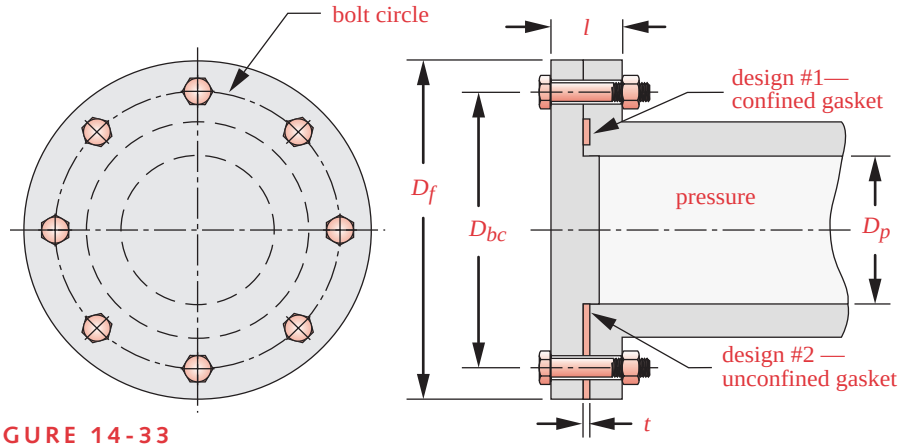

FIGURE 14-33

Pressure Vessel End Plate Secured with Preloaded Bolts on a Bolt Circle

$$P_{total} = pA = p\frac{\pi D_p^2}{4} = 1\,500\frac{\pi(4)^2}{4} = 18\,850 \text{ lb} \qquad (a)$$

and the applied force P on each bolt is

$$P = \frac{P_{total}}{N_{bolts}} = \frac{18\,850}{8} = 2\,356 \text{ lb} \qquad (b)$$

3 First find the stiffness of one bolt. Its tensile-stress area is found from Table 14-1 (p. 881) to be 0.077 in^2. The clamp length is given as 1.5 in. A 2-in bolt will have sufficient protrusion to grip the nut. The lengths of thread and shank of the bolt are then

$$\begin{aligned} l_{thd} &= 2d + 0.25 = 2(0.375) + 0.25 = 1.0 \text{ in} \\ l_s &= l_{bolt} - l_{thd} = 2.0 - 1.0 = 1.0 \text{ in} \end{aligned} \qquad (c)$$

from which we can find the length of thread l_t that is in the clamp zone:

$$l_t = l - l_s = 1.5 - 1.0 = 0.5 \text{ in} \qquad (d)$$

4 Find the stiffness of the bolt from equation 14.11*a* (p. 903).

$$\frac{1}{k_b} = \frac{l_t}{A_t E} + \frac{l_s}{A_b E} = \frac{0.5}{0.077(30E6)} + \frac{1.0(4)}{\pi(0.375)^2(30E6)}$$

$$k_b = 1.935E6 \text{ lb/in} \qquad (e)$$

5 A confined gasket allows the metal surfaces to contact just as if there were no gasket present. So the analysis of the material stiffness can ignore the confined gasket. The material stiffness in the clamp zone around any one bolt can be estimated with equation 14.17*b* (p. 916) using the factors from Table 14-9 (p. 916–918) for steel.

$$A = 0.78715 \qquad b = 0.62873 \qquad (f)$$