9. Check deflection criteria for gravity load condition (Section 5.2.2)

$$\rho_{all} = \frac{\ell}{180} = \frac{(14.4\ \text{ft})(12\ \text{in/ft})}{180} = 1.0\ \text{in}$$

$$\rho_{max} = \frac{5w\ell^4}{384\,EI} = \frac{5(36\ \text{plf})(14.4\ \text{ft})^4}{384(1.6\times10^6\ \text{psi})(47.6\ \text{in}^4)}\quad(1{,}728\ \text{in}^3/\text{ft}^3)$$

$$= 0.4\ \text{in}$$

$\rho_{max} << \rho_{all}$ (OK, usually not a mandatory roof check)

Conclusion

A 2x8, No. 2 Douglas-Fir-Larch rafter spaced at 16 inches on center was shown to have ample capacity and stiffness for the given design conditions. In fact, using a 19.2 inch on center spacing (i.e., five joists per every 8 feet) would also work with a more efficient use of lumber. It is also possible that a 2x6 could result in a reasonable rafter design for this application. For other concepts in value-added framing design, consult *Cost Effective Home Building: A Design and Construction Handbook* (NAHBRC, 1994). The document also contains prescriptive span tables for roof framing design.

EXAMPLE 5.10 *Ridge Beam Design*

Given

One-story building
Ridge beam span = 13 ft
Roof slope = 6:12
Rafter horizontal span = 12 ft

Loading (Chapter 3)

Dead	=	15 psf
Snow	=	20 psf
Wind (110 mph, gust)	=	6.3 psf (inward)
	=	14.2 psf (outward, uplift)
Live	=	10 psf

Find Optimum size and grade of lumber to use for a solid (single-member) ridge beam.

Solution

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

$D + (L_r \text{ or } S)$ Controls ridge beam design in the inward-bending direction (compression side of beam laterally supported by top bearing rafters); L_r can be ignored because the roof snow load is greater.

$0.6\ D + W_u$ May control ridge beam design in outward-bending direction because the bottom (compression side) is laterally unsupported (i.e., exposed ridge beam for cathedral ceiling); also important to ridge beam connection to supporting columns. However, a ridge beam supporting rafters that are tied-down to resist wind uplift cannot experience significant uplift without significant upward movement of the rafters at the wall connection, and deformation of the entire sloped roof diaphragm (depending on roof slope).

$D + W$ Not controlling because snow load is greater in the inward direction; also, positive pressure is possible only on the sloped windward roof surface while the leeward roof surface is always under negative (suction) pressure for wind perpendicular to the ridge; the case of wind parallel to the ridge results in uplift across both sides of the roof, which is addressed in the $0.6\ D + W_u$ load combination and the roof uplift coefficients in Chapter 3 and based on this worst case wind direction.