

PROBLEM 1.44

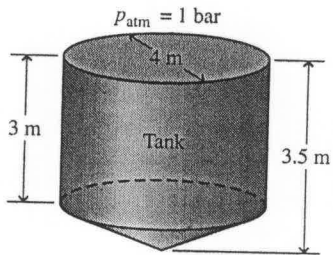


Fig. P1.44

- (a) The depth at the center of the cistern is 3.5 m and the corresponding pressure at the center (p_c) in kPa is as follows

$$p_c = p_{\text{atm}} + \rho gh = 1 \text{ bar} \left| \frac{100 \text{ kPa}}{1 \text{ bar}} \right| + (987.1 \frac{\text{kg}}{\text{m}^3})(9.8 \frac{\text{m}}{\text{s}^2})(3.5 \text{ m}) \left| \frac{1 \text{ N}}{1 \frac{\text{kg} \cdot \text{m}}{\text{s}^2}} \right| \left| \frac{1 \text{ kPa}}{10^3 \frac{\text{N}}{\text{m}^2}} \right| =$$

$$p_c = 100 \text{ kPa} + 33.9 \text{ kPa} = 133.9 \text{ kPa}$$

- (b) The force acting on the bottom (F_{tot}) of the tank is the sum of the weight of the water plus the force of the atmosphere. The force of the atmosphere (F_{atm}) in kN is

$$F_{\text{atm}} = p_{\text{atm}} \pi \frac{D^2}{4} = 1 \text{ bar} \left| \frac{10^5 \frac{\text{N}}{\text{m}^2}}{1 \text{ bar}} \right| \pi \frac{(4 \text{ m})^2}{4} \left| \frac{1 \text{ kN}}{10^3 \text{ N}} \right| = 12.6 \times 10^2 \text{ kN}$$

The weight of the water is given by

$$m_w g = \rho V g \quad (1)$$

where ρ is the density of the water and g is the acceleration of gravity which were both given. The total volume of the water in the tank (V) is equal to the volume of a cylinder having a diameter, $D = 4 \text{ m}$ and a length, $L = 3 \text{ m}$ plus the volume of a cone having $D = 4 \text{ m}$ and a height, $H = 0.5 \text{ m}$. Thus,

$$V = V_{\text{cyl}} + V_{\text{cone}} = \pi L \left(\frac{D^2}{4} \right) + \left(\frac{1}{3} \right) \pi H \left(\frac{D^2}{4} \right) = \pi \left(\frac{D^2}{4} \right) \left(L + \frac{H}{3} \right) = \pi (4 \text{ m}^2) \left(3 + \frac{0.5}{3} \right) \text{ m} = 39.8 \text{ m}^3$$

Substituting value $\dot{\lambda}$ into Eq. (1)

$$\rho g V = 987.1 \frac{\text{kg}}{\text{m}^3} \left(9.8 \frac{\text{m}}{\text{s}^2} \right) (39.8 \text{ m}^3) \left| \frac{1 \text{ N}}{1 \frac{\text{kg} \cdot \text{m}}{\text{s}^2}} \right| \left| \frac{1 \text{ kN}}{10^3 \text{ N}} \right| = 3.85 \times 10^2 \text{ kN}$$

Finally, the total force acting on the bottom of the tank is

$$F_{\text{tot}} = \text{weight} + F_{\text{atm}} = 3.85 \times 10^2 \text{ kN} + 12.6 \times 10^2 \text{ kN} = 16.5 \times 10^2 \text{ kN}$$

