2.117

2.117 The 18-ft-long gate of Fig. P2.117 is a quarter circle and is hinged at H. Determine the horizontal force, P, required to hold the gate in place. Neglect friction at the hinge and the weight of the gate.

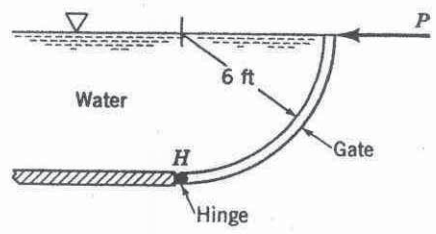
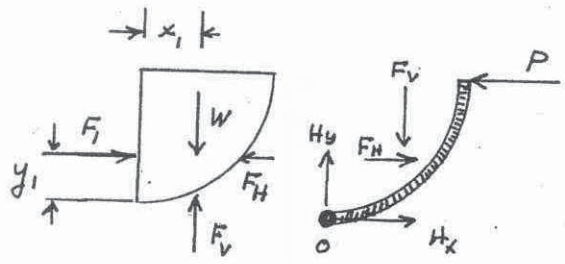


FIGURE P2.117



For equilibrium (from free-body-diagram of fluid mass),

$$\Sigma F_x = 0$$

so that

$$F_H = F_1 = \gamma h_{c_1} A_1$$

$$= \left(62.4 \frac{lb}{ft^3}\right)\left(\frac{6\,ft}{2}\right)(6\,ft \times 18\,ft) = 20{,}200\,lb$$

Similarly,

$$\Sigma F_y = 0$$

so that

$$F_V = W = \gamma_{H_2O} \times (\text{volume of fluid}) = \left(62.4 \frac{lb}{ft^3}\right)\left[\frac{\pi}{4}(6\,ft)^2 \times 18\,ft\right] = 31{,}800\,lb$$

Also,

$$x_1 = \frac{4(6\,ft)}{3\pi} = \frac{8}{\pi}\,ft \qquad (\text{see Fig. 2.18e})$$

and

$$y_1 = \frac{6\,ft}{3} = 2\,ft$$

For equilibrium (from free-body-diagram of gate)

$$\Sigma M_O = 0$$

so that

$$P(6\,ft) = F_H(y_1) + F_V(x_1)$$

or

$$P = \frac{(20{,}200\,lb)(2\,ft) + (31{,}800\,lb)\left(\frac{8}{\pi}\,ft\right)}{6\,ft} = \underline{\underline{20{,}200\,lb}}$$