The effective cross-sectional area in the threaded portion of a rod is called the *stress area* and is a function of the unthreaded diameter and the number of threads per inch. The ratio of stress area to nominal area varies but has a lower bound of approximately 0.75. The nominal tensile strength of the threaded rod can therefore be written as

$$P_n = A_s F_u = 0.75 A_b F_u \tag{3.5}$$

where

A_s = stress area
A_b = nominal (unthreaded) area

The AISC Specification, in Chapter J, presents the nominal strength in a somewhat different form:

$$R_n = F_n A_b \qquad \text{(AISC Equation J3-1)}$$

where R_n is the nominal strength and F_n is given in Table J3.2 as $F_{nt} = 0.75F_u$. This associates the 0.75 factor with the ultimate tensile stress rather than the area, but the result is the same as that given by Equation 3.5.

For LRFD, the resistance factor ϕ is 0.75, so the strength relationship is

$$P_u \le \phi_t P_n \quad \text{or} \quad P_u \le 0.75(0.75 A_b F_u)$$

and the required area is

$$A_b = \frac{P_u}{0.75(0.75F_u)} \tag{3.6}$$

For ASD, the safety factor Ω is 2.00, leading to the requirement

$$P_a \le \frac{P_n}{2.00} \quad \text{or} \quad P_a \le 0.5 P_n$$

Using P_n from Equation 3.5, we get

$$P_a \le 0.5(0.75 A_b F_u)$$

If we divide both sides by the area A_b, we obtain the allowable stress

$$F_t = 0.5(0.75F_u) = 0.375F_u \tag{3.7}$$

EXAMPLE 3.14

A threaded rod is to be used as a bracing member that must resist a service tensile load of 2 kips dead load and 6 kips live load. What size rod is required if A36 steel is used?

LRFD SOLUTION

The factored load is

$$P_u = 1.2(2) + 1.6(6) = 12 \text{ kips}$$

From Equation 3.6,

$$\text{Required area } = A_b = \frac{P_u}{0.75(0.75F_u)} = \frac{12}{0.75(0.75)(58)} = 0.3678 \text{ in.}^2$$

From $A_b = \dfrac{d^2}{4}$,

$$\text{Required } d = \sqrt{\frac{4(0.3678)}{}} = 0.684 \text{ in.}$$

ANSWER Use a ¾-inch-diameter threaded rod ($A_b = 0.442$ in.^{2}).

ASD SOLUTION

The required strength is

$$P_a = D + L = 2 + 6 = 8 \text{ kips}$$

From Equation 3.7, the allowable tensile stress is

$$F_t = 0.375F_u = 0.375(58) = 21.75 \text{ ksi}$$

and the required area is

$$A_b = \frac{P_a}{F_t} = \frac{8}{21.75} = 0.3678 \text{ in.}^2$$

ANSWER Use a ¾-inch-diameter threaded rod ($A_b = 0.442$ in.^{2}).

To prevent damage during construction, rods should not be too slender. Although there is no specification requirement, a common practice is to use a minimum diameter of ⅝ inch.

Flexible cables, in the form of strands or wire rope, are used in applications where high strength is required and rigidity is unimportant. In addition to their use in bridges and cable roof systems, they are also used in hoists and derricks, as guy lines for towers, and as longitudinal bracing in metal building systems. The difference between strand and wire rope is illustrated in Figure 3.27. A strand consists of individual wires wound helically around a central core, and a wire rope is made of several strands laid helically around a core.

Selection of the correct cable for a given loading is usually based on both strength and deformation considerations. In addition to ordinary elastic elongation, an initial stretching is caused by seating or shifting of the individual wires, which results in a permanent stretch. For this reason, cables are often prestretched. Wire rope and strand are made from steels of much higher strength than structural steels and are not covered by the AISC Specification. The breaking strengths of various cables, as well as details of available fixtures for connections, can be obtained from manufacturers• literature.