

2.81

2.81 Three gates of negligible weight are used to hold back water in a channel of width b as shown in Fig. P2.81. The force of the gate against the block for gate (b) is R . Determine (in terms of R) the force against the blocks for the other two gates.

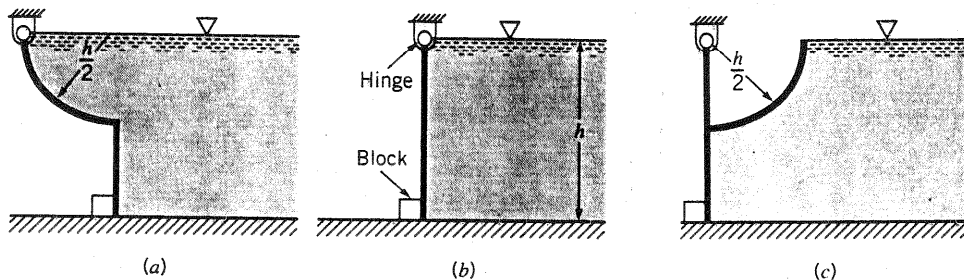


FIGURE P2.81

For case (b)

$$F_R = \gamma h_c A = \gamma \left(\frac{h}{2} \right) (h \times b) = \frac{\gamma h^2 b}{2}$$

$$\text{and } y_R = \frac{2}{3} h$$

Thus,

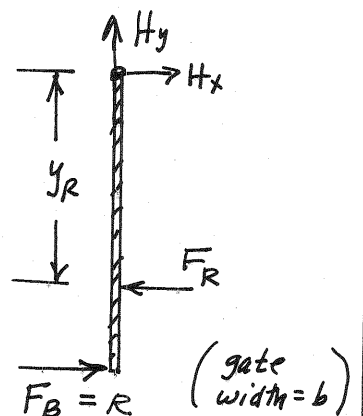
$$\text{so that } \sum M_H = 0$$

$$h R = \left(\frac{2}{3} h \right) F_R$$

$$h R = \left(\frac{2}{3} h \right) \left(\frac{\gamma h^2 b}{2} \right)$$

$$R = \frac{\gamma h^2 b}{3}$$

(1)



For case (a) on free-body-diagram shown

$$F_R = \frac{\gamma h^2 b}{2} \text{ (from above) and}$$

$$y_R = \frac{2}{3} h$$

and

$$W = \gamma \times \text{Vol}$$

$$= \gamma \left[\frac{\pi \left(\frac{h}{2} \right)^2}{4} (b) \right]$$

$$= \frac{\pi \gamma h^2 b}{16}$$

$$\text{Thus, } \sum M_H = 0$$

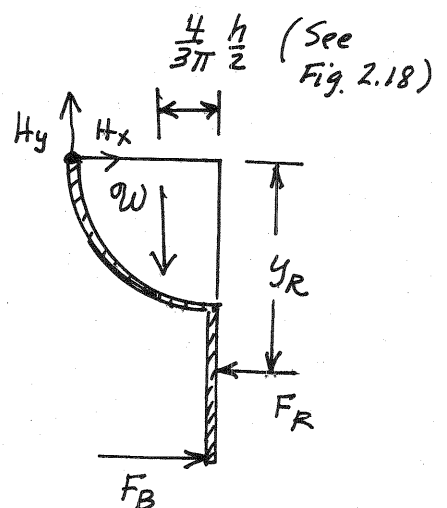
so that

$$W \left(\frac{h}{2} - \frac{4h}{6\pi} \right) + F_R \left(\frac{2}{3} h \right) = F_B h$$

and

$$\frac{\pi \gamma h^2 b}{16} \left(\frac{h}{2} - \frac{4h}{6\pi} \right) + \frac{\gamma h^2 b}{2} \left(\frac{2}{3} h \right) = F_B h$$

(cont)



2.81

(cont.)

It follows that

$$F_B = \gamma h^2 b (0.390)$$

From Eq. (1) $\gamma h^2 b = 3R$, thus

$$F_B = \underline{\underline{1.17R}}$$

For case (c), for the free-body diagram shown, the force F_{R_1} on the curved section passes through the hinge and therefore does not contribute to the moment around H. On bottom part of gate

$$F_{R_2} = \gamma h_c A = \gamma \left(\frac{3h}{4} \right) \left(\frac{h}{2} \times b \right) = \frac{3}{8} \gamma h^2 b$$

and

$$y_{R_2} = \frac{I_{xc}}{y_c A} + y_c = \frac{\frac{1}{12}(b)\left(\frac{h}{2}\right)^3}{\left(\frac{3h}{4}\right)\left(\frac{h}{2} \times b\right)} + \frac{3h}{4}$$

$$= \frac{28}{36} h$$

Thus, $\sum M_H = 0$

so that

$$F_{R_2} \left(\frac{28}{36} h \right) = F_B h$$

or

$$F_B = \left(\frac{3}{8} \gamma h^2 b \right) \left(\frac{28}{36} \right) = \frac{7}{24} \gamma h^2 b$$

From Eq. (1) $\gamma h^2 b = 3R$, thus

$$F_B = \frac{7}{8} R = \underline{\underline{0.875R}}$$

