Total Loads

In computing the total load to the rafters in the roof, the different lengths of the dead and snow loads must be taken into account. In addition, the shear and moment in the rafters may be analyzed using the sloping beam method or the horizontal plane method. In the *sloping beam method,* the gravity load is resolved into components that are parallel and perpendicular to the member. The values of shear and moment are based on the normal (perpendicular) component of load and a span length equal to the full length of the rafter. In the *horizontal plane method,* the gravity load is applied to a beam with a

span that is taken as the horizontal projection of the rafter. Both methods are illustrated, and the maximum values of shear and moment are compared.

Sloping beam method
(left rafter illustrated)

Horizontal plane method
(right rafter illustrated)

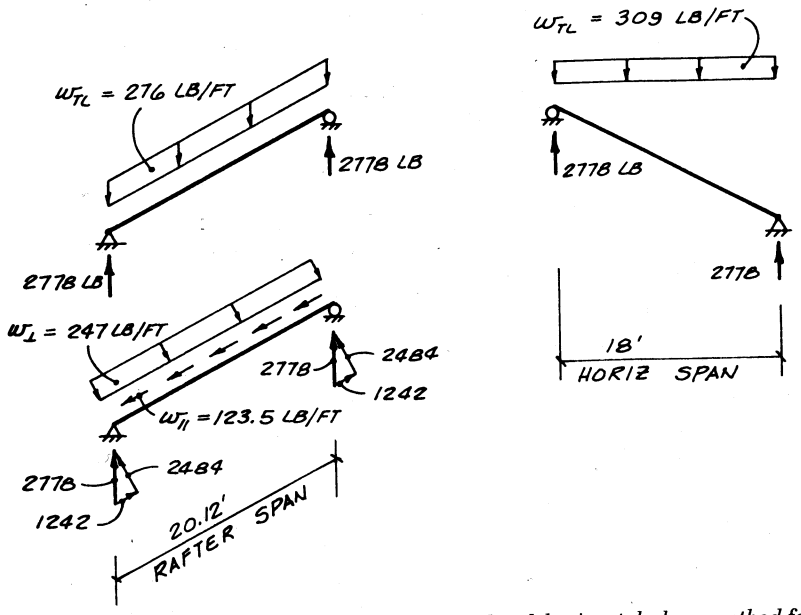

Figure 2.5*b* Comparison of *sloping beam method* and *horizontal plane method* for determining shears and moments in an inclined beam.

$$\begin{aligned} \text{TL} &= \text{DL} + \text{SL} \\ &= 10 + 66\left(\frac{18}{20.12}\right) \\ &= 69 \text{ psf} \\ w &= 69 \text{ psf} \times 4 \text{ ft} \\ &= 276 \text{ lb/ft} \end{aligned}$$

Use load normal to roof and rafter span **par**allel to roof.

$$\begin{aligned} V &= \frac{wL}{2} = \frac{0.247(20.12)}{2} \\ &= 2.48 \text{ k} \\ M &= \frac{wL^2}{8} = \frac{0.247(20.12)^2}{8} \\ &= 12.5 \text{ ft-k} \end{aligned}$$

$$\begin{aligned} \text{TL} &= \text{DL} + \text{SL} \\ &= 10\left(\frac{20.12}{18}\right) + 66 \\ &= 77.2 \text{ psf} \\ w &= 77.2 \text{ psf} \times 4 \text{ ft} \\ &\approx 309 \text{ lb/ft} \end{aligned}$$

Use total vertical load and projected horizontal span.

$$\begin{aligned} V &= \frac{wL}{2} = \frac{0.309(18)}{2} \\ &= 2.78 \text{ k} \quad \text{(conservative)} \\ M &= \frac{wL^2}{8} = \frac{0.309(18)^2}{8} \\ &= 12.5 \text{ ft-k} \quad \text{(same)} \end{aligned}$$

NOTE: The horizontal plane method is commonly used in practice to calculate design values for inclined beams such as rafters. This approach is convenient and gives equivalent design moments and conservative values for shear compared with the sloping beam analysis. (By definition *shear* is an internal force *perpendicular* to the longitudinal axis of a beam. Therefore, the calculation of shear for the left rafter in this example is theoretically correct.)