5.62

5.62 Determine the magnitude of the horizontal component of the anchoring force required to hold in place the sluice gate shown in Fig. 5.62. Compare this result with the size of the horizontal component of the anchoring force required to hold in place the sluice gate when it is closed and the depth of water upstream is 10 ft.

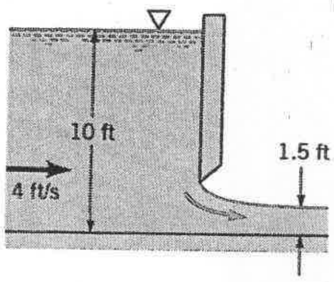

FIGURE P5.62

This analysis is similar to the one of Example 5.15. The control volumes of Fig. E 5.15 are appropriate for use in solving this problem. When the sluice gate is closed (see Figs. E5.15a and E 5.15c) application of the x direction component of the linear momentum equation leads to

$$R_x = \frac{1}{2}\gamma H^2 = \frac{1}{2}\left(62.4\frac{lb}{ft^3}\right)(10ft)^2 = \underline{\underline{3120}}\ \frac{lb}{ft}$$

When the sluice gate is open (see Figs. E5.15b and E5.15d) application of the x direction component of the linear momentum equation leads to

$$R_x = \frac{1}{2}\gamma H^2 - \frac{1}{2}\gamma h^2 - F_f + \rho u_1^2 H - \rho u_2^2 h$$

The exit velocity u_2 may be expressed in terms of the inlet velocity u_1 with the conservation of mass equation as follows

$$u_2 = u_1 \frac{H}{h}$$

Thus

$$R_x = \frac{1}{2}\gamma H^2 - \frac{1}{2}\gamma h^2 - F_f + \rho u_1^2 H - \rho u_1^2 \frac{H^2}{h}$$

Assuming F_f is negligibly small, we obtain

$$R_x = \frac{1}{2}\left(62.4\frac{lb}{ft^3}\right)(10ft)^2 - \frac{1}{2}\left(62.4\frac{lb}{ft^3}\right)(1.5ft)^2$$
$$+\left(1.94\frac{slugs}{ft^3}\right)\left(4\frac{ft}{s}\right)^2(10ft)\left(\frac{1\,lb}{slug\cdot\frac{ft}{s^2}}\right) - \left(1.94\frac{slugs}{ft^3}\right)\left(4\frac{ft}{s}\right)^2\frac{(10ft)^2}{(1.5ft)}\left(\frac{1\,lb}{slug\cdot\frac{ft}{s^2}}\right)$$

$$R_x = \underline{\underline{1290}}\ \frac{lb}{ft}$$

Thus it takes considerably less force to hold in place the sluice gate when it is opened as compared to when it is closed.