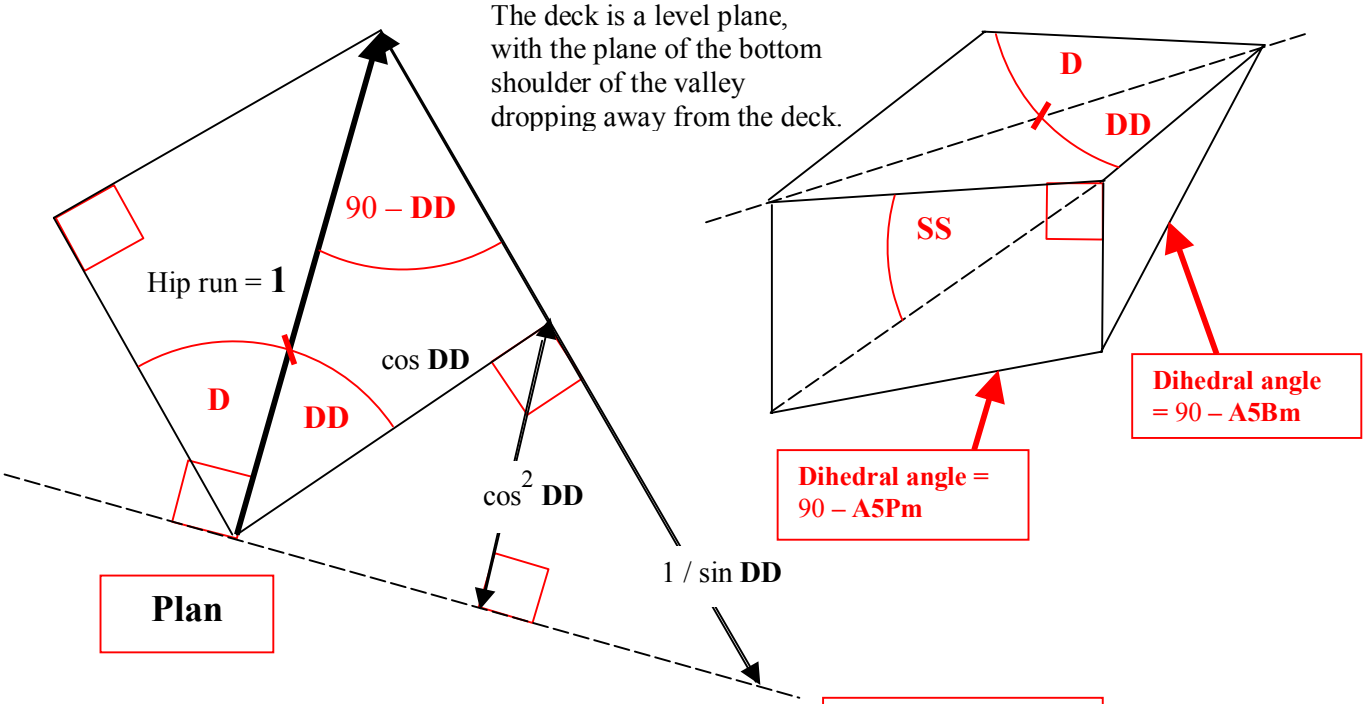
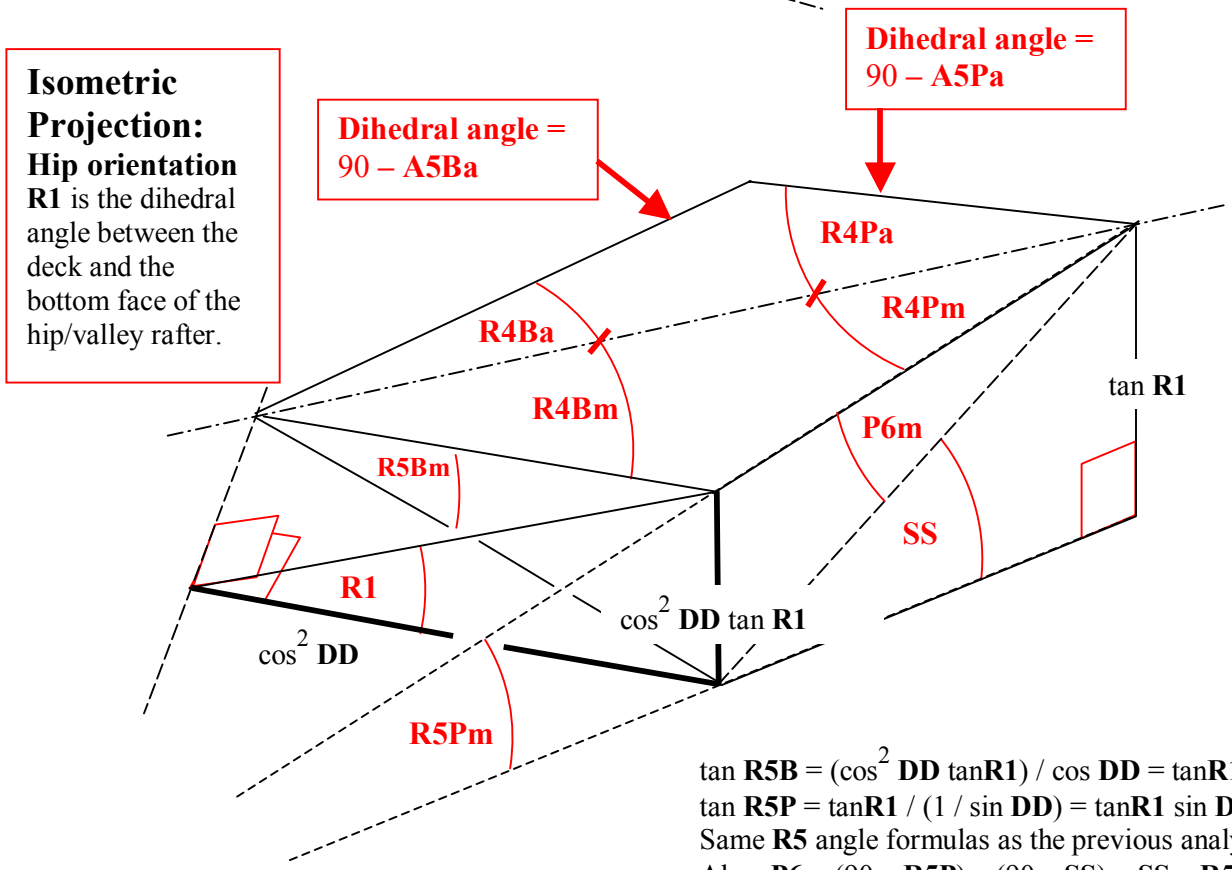
An ALTERNATE MODEL for HIP / VALLEY RAFTERS:

Valley orientation:
The deck is a level plane, with the plane of the bottom shoulder of the valley dropping away from the deck.



Isometric Projection:
Hip orientation
R1 is the dihedral angle between the deck and the bottom face of the hip/valley rafter.

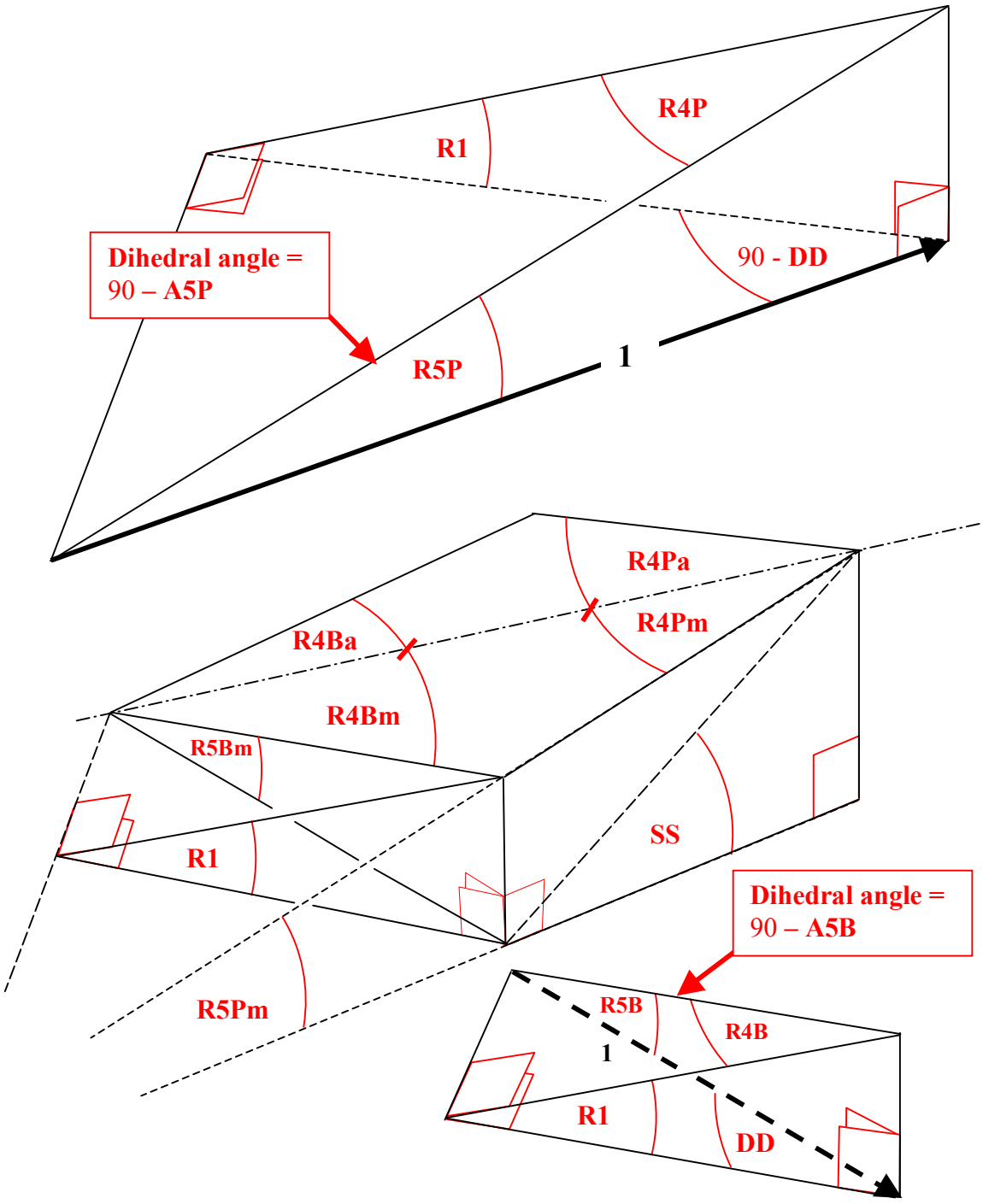


tan **R5B** = (cos² **DD** tan**R1**) / cos **DD** = tan**R1** cos **DD**
tan **R5P** = tan**R1** / (1 / sin **DD**) = tan**R1** sin **DD**
Same **R5** angle formulas as the previous analysis.
Also: **P6** = (90 – **R5P**) – (90 – **SS**) = **SS** – **R5P**

An ALTERNATE MODEL for HIP / VALLEY RAFTERS:

Kernels of **R4**, **R5** and **A5** Angles

Kernels re-scaled to "Hip run" = **1:** Compare the drawings below to the models extracted directly from the Valley rafter in the previous section, as well as the kernels extracted from the stick.



GENERAL HIP / VALLEY MODEL:

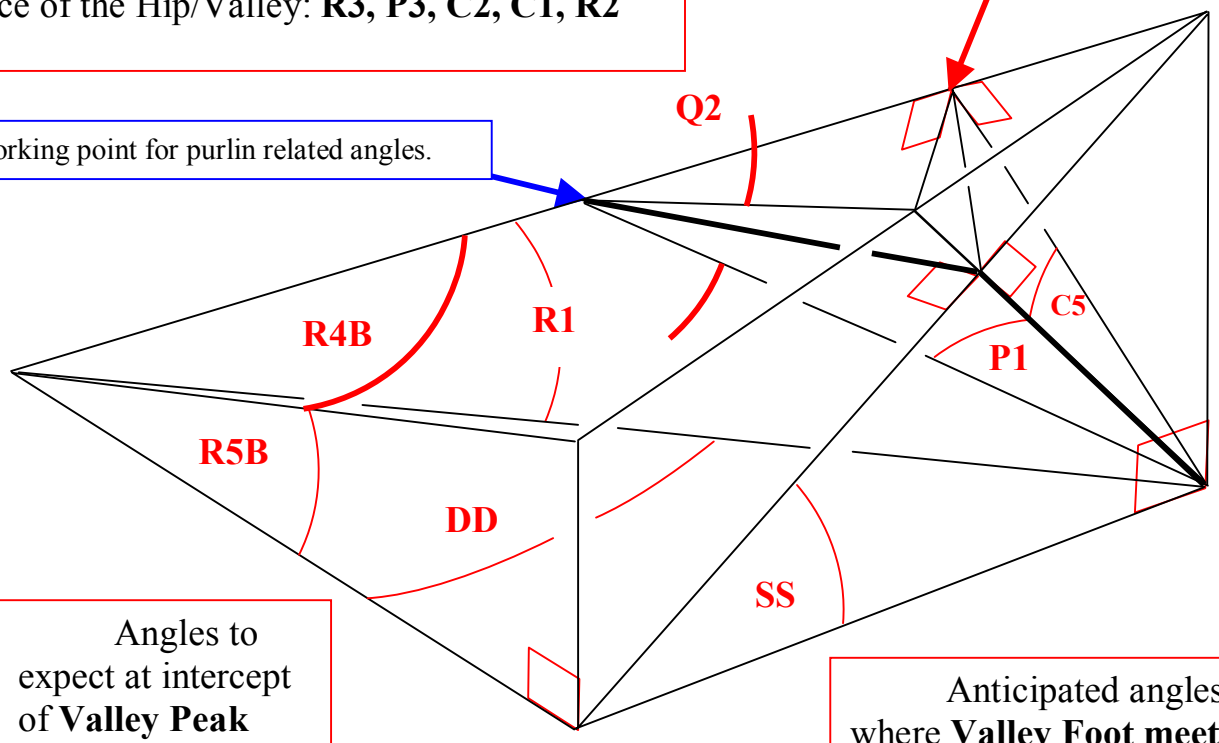
VALLEY meets RIDGE or HEADER
VALLEY meets MAIN COMMON RAFTER
VALLEY meets MAIN PURLIN

The triangle showing angles labeled **Q2** and **P1** defines the plane of the Main Purlin perpendicular to the Roof plane.

Other angular values to expect at the intercept of the Purlin plane and the bottom face of the Hip/Valley: **R3, P3, C2, C1, R2**

Dihedral angle between side face and bottom face of Valley rafter = **90** degrees.
Dihedral angle between Roof plane and bottom face of Valley rafter = **C5**.

Working point for purlin related angles.



MAIN SIDE VIEW

Angles to expect at intercept of **Valley Peak meets Ridge** or **Header**:
DD, R4B, R5B, A5B

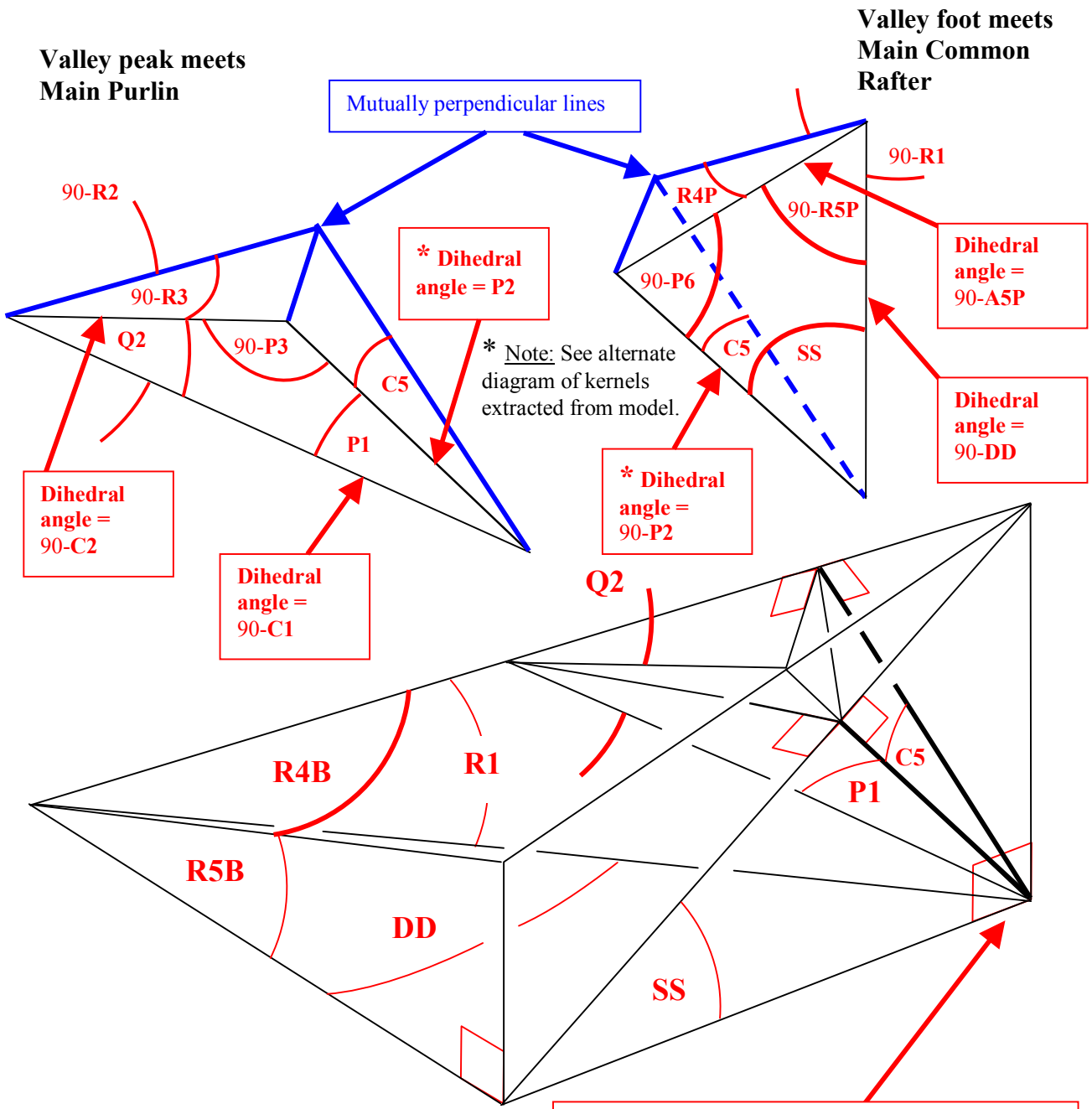
Anticipated angles where **Valley Foot meets Main Common Rafter** or **Eave**:
90 – **DD, R4P, R5P, A5P, P6**

For the sake of clarity, only some of the major angles on the model faces have been labeled. Exploded views will show the remaining angles in more detail.

The planes that form the boundaries of the model (planes of **R4** and **R5** angles) are the same planes created by cutting a plane on the top of a post to conform to the bottom face of a Hip/Valley rafter. Expect **R1**, **A5**, **R4**, and **R5** angles at **Valley meets Post**.

GENERAL HIP / VALLEY MODEL:

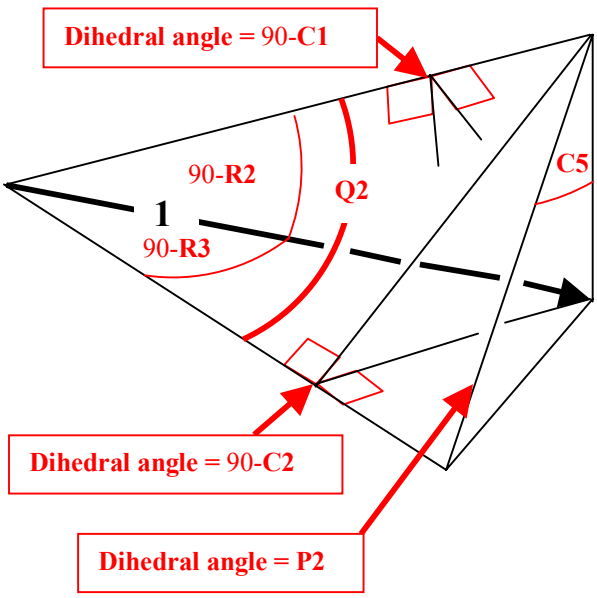
Kernels extracted from the general model



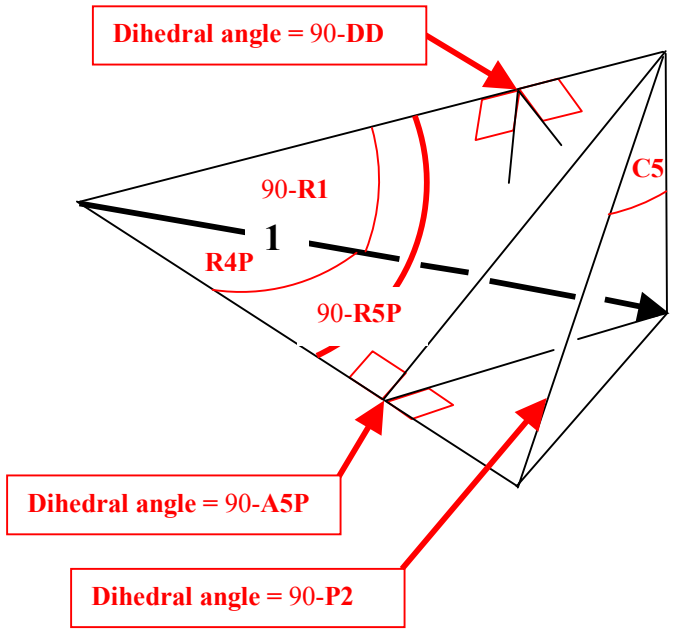
GENERAL HIP / VALLEY MODEL:

Kernels rotated and re-scaled

Valley peak meets Main Purlin (opposite hand)



Valley foot meets Main Common Rafter



NOTES:

Three mutually perpendicular lines form one of the vertices (see "Purlin kernel extracted from Hip kernel"); the kernels may positioned with any face containing a right angle as the "deck". The angle arrangements shown above match those of the kernels extracted from the stick.

The kernels may be split along their respective dihedral angles: **Valley peak meets Main Purlin** along 90-**C2**, 90-**C1** or **P2**, and **Valley foot meets Main Common** along 90-**A5P**, 90-**DD** or 90-**P2**. Each split produces an arrangement of angles as per a standard Hip kernel. The alternate exploded view depicts the kernels split along dihedral angles **P2** and 90-**P2**.

Angles that upon casual inspection seem to have no direct connection to one another are now related through their respective kernels, which may be used for dimensioning as well as simply producing formulas. In addition, since the groups of angles are now defined, and a given angle occurs in more than one kernel, angular values may be determined empirically by developing the kernels using compass and straightedge only.

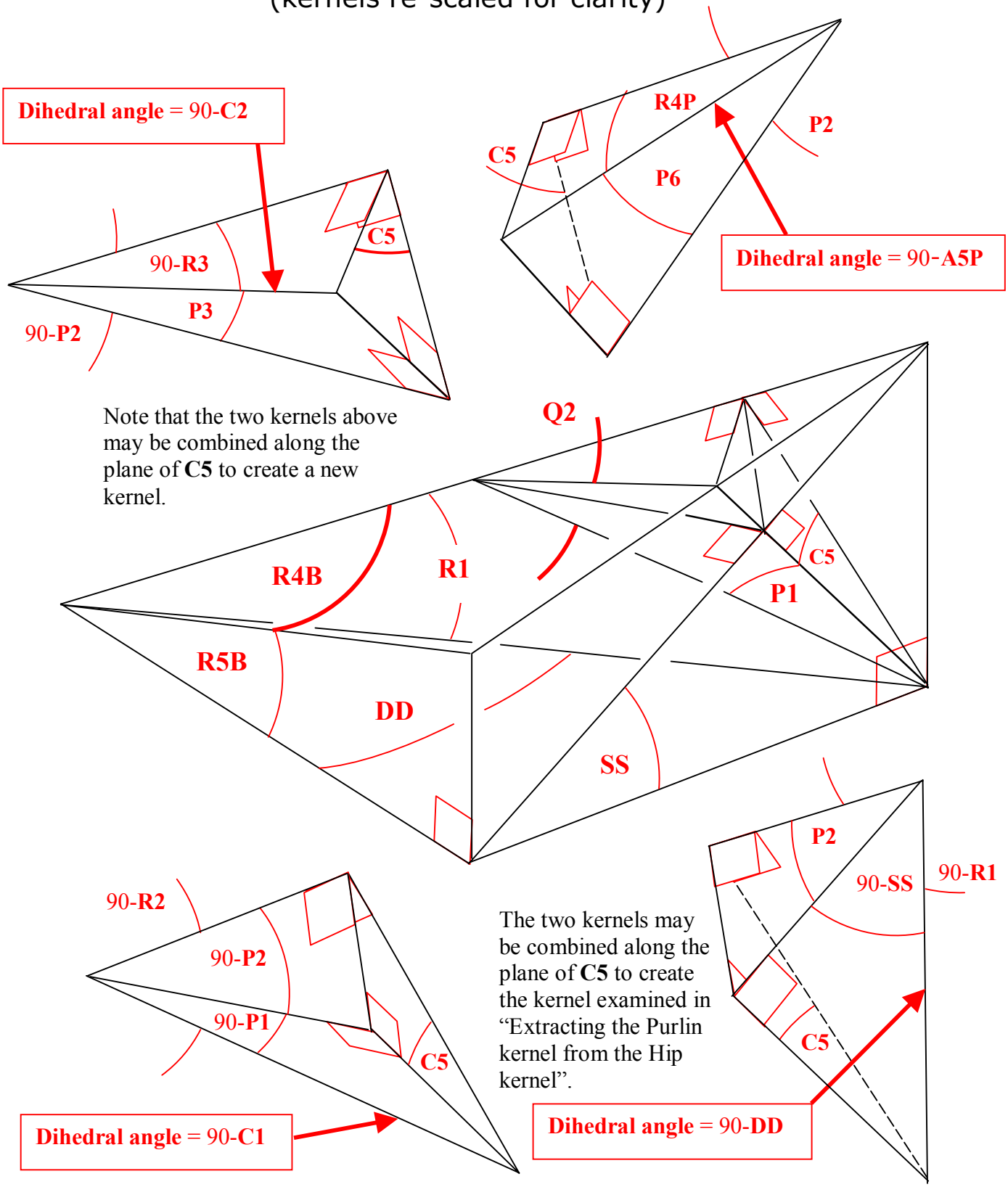
The sample equations given on the following page cover only a very few possible formulas.

VALLEY ANGLE FORMULAS:

Valley Peak meets Main Purlin	KNOWN EQUATION	Valley Foot meets Main Common Rafter
tan**R2** = tan**C5** tan**R3** tan**R3** = tan**R2** / tan**C5**	(From "Extracting the Purlin kernel from the Hip kernel") tan**P1** = tan**SS** tan**P2**	tan**R1** = tan**C5** tan(90-**R4P**) tan**R4P** = tan**C5** / tan**R1**
Divide the kernel along dihedral angle 90–**C2**, producing two standard Hip kernels. Consider the kernel on the left hand side:		Divide the kernel along dihedral angle 90–**A5P**, producing two standard Hip kernels. Consider the kernel on the left hand side:
cos**C1** = sin**C2** / sin**R2** sin**C2** = sin**R2** cos **C1**	cos**C1** = sin**C5** / sin**P1**	cos**DD** = sin**A5P** / sin**R1** sin**A5P** = sin**R1** cos **DD**
cos(90- **Q2**) = cos**R3** / cos**C1** sin**Q2** = cos**R3** / cos**C1**	cos**R2** = cos**P2** / cos**C1**	cos**R5P** = cos(90-**R4P**) / cos**DD** cos**R5P** =sin **R4P** / cos**DD**
tan(90-**R2**) = tan(90-**C2**)sin(90-**R3**) tan**C2** = tan**R2** cos**R3**	(From Standard Hip kernel) tan**R1** = tan**SS** sin**DD**	tan(90-**R1**) = tan(90-**A5P**) sin**R4P** tan**A5P** = tan**R1** sin**R4P**
Consider the standard Hip kernels created on the right hand side:		
tan(90-**C5**) = tan(90-**C2**) sin**R3** tan**C2** = tan**C5** sin**R3**	tan**R1** = tan**SS** sin**DD**	tan(90-**C5**) = tan(90-**A5P**) sin(90-**R4P**) tan**A5P** = tan**C5** cos**R4P**
tan(90-**P2**) = sin(90-**C5**) / tan**R3** tan**R3** = tan**P2** cos**C5**	tan**C5** = sin**R1** / tan**DD**	tan**P2** = sin(90-**C5**) / tan(90-**R4P**) tan**R4P** = tan**P2** / cos**C5**
The process may be continued, using any known formula as a template (for example, tan**P2** = cos**SS** / tan**DD**), and substituting cognate angles from the unsolved kernel. Remember to compensate for trig functions of complementary angles. The next diagram depicts an alternate method of extracting Hip kernels from the general model. Rotate any appropriate face to the deck, and apply the methods outlined above to obtain solutions.		

GENERAL HIP / VALLEY MODEL:

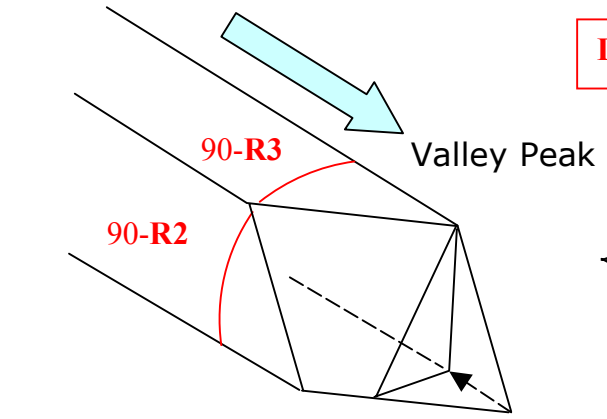
Standard kernels extracted from General Model
(kernels re-scaled for clarity)

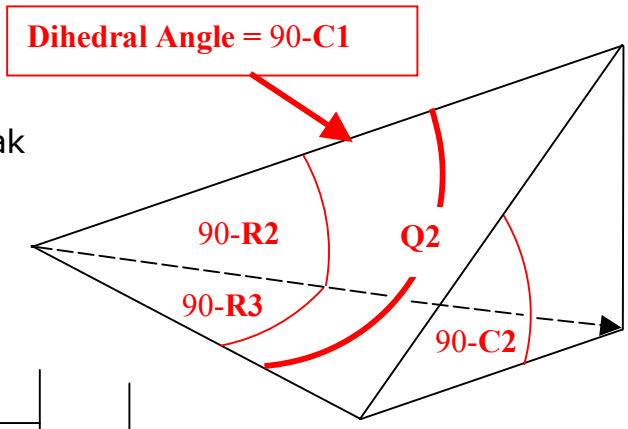


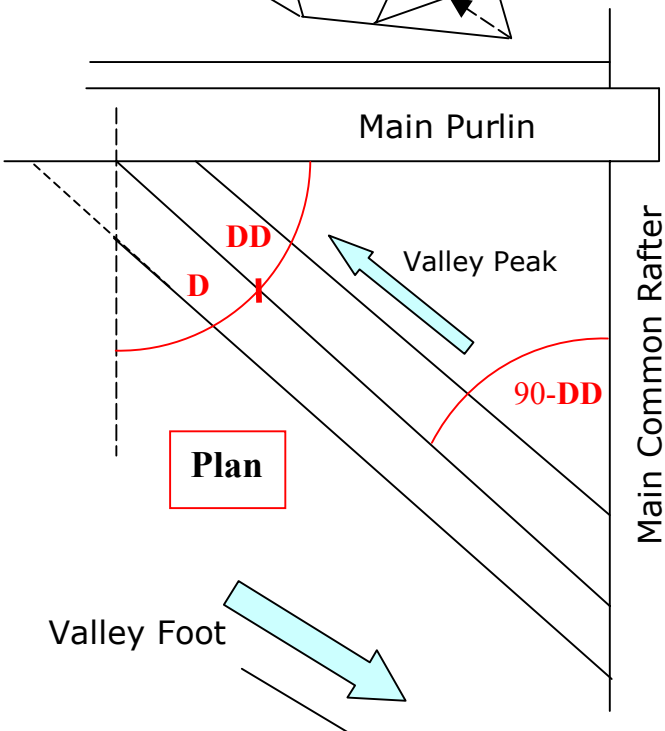
The two kernels may be combined along the plane of **C5** to create the kernel examined in "Extracting the Purlin kernel from the Hip kernel".

EXTRACTING KERNELS from "the STICK":

Valley Peak meets Main Purlin
DD projected to bottom shoulder of Valley is 90-**R3**



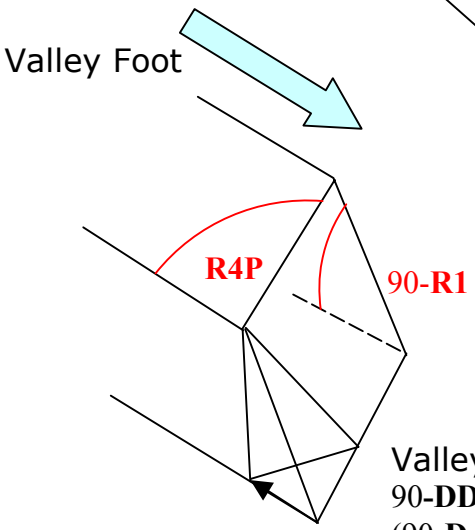


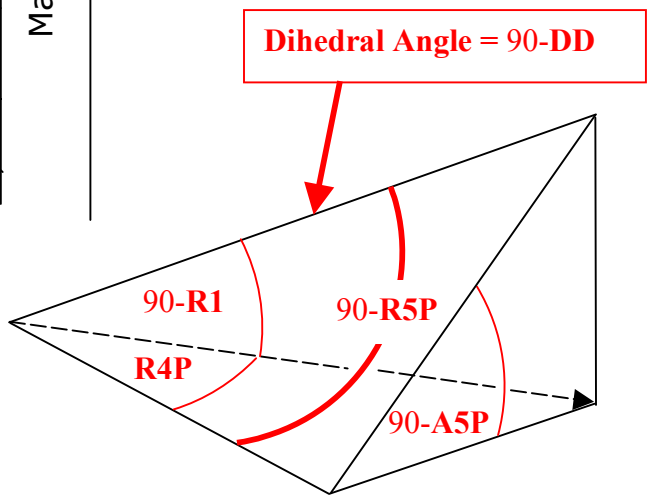


For the purpose of clarity, backing angles and other cuts are not shown.

Valley Foot meets Adjacent Common Rafter: same kernel as **Valley Foot meets Main Common Rafter**, substitute adjacent side values.

Also anticipate these angular values at **Valley meets Post** or **Eaves**.





Valley Foot meets Main Common Rafter
90-**DD** projected to bottom face of Valley is **R4Pm**
(90-**D** projected is **R4Pa** at **Adjacent Common Rafter**)

EXTRACTING KERNELS from "the STICK":