2. Determine the ridge beam bending load, shear, and moment for the wind uplift load case

In accordance with a procedure similar to Step 4 of Example 5.9, the following ridge beam loads are determined:

Rafter sloped span = horizontal span/cos θ
= 12 ft/cos 26.6°
= 13.4 ft

Load on ridge beam

w_{dead} = (rafter sloped span)(15 psf)
[1/2 rafter span on each side]
= (13.4 ft)(15 psf)
= 201 plf

0.6 w_{dead} = 121 plf

w_{wind} = (13.4 ft)(14.2 psf) cos 26.6°
= 170 plf

w_{total} = 170 plf - 121 plf = 49 plf (outward or upward)

Shear, V_{max} = $1/2\ w\ell$ = 1/2 (49 plf)(13 ft)
= 319 lb

Moment, M_{max} = $1/8\ w\ell^2$ = $1/8\ (49\ \text{plf})(13\text{ft})^2$
= 1,035 ft-lb

Note: If the rafters are adequately tied-down to resist uplift from wind, the ridge beam cannot deform upward without deforming the entire sloped roof diaphragm and the rafter-to-wall connections. Therefore, the above loads should be considered with reasonable judgment. It is more important, however, to ensure that the structure is appropriately tied together to act as a unit.

3. Determine the ridge beam loading, shear, and moment for the D + S gravity load case

D + S = 15 psf + 20 psf = 35 psf
(pressures are additive because both are gravity loads)
load on ridge beam

W_{D+S} = (13.4 ft)(35 psf) = 469 plf

Shear, V_{max} = 1/2 (469 plf)(13 ft) = 3,049 lb

Moment, M_{max} = $1/8\ (469\ \text{plf})(13\ \text{ft})^2$ = 9,908 ft-lb

4. Determine the optimum ridge beam size and grade based on the above bending loads and lateral support conditions.

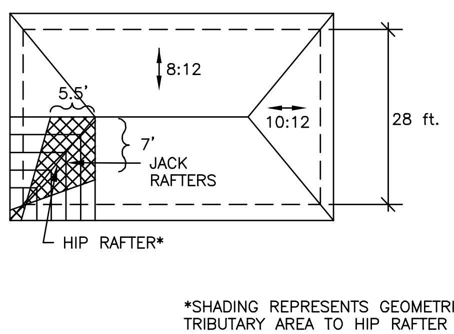
Note. The remainder of the problem is essentially identical to Example 5.9 with respect to determining the strength of the wood member. However, a trial member size and grade are needed to determine the lumber stresses as well as the lumber property adjustment values. Thus, the process of optimizing a lumber species, size, and grade selection from the multitude of choices is iterative and time consuming by hand calculation. Several computerized wood design products on the market can perform the task. However, the computerized design procedures may not allow for flexibility in design approach or assumptions if the designer is attempting to use recommendations similar to those given in this guide. For this reason, many designers prefer to create their own analysis spreadsheets as a customized personal design aid. The remainder of this problem is left to the reader for experimentation.

EXAMPLE 5.11 *Hip Rafter Design*

Given

One-story building
Hip rafter and roof plan as shown below
Rafters are 2x8 No. 2 Hem-Fir at 16 in on center
Loading (see Chapter 3)

Dead	=	10 psf
Snow	=	10 psf
Wind (90 mph, gust)	=	4 psf (inward)
	=	10 psf (uplift)
Live (roof)	=	15 psf



Roof Plan, Hip Rafter Framing, and Tributary Load Area

Find

1. Hip rafter design approach for rafter-ceiling joist roof framing.
2. Hip rafter design approach for cathedral ceiling framing (no cross-ties; ridge beam and hip rafter supported by end-bearing supports).

Solution

1. Evaluate load combinations applicable to the hip rafter design (see Chapter 3, Table 3.1)

By inspection, the D + L_r load combination governs the design. While the wind uplift is sufficient to create a small upward bending load above the counteracting dead load of 0.6 D, it does not exceed the gravity loading condition in effect. Since the compression edge of the hip rafter is laterally braced in both directions of strong-axis bending (i.e., jack rafters frame into the side and sheathing provides additional support to the top), the 0.6 D + W_u condition can be dismissed by inspection. Likewise, the D + W inward-bending load is considerably smaller than the gravity load condition. However, wind uplift should be considered in the design of the hip rafter connections; refer to Chapter 7.