2.84 Determine (a) the total hydrostatic force on curved surface AB in Fig. P2.84 and (b) its line of action. Neglect atmospheric pressure and assume unit width into the paper.

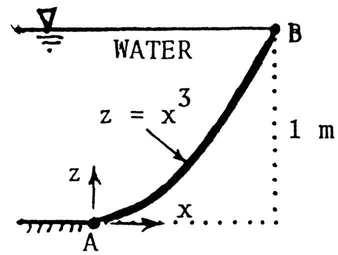


Fig. P2.84

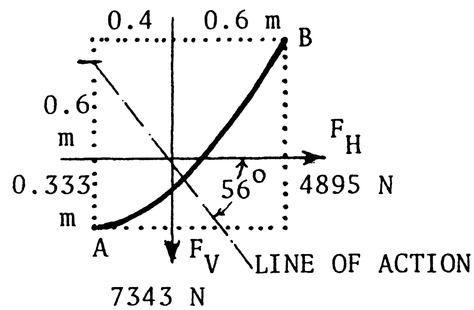
Solution: The horizontal force is

$$F_H = \gamma h_{CG} A_{vert} = (9790\ \text{N/m}^3)(0.5\ \text{m})(1\times 1\ \text{m}^2) = 4895\ \text{N} \quad \text{at } 0.667\ \text{m below B.}$$

For the cubic-shaped surface AB, the weight of water above is computed by integration:

$$F_V = \gamma b \int_0^1 (1 - x^3)\,dx = \frac{3}{4}\gamma b$$

$$= (3/4)(9790)(1.0) = 7343\ \text{N}$$



The line of action (water centroid) of the vertical force also has to be found by integration:

$$\bar{x} = \frac{\int x\,dA}{\int dA} = \frac{\int_0^1 x(1-x^3)\,dx}{\int_0^1 (1-x^3)\,dx} = \frac{3/10}{3/4} = 0.4\ \text{m}$$

The vertical force of 7343 N thus acts at 0.4 m to the right of point A, or 0.6 m to the left of B, as shown in the sketch above. The resultant hydrostatic force then is

$$F_{total} = [(4895)^2 + (7343)^2]^{1/2} = \mathbf{8825\ N} \quad \text{acting at } \mathbf{56.31°} \text{ down and to the right.} \quad \textit{Ans.}$$

This result is shown in the sketch at above right. The line of action of F strikes the vertical above point A at 0.933 m above A, or 0.067 m below the water surface.

2.85 Compute the horizontal and vertical components of the hydrostatic force on the quarter-circle panel at the bottom of the water tank in Fig. P2.85.

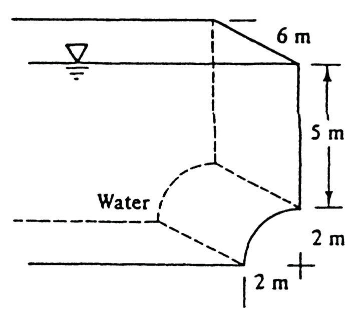


Fig. P2.85

Solution: The horizontal component is

$$F_H = \gamma h_{CG} A_{vert} = (9790)(6)(2\times 6)$$

$$= \mathbf{705000\ N} \quad \textit{Ans.}\ \text{(a)}$$