Kenny

(4.2) The flat left end of the tank shown in fig. P4.1 is secured with a bolted flange. If inside diameter of the tank is 30.in and the internal pressure is raised to + 23.6 psig, calculate the total force that must be resisted by the bolts in the flange

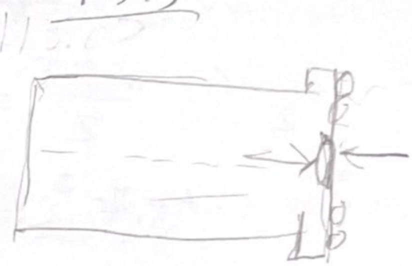
Given: Inside diameter of tank: 30 in, internal pressure 23.6 psig, window 12 in diameter

Solution: Area of the window

$r = \frac{\text{diameter}}{2} = \frac{12in}{2} = 6in$

$A_{window} = \pi r^2 = \pi \times 6^2 = 113.10$

FBD



Area of window

$r = \frac{\text{diameter}}{2} = \frac{30in}{2} = 15$

$A_{total} = \pi r^2 = \pi \times 15^2 = 706.86$

Effected area

$A_{effective} = A_{total} - A_{window} \Rightarrow 706.86 - 113.10 = 593.76$

Force on effective area

$F_{effective} = P \times A_{effective} \Rightarrow 23.6 \times 593.76 = 14012.736$

$F_{window} = P \times A_{window} \Rightarrow 23.6 \times 113.10 = 2669.16$

Total force $= F_{effective} + F_{window} \Rightarrow 14012.736\ lbf + 2669.36\ lbf = \boxed{16682.096\ lbf}$

4.10 A simple shower for remote locations is designed with a cylindrical tank 500mm in diameter and 1.800m high a shown in fig. The water flows through a flapper valve in the bottom through a 75mm diameter opening. The flapper must be pushed upward to open the valve. How much force is required to open the valve?

Given: $\rho = 1000\ kg/m^3$, $g = 9.81 m/s^2$, $h = 1.80m$

Solution: <u>Water pressure at valve</u>

$p = \rho g h \Rightarrow 1000\ kg/m^3 \times 9.81 m/s \times 1.80m = 17658\ Pa$

<u>The area of the valve opening</u>

$r = \frac{Diameter}{2} = \frac{0.075}{2} = 0.0375m$

Area of valve: $A = \pi r^2 = \pi (0.0375)^2 = 0.00442m^2$

<u>Force required to open valve</u>

$F = P \times A \Rightarrow 17658 Pa \times 0.00442m^2 = \boxed{78.05N}$

FBD

5-66 problem: A boat is shown in Fig. Its geometry at the water line is the same as the top surface. The hull is solid. Is the boat stable?

Given: $h = 1.5m$, $b = 0.6m$, $I = 5.5m$

Solution: Metacentric radius

$$I = \frac{bI^3}{12} \Rightarrow \frac{0.6 \times (5.5)^3}{12} = 8.319\, m^4$$

$$V = b \times l \times h_s = 0.6 \times 5.5 \times 1.5 = 4.95\, m^3$$

$$BM = \frac{I}{V} = \frac{8.319}{4.95} = 1.68\, m$$

Metacentric Height

$$GM = BM - BG \Rightarrow BG = BM + GM \Leftrightarrow BG = h_G - h_B$$

$$h_{total} = 1.5 + 0.3 = 1.8m$$

$$h_g = \frac{1.8}{2} = 0.9\, m$$

$$h_B = \frac{h_s}{2} = \frac{1.5}{2} = 0.75m$$

$$BG = 0.9 - 0.75 = 0.15\, m$$

$$GM = 1.88 - 0.15 = 1.73m$$

FBD

(5.8)

Problem: A steel cube 100 mm on a side weighs 80 N. We want ~~to hol~~ to hold the cube in equilibrium underwater by attaching a light buoy to it. If the foam weighs 470 N/m³, what is the minimum required volume of the buoy?

Given: cube is 100 mm (0.1 m), side weigh 80 N, foam weighs 470 N/m³

Solution: Volume of Steel

$V_{cube} = (side)^3 \Rightarrow (0.1\,m)^3 = 0.001\,m^3$

Buoyant Force on steel cube

$F_{cube} = \rho g V \Rightarrow 1000\,kg/m^3 \times 9.81\,m/s^2 \times 0.001 = 9.81\,N$

Net weight of cube underwater

$F_{net} = F_{weight} - F_{buoyant} \Rightarrow 80N - 9.81N = 70.19N$

Volume of Foam Buoy

$F_{net} = F_{buoyant} - W_{foam}$

$70.19N = 1000\,kg/m^3 \cdot 9.81\,m/s^2 \cdot V_{foam}) - 470\,N/m^3.$

$70.19N = 9340\,N/m^3 \cdot V_{foam}$

$V_{foam} = \dfrac{70.19N}{9340\,N/m^3} = 0.00752\,m^3$

FBD