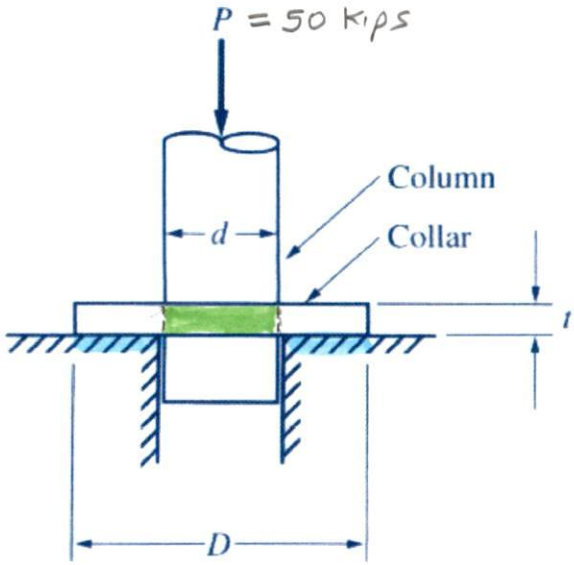
9-30

In the collar bearing shown in Fig. P9-30, the thickness of the collar is ½ in. The load P is 50 kips. The allowable compressive stress in the column is 20 ksi, the allowable shear stress in the collar is 15 ksi, and the allowable bearing stress between the collar and the support is 5 ksi. Select the proper sizes for d and D.



Compressive stress in column

$$\sigma_{allow} = \frac{P}{A} \qquad \sigma_{allow} = 20 \text{ ksi}$$

Shear stress in collar

$$\tau_{allow} = \frac{P}{A_s} \qquad \tau_{allow} = 15 \text{ ksi}$$

Bearing stress between Collar and Support

$$(\sigma_b)_{allow} = \frac{P}{A_b} \qquad (\sigma_b)_{allow} = 5 \text{ ksi}$$

Solution.

Compressive stress in column

$$A = \frac{P}{\sigma_{allow}} = \frac{50 \text{ kips}}{20 \text{ kips/in.}^2} = 2.5 \text{ in.}^2$$

$$A = \frac{\pi d^2}{4} = 0.7854\, d^2 = 2.5 \text{ in.}^2$$

$$d = \sqrt{\frac{2.5 \text{ in.}^2}{0.7854}} = 1.78 \text{ in.}$$

Shear stress in collar

$$A_s = \frac{P}{\tau_{allow}} = \frac{50 \text{ kips}}{15 \text{ kip/in.}^2} = 3.33 \text{ in.}^2$$

$$A_s = \pi d\, t = \pi d\, (\tfrac{1}{2} \text{ in.}) = 1.571\, d = 3.33 \text{ in.}^2$$

$$d = \frac{3.33 \text{ in.}^2}{1.571 \text{ in.}} = 2.12 \text{ in.}$$

use $d = 2\tfrac{1}{8}$ in (2.125 in)

Bearing stress between Collar and Support

$$A_b = \frac{P}{(\sigma_b)_{allow}} = \frac{50 \text{ kips}}{5 \text{ kips/in.}^2} = 10 \text{ in.}^2$$

$$A_b = \frac{\pi D^2}{4} - \frac{\pi (2.125 \text{ in.})^2}{4}$$

$$= 0.7854 (D^2 - 4.52 \text{ in.}^2) = 10 \text{ in.}^2$$

$$D^2 - 4.52 \text{ in.}^2 = \frac{10 \text{ in.}^2}{0.7854} = 12.73 \text{ in.}^2$$

$$D = \sqrt{12.73 \text{ in}^2 + 4.52 \text{ in}^2}$$

$$= 4.12 \text{ in.}$$

use $D = 4\ 1/4$ in (4.25 in.)