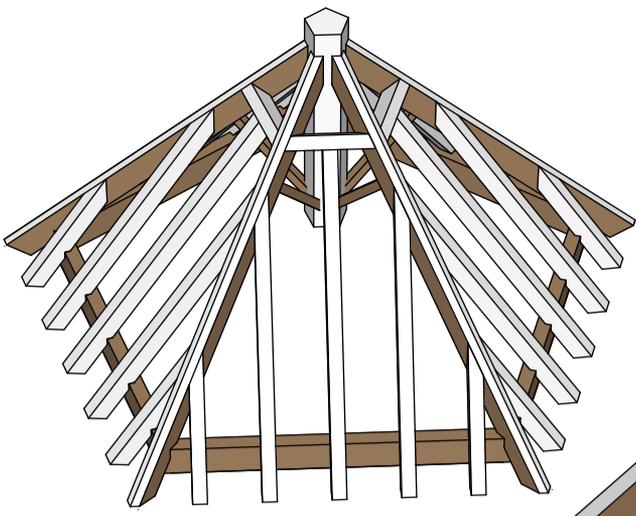
Level 3 Roof Cutter's Exam



D3 = obholz seat height
Obholz is the German method to call out the height of the seat cut. It used by most European countries as well.
It is also the standard way an American engineer calculates the allowed depth of the seat cut.



Level 3 Roof Cutter's Exam



Level 3 Roof Cutter's Exam

Plan angle = 54°

Roof Slope Angle = 53.13010°

Provide dimensions or angles to these Level 3 Roof Cutter's Exam roof cutting questions

Hip Rafter Slope Angle and Framing Usage

Main 16:12 Common Rafter Length to theoretical Ridge Line

Main 16:12 Overhang Rafter Length

Hip Rafter Length to theoretical Ridge Line

Hip Rafter Length to King Post

Hip Rafter Overhang Length

Hip Rafter Backing Angle

Hip Rafter Backing Depth

Hip Rafter Plumb Line Shift Dimension E

Hip Rafter Plumb Line Shift Dimension F

Hip Rafter Plumb Line Shift Dimension G

Jack Rafter Plumb Line Shift Dimension J

Jack Rafter Saw Blade Bevel Angle

Jack Rafter Saw Blade Bevel Angle to cut the Jack Rafter From the Top Edge

Length of First Jack Rafter

Jack Rafter Length Difference

Jack Rafter Layout Dimension on Hip Rafter

Roof Sheathing Angle

Purlin Rafter Miter Angle

Purlin Rafter Saw Blade Bevel Angle

Length of Purlin Rafter

Miter Angle to cut 2x6 T&G Roof Decking in the roof surface plane

Saw Blade Bevel Angle for 2x6 T&G Roof Decking

Hip Rafter Miter Angle K for 75° Rafter Tails

Hip Rafter Saw Blade Bevel Angle for 75° Rafter Tails

Which one of the following formulas is correct for the miter angle on the hip rafter tail.

When the profile rafters have a tail angle of 75° to the roof surface plane. Why is it correct?

HawkinDale Formula

#1 $C1 = \arctan(\sin P1 \div \tan SS)$

#1 $C1 = \arctan(\sin(\text{Purlin Miter Angle}) \div \tan(\text{Profile Rafter Slope Angle}))$

My formulas

#2 Hip Rafter Square Tail Miter Angle = $90^\circ - \arcsin(\cos \text{Roof Sheathing Angle} \times \sin \text{Purlin Miter Angle})$

#3 Hip Rafter Square Tail Miter Angle on stick = $\arctan(\sin(\text{plan angle}) \times \tan(\text{tail rotation angle} - \text{roof slope angle}) + \text{hip slope angle}^*$

Which one of the following formulas is correct for the saw blade bevel angle on the hip rafter tail. When the profile rafters have a tail angle of 75° to the roof surface plane.

#1 Hip Rafter Square Tail Saw Blade Bevel Angle = $\arcsin(\cos(\text{plan angle}) \times \cos(\text{Profile Rafter Slope Angle}))$

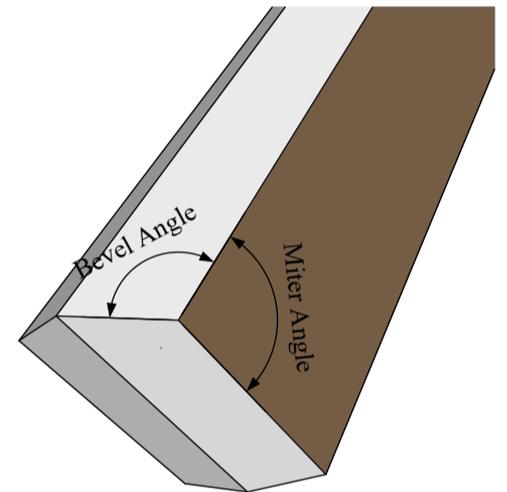
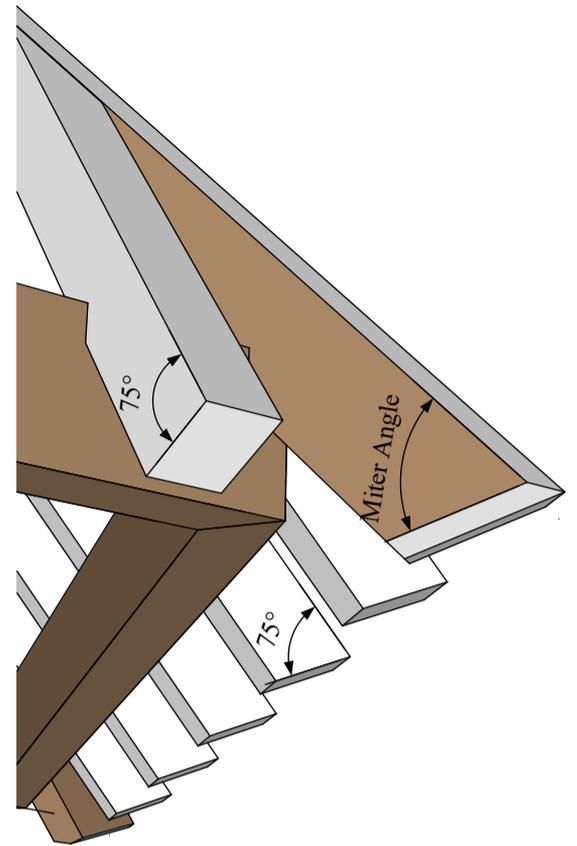
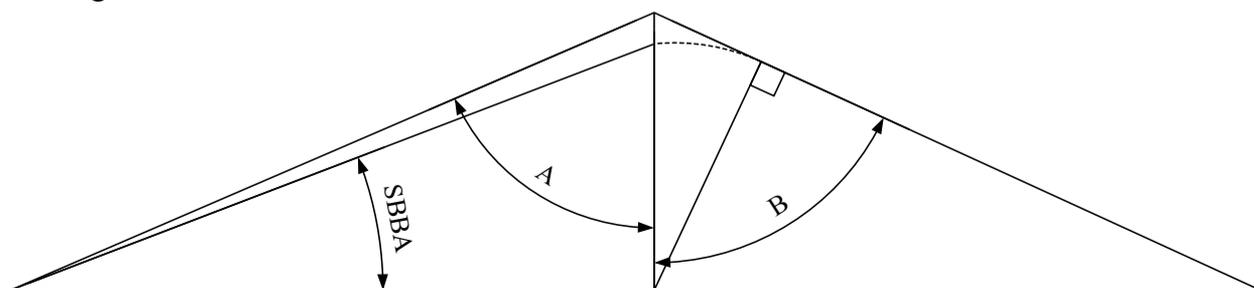
#2 Hip Rafter Square Tail Saw Blade Bevel Angle = $C1 = \arctan(\sin P1 \div \tan SS)$

#3 Hip Rafter Square Tail Saw Blade Bevel Angle = $\arctan(\sin(\text{Miter Angle}) \div \tan(\text{Bevel Angle}))$

#4 Hip Rafter Square Tail Saw Blade Bevel Angle = $\arctan(\cos(\text{Miter Angle}) \div \tan(\text{Bevel Angle}))$

#5 Hip Rafter Square Tail Saw Blade Bevel Angle = $\arcsin(\cos(\text{main slope angle}) \times \cos(\text{main plan angle}))$

SBBA drawing

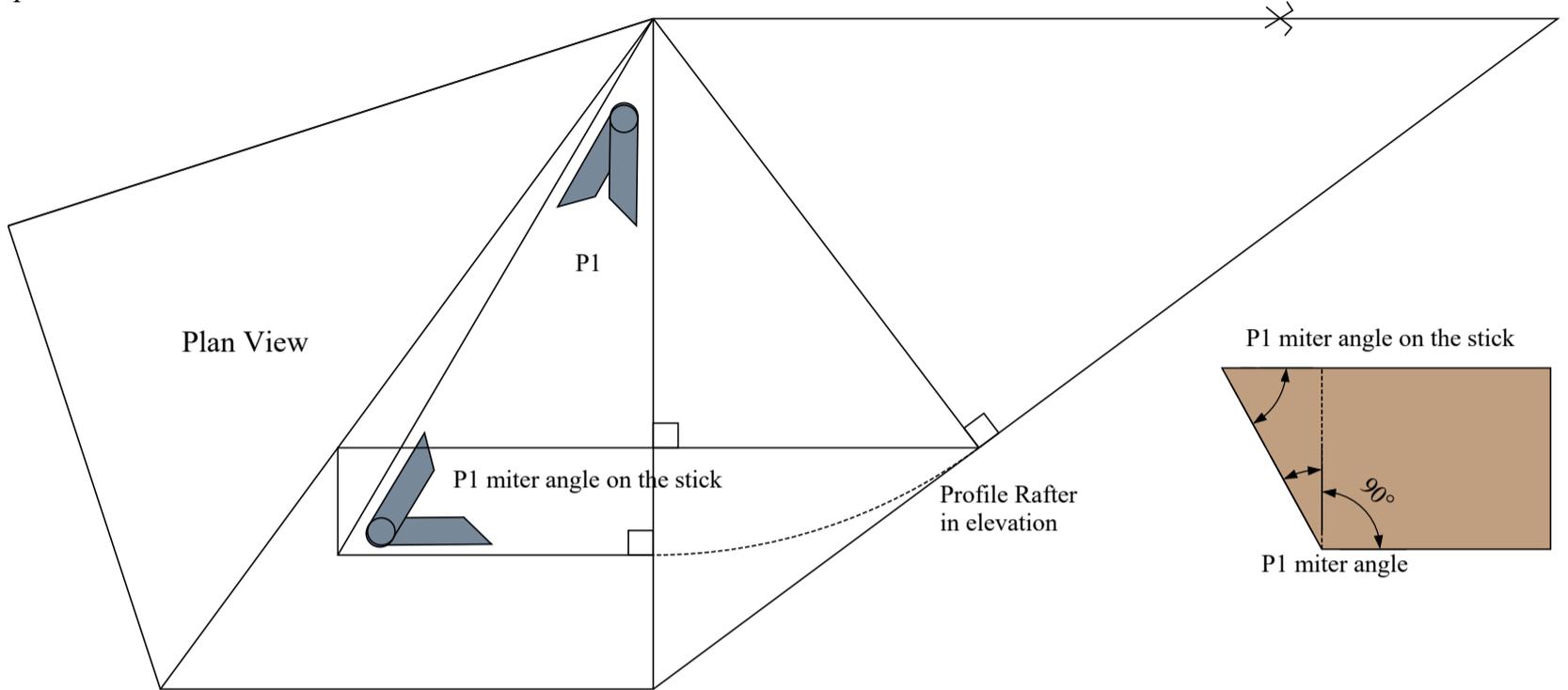


Hip Rafter Tail

Level 3 Roof Cutter's Exam

P1 = Purlin Rafter miter angle on the side of the purlin rafter

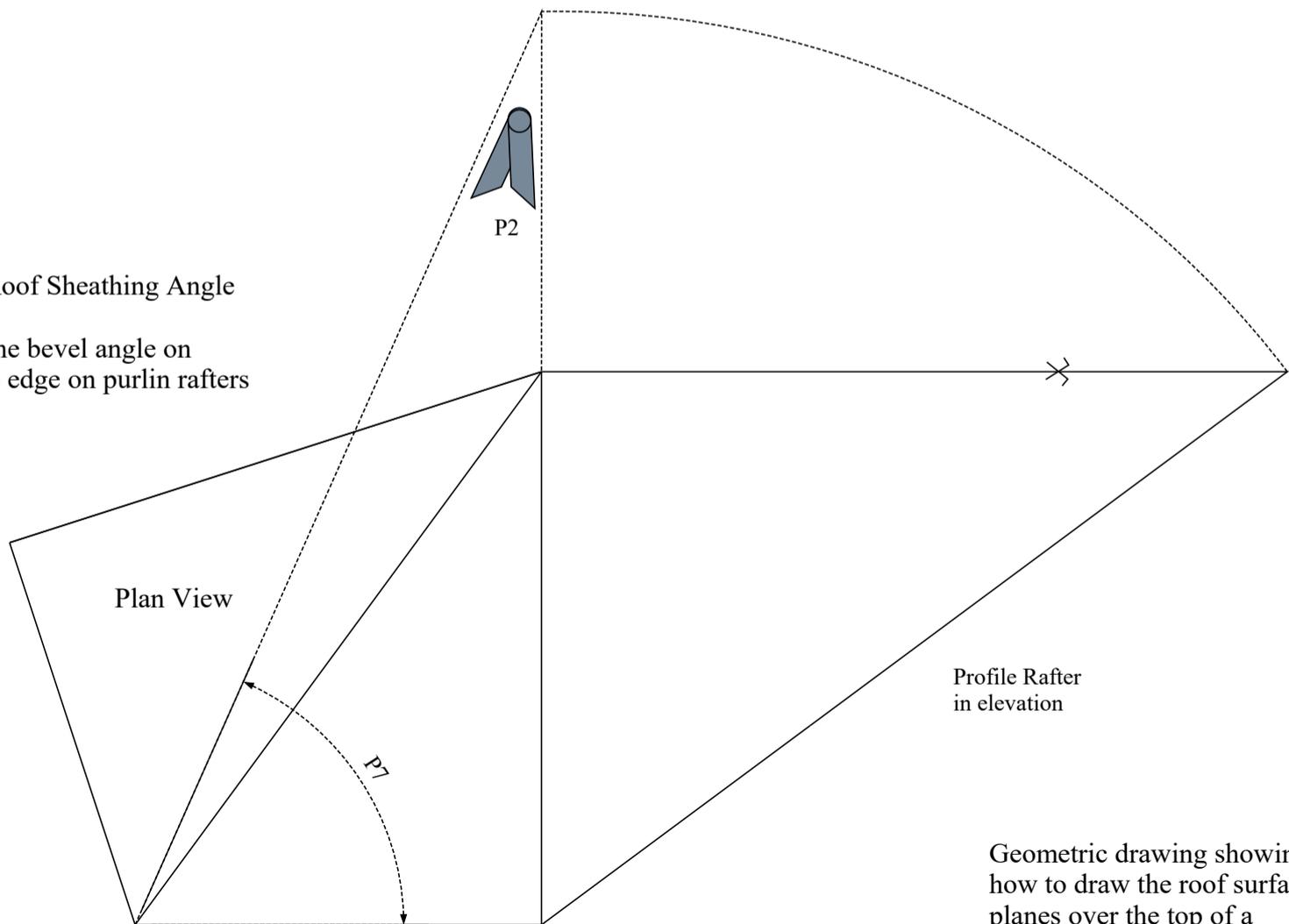
Geometric drawing showing how to draw the purlin rafter miter angle on the stick in a plan view drawing.



To lay out any angle using a framing square
 $\tan(\text{angle}) \times 12 = \text{xxx}$
 use xxx and 12 on the square

P7 = Roof Sheathing Angle

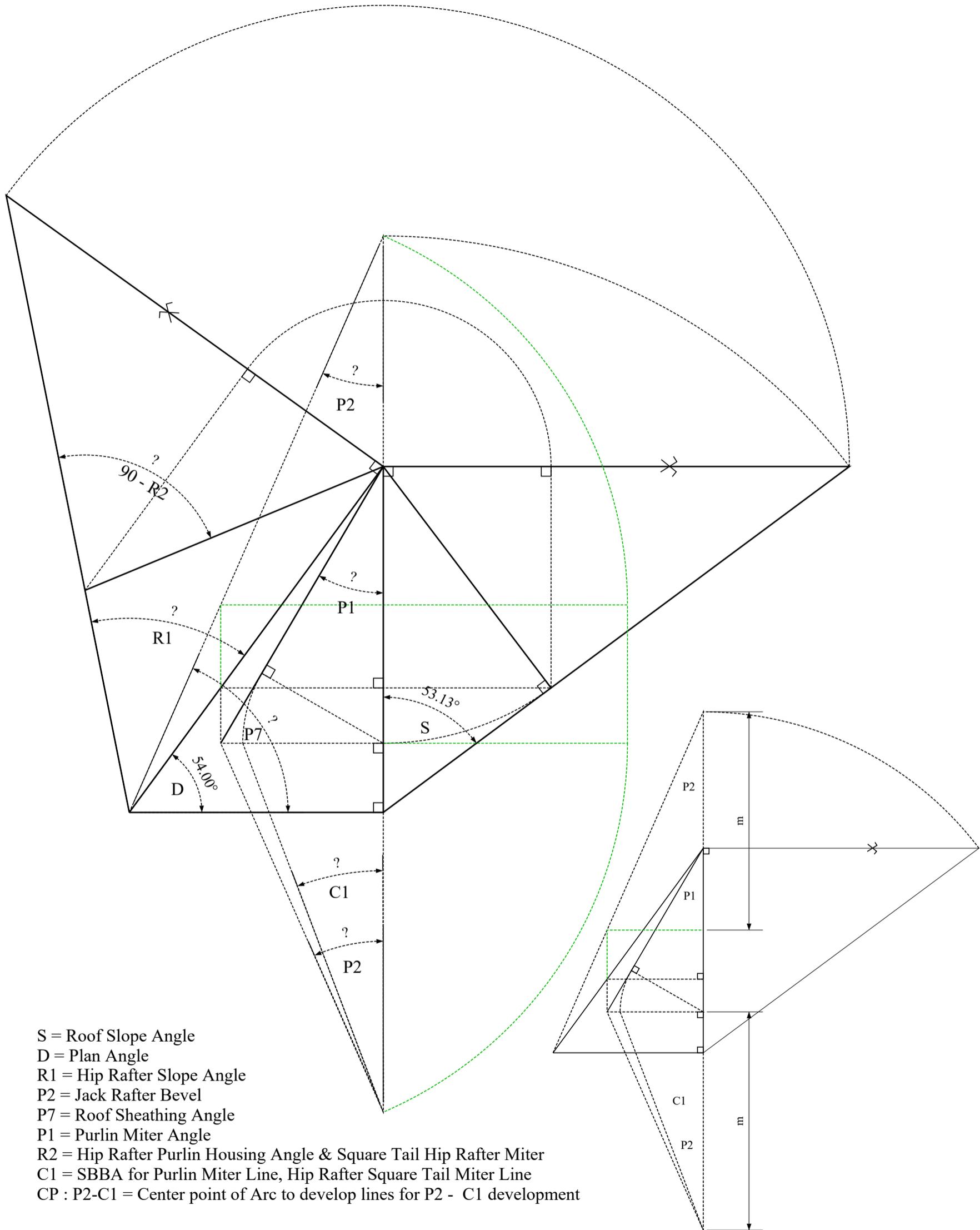
P7 is the bevel angle on the top edge on purlin rafters



Geometric drawing showing how to draw the roof surface planes over the top of a plan view drawing.

Level 3 Roof Cutter's Exam

TFG - Roof Framing Kernel geometric development for the purlin miter angle and the SBBA for purlin rafters 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.



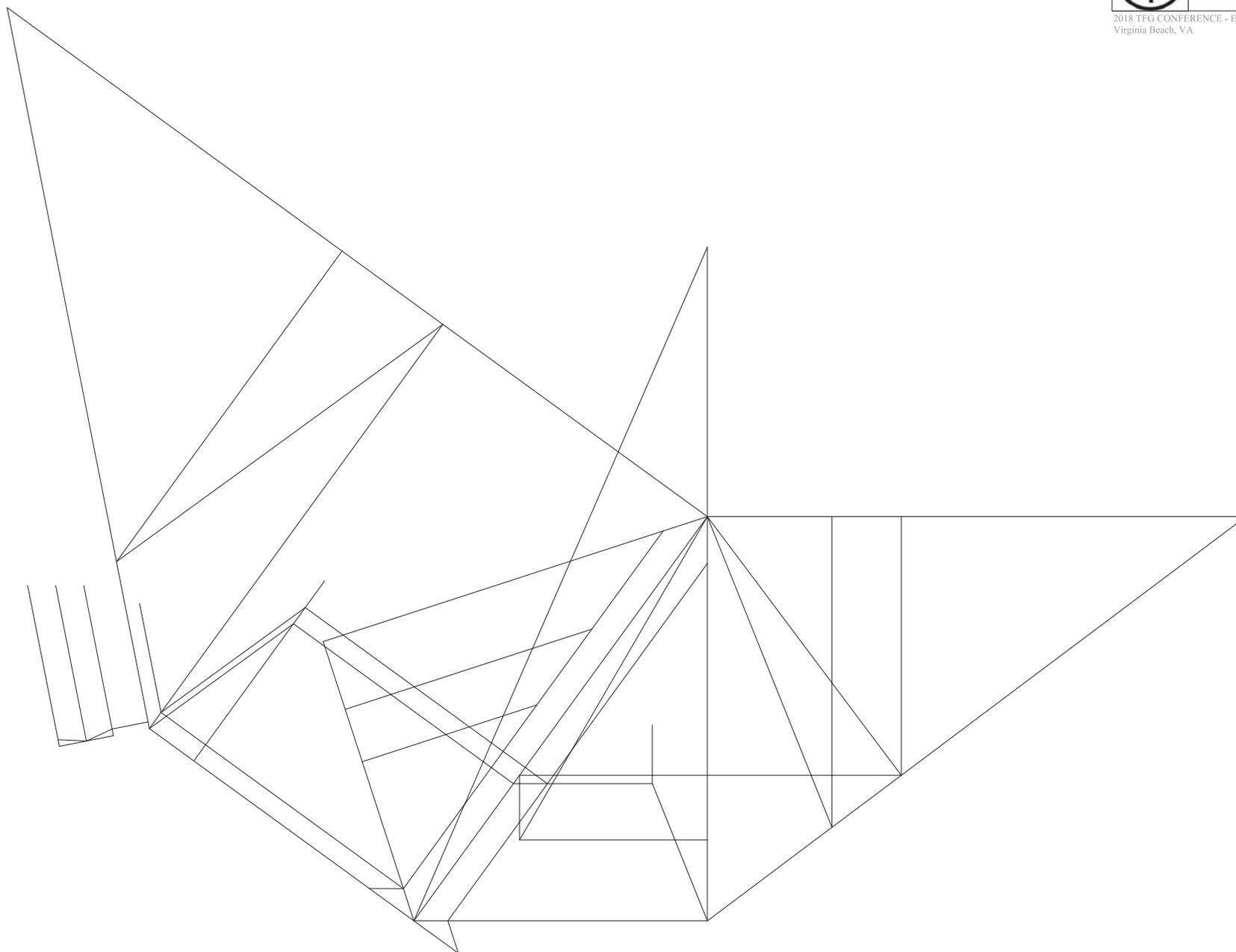
- S = Roof Slope Angle
- D = Plan Angle
- R1 = Hip Rafter Slope Angle
- P2 = Jack Rafter Bevel
- P7 = Roof Sheathing Angle
- P1 = Purlin Miter Angle
- R2 = Hip Rafter Purlin Housing Angle & Square Tail Hip Rafter Miter
- C1 = SBBA for Purlin Miter Line, Hip Rafter Square Tail Miter Line
- CP : P2-C1 = Center point of Arc to develop lines for P2 - C1 development

Alternate method: use dimensions to develop the geometry for the saw blade bevel angle C1.

Level 3 Task Model



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Virginia Beach, VA



Level 3 Task Model



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