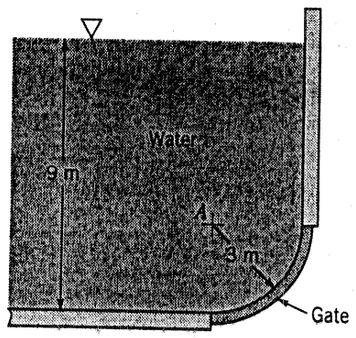
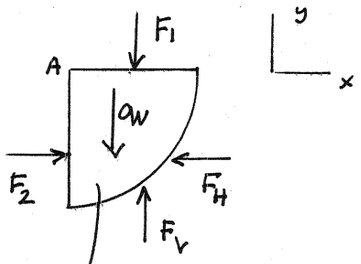
2.70

2.70 A 4-m-long curved gate is located in the side of a reservoir containing water as shown in Fig. P2.70. Determine the magnitude of the horizontal and vertical components of the force of the water on the gate. Will this force pass through point *A*? Explain.



■ FIGURE P2.70



For equilibrium,

$$\Sigma F_x = 0$$

or

$$F_H = F_2 = \gamma h_{c2} A_2 = \gamma (6m + 1.5m)(3m \times 4m)$$

so that

$$F_H = \left(9.80 \frac{kN}{m^3}\right)(7.5m)(12 m^2) = \underline{\underline{882\ kN}}$$

Similarly,

$$\Sigma F_y = 0$$

$$F_V = F_1 + q_W \qquad \text{where :}$$

$$F_1 = [\gamma (6m)](3m \times 4m) = \left(9.80 \frac{kN}{m^3}\right)(6m)(12 m^2)$$

$$q_W = \gamma \forall = \left(9.80 \frac{kN}{m^3}\right)(9\pi\ m^3)$$

Thus,

$$F_V = \left(9.80 \frac{kN}{m^3}\right)\left[72\ m^3 + 9\pi\ m^3\right] = \underline{\underline{983\ kN}}$$

(Note: Force of water on gate will be opposite in direction to that shown on figure.)

volume $\sim \forall$

and

$$\forall = \frac{\pi (3m)^2}{4} \times 4\ m = 9\pi\ m^3$$

The direction of all differential forces acting on the curved surface is perpendicular to surface, and therefore, the resultant must pass through the intersection of all these forces which is at point A. Yes.