

2.59

2.59 The massless, 4-ft-wide gate shown in Fig. P2.59 pivots about the frictionless hinge O. It is held in place by the 2000 lb counterweight, W. Determine the water depth, h .

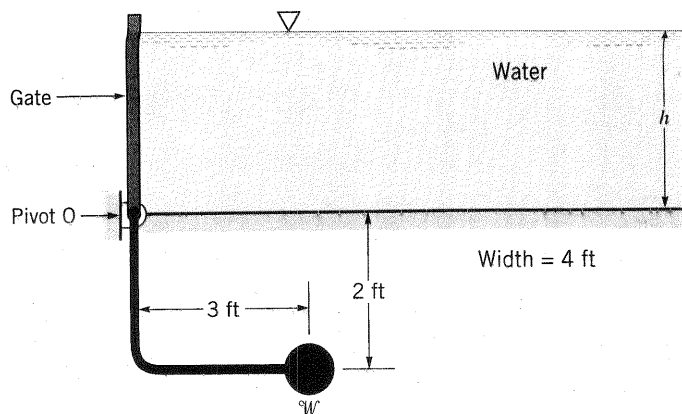


FIGURE P2.59

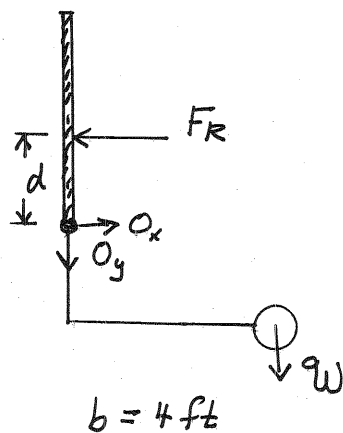
$$F_R = \gamma h_c A \quad \text{where } h_c = \frac{h}{2}$$

Thus,

$$\begin{aligned} F_R &= \gamma_{H_2O} \frac{h}{2} (h \times b) \\ &= \gamma_{H_2O} \frac{h^2}{2} (4 \text{ ft}) \end{aligned}$$

To locate F_R ,

$$\begin{aligned} y_R &= \frac{I_{xc}}{y_c A} + y_c = \frac{\frac{1}{12} (4 \text{ ft}) (h^3)}{\frac{h}{2} (4 \text{ ft} \times h)} + \frac{h}{2} \\ &= \frac{2}{3} h \end{aligned}$$



For equilibrium,

$$\sum M_O = 0$$

$$F_R d = W (3 \text{ ft}) \quad \text{where } d = h - y_R = \frac{h}{3}$$

so that

$$\frac{h}{3} = \frac{(2000 \text{ lb}) (3 \text{ ft})}{(\gamma_{H_2O}) \left(\frac{h^2}{2} \right) (4 \text{ ft})}$$

Thus,

$$h^3 = \frac{(3)(2000 \text{ lb}) (3 \text{ ft})}{(62.4 \frac{\text{lb}}{\text{ft}^3}) \left(\frac{1}{2} \right) (4 \text{ ft})}$$

$$h = \underline{\underline{5.24 \text{ ft}}}$$