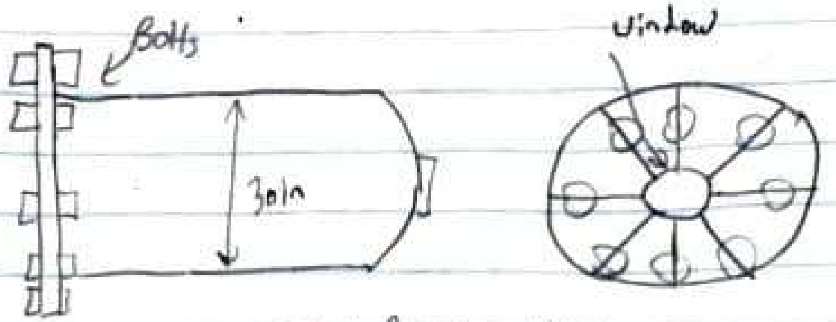
When a object is floating within a liquid substance, there is a buoyance force pushing the object up to the surface. Depending on object's weight, it either be sink to the bottom due to its larger weight or moves up to the surface due to small weight less than the buoyance force. Using the free-body of forces and Newton's 2nd law of forces, the buyoance force equals to the weight of the object.

The object's floating body is stable if the metacenter is above center of gravity but if its below the floating is unstable. For a floating body to be stable, the center of buoyance and the distance of MB greater than the center of gravity. MB is determine by the moment of inertia of the imaginary plan by the displace submerged volume.

2.1 2,10,17,20

4.2)



Internal Pressure = +14.4 psig

Calculate the total force that must be resisted by the bolts in the flange

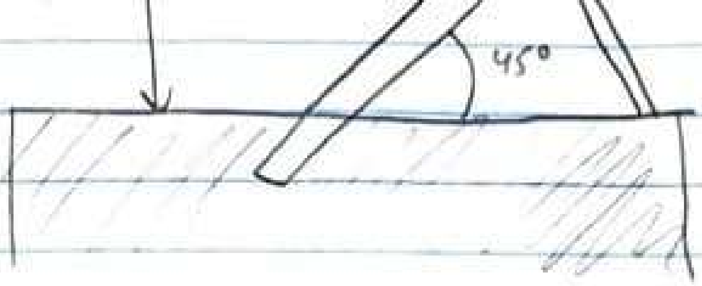
$$F = PA$$

$$A = \frac{\pi D^2}{4} = \frac{\pi (30)^2}{4} = 706\,in^2$$

$$=$$

$$F = (14.4\,psig)(706\,in^2)$$

$$\boxed{= 10166.4\,lb}$$



Calc the total force on the wall due to oil pressure.

Determine the location of the center of pressure and show the resultant force on the wall.

$\sin\theta = \frac{1.4}{\sin 45} = 1.980m$

$A = 1.980m(4m) = \boxed{7.920m^2}$

$F = \gamma \frac{h}{2} A$ $F = 8{,}436.6 \cdot \frac{1.4}{2} \cdot 7.920m^2$

$\boxed{= 46.77\ kN}$

$L_p = L - \frac{L}{3}$

$1.980 - 0.659 = 1.32m$

$h_p = h - \frac{h}{3} = \frac{2(1.4)}{3} = \boxed{9.3\overline{3}m}$

4.10) $L = 300\,mm$ $h = 1.800\,m$

shower

$D = 75\,mm$ opening

Find how much force is required to open the valve.

$$A = \frac{\pi (75\,mm)^2}{4} = 4417.86\,mm^2$$

$F = PA$

$$= 4.418 \times 10^{-3}\,m^2$$

$h = P_a / \gamma$

$$P_a = (h)(\gamma) = 9.81\,\frac{kN}{m^3} \cdot 1.800\,m = 17.658\,\frac{kN}{m^2}$$

$$F = (4.418 \times 10^{-3}\,\cancel{m^2})(17.658\,\frac{kN}{\cancel{m^2}})$$

$$\boxed{= 0.0780\,kN}$$

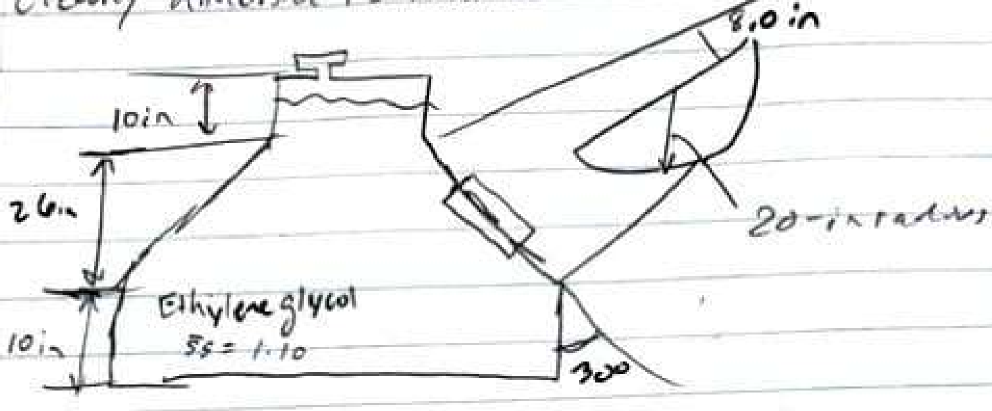
$\Sigma M_o = 0$

$(0.0780\,kN)(37.5)$

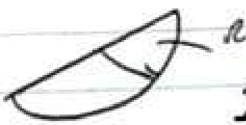
$$\boxed{= 0.0450\,kN}$$

4.28

- Compute the magnitude of the resultant force and location of the center of pressure. Show resultant force on the area and clearly dimension it's location



MOI



$$I_{cm} = I_x - Ad^2$$

$$\frac{\pi (20in)^4}{8} - \frac{8(20)^4}{9\pi}$$

$$= 17{,}561\ (\ (0.0254)^4)$$

$$= 7.309 \times 10^{-3} m^4$$

Centroid Distance:

$$h_c = 10 + (8.48 + 8)\cos 30$$

$$= 24.272\ (0.0254m)$$

$$\boxed{= 0.617m}$$

$$F = (1{,}100)(0.405)(4.81)(0.617)$$

$$\boxed{F_{resultant} = 2.696\ kN}$$

~~A semi-circular~~

Semicircular arc

$$A = \frac{\pi (20)^2}{2}$$

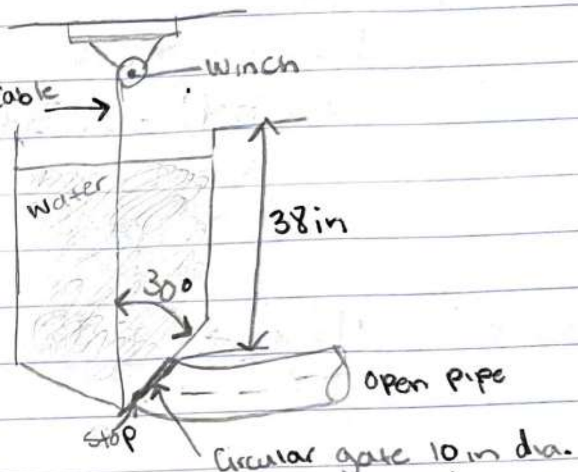
$$= 628.32 in^2\ (0.02m)$$

$$= 0.405 m^2$$

Ch 4: 42, 54
Ch 5: 8

pg 87

4.42 The figure below shows a tank of water with a circular pipe connected to its bottom. A circular gate seals the pipe opening to prohibit flow. To drain the tank, a winch is used to pull the gate open. Compute the amount of force that the winch cable must exert to open the gate.



$L = \frac{h}{\cos\theta} \rightarrow \frac{42.33\,in}{\cos 30} = 48.88\,in$

$y = D/2 \cos\theta \rightarrow 10/2 \cos\theta = 4.33\,in$

$h = 4.33 + 38 = 42.33\,in$

$A = \frac{\pi D^2}{4} \rightarrow \frac{\pi (10)^2}{4} = 78.54\,in^2$

$I = \frac{\pi D^4}{64} \rightarrow \frac{\pi (10)^4}{64} = 490.87\,in^4$

$F_R = \gamma h A \rightarrow 62.4\,lb/ft^3 (42.33\,in)(78.54\quad)(1/12)(1/12)(1/12)$

$F_R = 120.05\,lb$

$L_p - L_c = \frac{I_c}{L_c A} \rightarrow L_p - L_c = \frac{490.87\,in^4}{(48.88\,in)(78.54\,in^2)} = .128\,in$

$F_R\,(D/2 + L_p - L_c) - F_c\,(D/2) = 0$

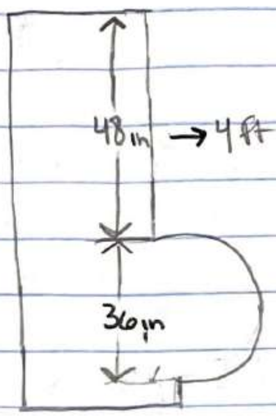
$120\,(10/2 + .128) = F_c(10/2)$

$615.36 = \cancel{F_c\,5}$

$F_c = 123.07\,lb$

Pg 8a

4.54 Compute the magnitude of the horizontal component of the force + Compute the vertical component of the force exerted by the fluid on that surface. Then compute the magnitude of the resultant force + its direction. Show the resultant force acting on the curved surface. The surface is 60 in long.



D = 36 in → 3 ft   W = 60 in → 5 ft

$A = \frac{\pi (3 ft)^2}{8} = 3.53 ft^2$

$V = AW \rightarrow (3.53 ft^2)(5 ft) = 17.67 ft^3$

W = Fv

$W = \gamma V \rightarrow (.79)(62.4 lb/ft^3)(17.67 ft^3)$

$F_v = 871.13 lb$

$F_H = \gamma o w h_c \rightarrow (49.29 lb/ft^3)(17.67 ft^3)(4 ft + 3ft/2)$

$F_H = 4790.83 lb$

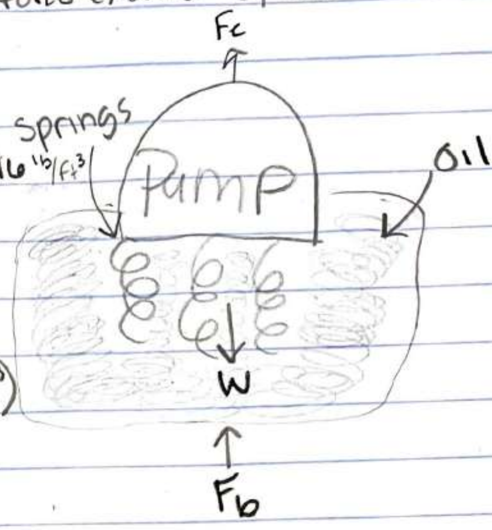
$F_R = \sqrt{F_v^2 + F_H^2} \rightarrow \sqrt{871.13^2 + 4790.83^2} = 4869.38 lb$

$Tan^{-1}\left(\frac{871.13}{4790.83}\right) = 10.31° = \theta$

Maya Hagstrom

Pg 109

5.8 The figure below shows a pump partially submerged in oil ($sg = 0.90$) + supported by springs. If the total weight of the pump is 14.6 lb + the submerged volume is 40 in^3, calculate the supporting force exerted by the springs.



$Sg = 50.90 \rightarrow \gamma = .90(62.4\ lb/ft^3) = 56.16\ lb/ft^3$

$V_d = 40\ in^3 \rightarrow .0231\ ft^3$

$W = 14.6\ lb$

$F_b = \gamma V_d = (56.16\ lb/ft^3)(.0231\ ft^3)$

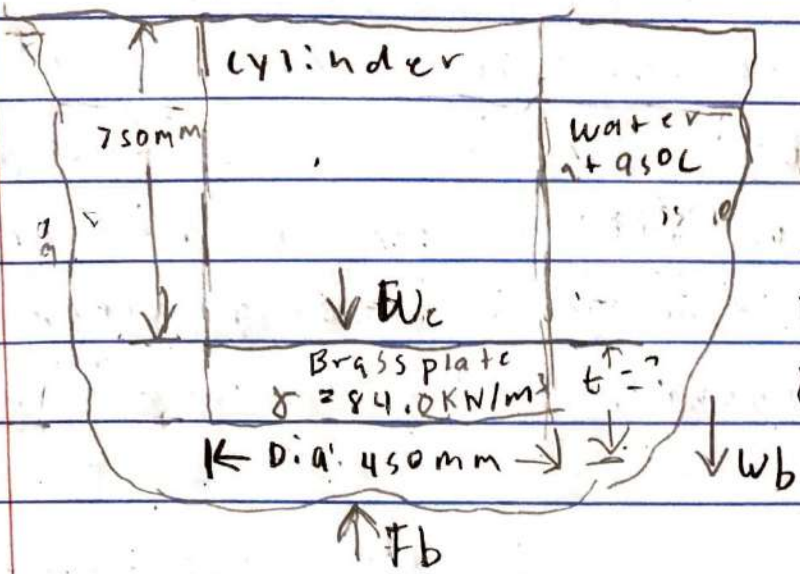
$F_b = 1.297\ lb$

$F_b - W + F_c = 0$

$F_c = W - F_b \rightarrow 14.6\ lb - 1.297$

$F_c = 13.301\ lb$

5.24



$L = 750\,mm$

$\gamma_B = 84.0\,kN/m^3$

$D = 450\,mm$

$\gamma_w = 9.44\,kN/m^3$

$\gamma_L = 6.45\,kN/m^3$

$\Sigma F = 0 = F_b - W_c - W_b$

$F_b = \gamma_w V_d$

Volume of the cylinder: $V_d = \frac{\pi}{4} D^2 h$

$V_d = \frac{\pi}{4}(0.45\,m)^2(0.75\,m) = 0.119\,m^3$

$W_c = (6.45\,\frac{kN}{m^3})(0.119\,m^3) = 0.768\,kN$

Volume of the Brass plate: $V_B = \frac{\pi}{4} D^2 h$

$V_B = \frac{\pi}{4}(0.45\,m)^2(t\,m) = 0.159\,t\,m^3$

$W_b = \gamma_b V_b = (84.0\,kN/m^3)(0.159\,t\,m^3) = 13.356\,t\,kN$

$F = \gamma_w(V_b + V_d) = (9.44\,kN/m^3)(0.119 + 0.159\,t)$

Equalibrium force

$F_b = W_c + W_b$

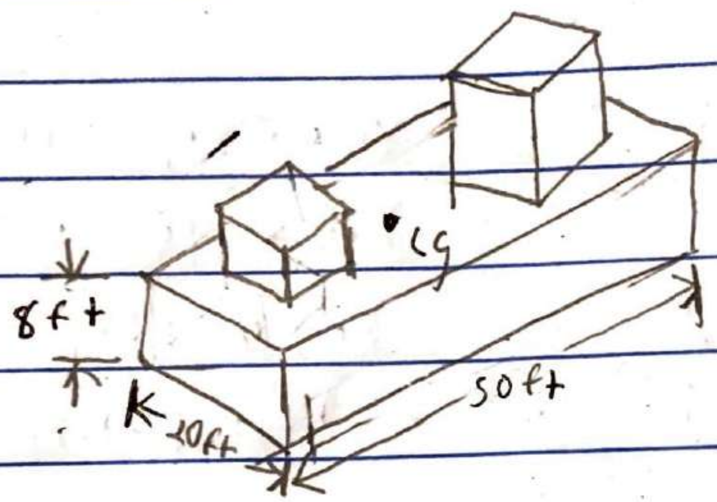
$(9.44\,kN/m^3)(0.1193 + 0.159\,t) = 0.768\,kN + 13.356\,t\,kN$

$1.126\,kN + 1.501\,t\,kN = 0.768\,kN + 13.356\,t\,kN$

$0.358 = 11.855\,t$

$t = \frac{0.358}{11.855} = 0.03\,m = \boxed{30\,mm}$

5.41



$D_{bottom\ tank} = 6.00\ in$

$L_{bottom\ tank} = 10.00\ in$

$\gamma_c = 0.284 \frac{lb}{in^3}$ (steel)

$\gamma_f = 62.4 \frac{lb}{ft^3}$

$W_{total\ system} = 450000\ lb$

$y_{cg} = 8ft$

Stable equilibrium forces: $\Sigma F_v = 0$

$F_b - W = 0 \rightarrow F_b = W$

$F_b = \gamma_f V_d = (62.4 \frac{lb}{ft^3})(50ft \times 20ft \times x) = 62400x\ lb$

$62400\ lb\ x = 450000\ lb$

$x = 7.212\ ft$

Metacenter: $MB = \frac{I}{V_d}$

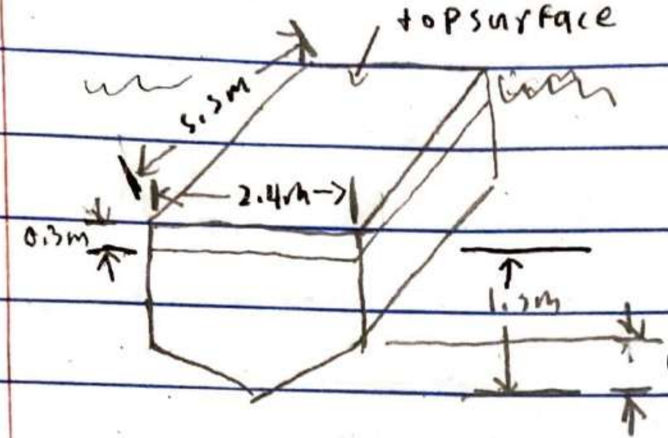
$$MB = \frac{\frac{LB^3}{12}}{(W \times L \times H)} = \frac{\frac{(50ft)(20ft)^3}{12}}{(20 \times 50 \times 7.212)} = 4.62ft$$

Center of buyoance: $y_{cb} = \frac{x}{2} = \frac{7.212ft}{2} = 3.606ft$

Metacenter distance; $y_{mc} = y_{cb} + MB$

$y_{cm} = 3.606 + 4.62 = \boxed{8.226\ ft}$

5.61



$y_{mc} > y_{cg}$ - stable

$y_{mc} < y_{cg}$ - unstable

$\gamma_f = 9.81$ kN

$h_{total} = 1.8$m

Apply equilibrium: $W = F_b = \gamma_f V_d$

Area of boat: $A_B = A_{under\,w} + A_{above\,w}$

$A_B = (1.2m \times 2.4m) + (\frac{1}{2} \times 0.6m \times 2.4m) = 3.6\ m^2$

Submerge area: $A_{under} + A_{above}$

$A_b = (0.9 \times 2.4m) + (\frac{1}{2} \times 0.6m \times 2.4m) = 2.88 m^3$

$$y_{cb} = \frac{A_1 y_1 + A_2 y_2}{A_{b\,nei}} = \frac{(0.5 \times 2.4 \times 0.6)\frac{2(0.6)}{3} + (0.9 \times 2.4)(0.6+}{2.88}$$

$y_{cg} = 0.8875m$

$V_d = A_b \times B = (2.88 m^2)(5.5m) = 15.84 m^3$

$I = \frac{BH^3}{12} = \frac{(5.5m)(2.4m)^3}{12} = 6.336 m^4$

$MB = \frac{I}{V_d} = \frac{6.336 m^4}{15.84 m^3} = 0.4 m$

$y_{mc} = y_{cb} + MB = 0.8875 + 0.4 = 1.2875 m$

$$y_{cg} = \frac{A_1 y_1 + A_2 y_2}{AB} = \frac{(0.5 \times 2.4 \times 0.6)\left(\frac{2(0.6)}{3}\right) + (1.2 \times 2.4)(0.6}{3.6}$$

$y_{cg} = 1.04 m$

$y_{mc} > y_{cg}$, therefore the floating body is stable