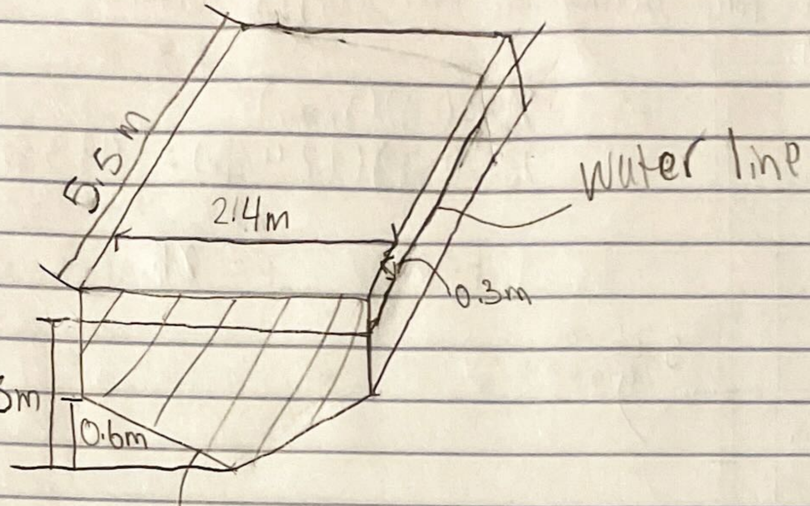
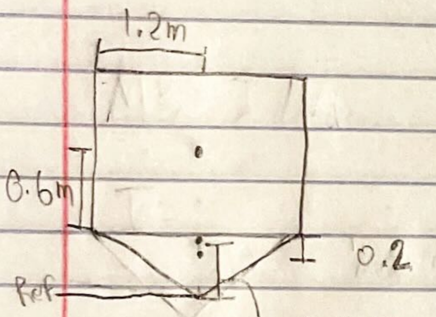
5.61 The boat in the figure has its geometry at the water line is the same as the top surface. the hull is solid Is the boat stable.



cross-section



$\bar{x} = 0.467m$

$x_1 = 1.2\,m$ $\quad A_1 = 2.88\,m^2$

$x_2 = 1.2\,m$ $\quad + A_2 = 0.72\,m^2$

$A = 3.6\,m^2$

$x_1 A_1 = 3.46\,m^3$

$+ x_2 A_2 = 1.73\,m^3$

$\frac{5.18\,m^3}{A_1 + A_2} = 1.2\,m$

$\bar{y}_1 = 1.2\,m$ $\quad A_1 = 2.88\,m^2$

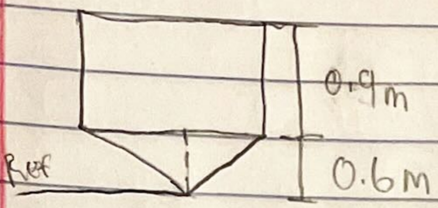
$\bar{y}_2 = 0.4\,m$ $\quad + A_2 = 0.72\,m^2$

$3.62\,m^2$

$y_1 A_1 = 3.46\,m^3$

$+ y_2 A_2 = 0.576\,m^3$

$\frac{4.04\,m^3}{A_1 + A_2}$ $1.125\,m = cg$



$\bar{Y}_{1_1} = 1.05\,m$ $\qquad A_{1_1} = 2.16\,m^2$

$\bar{Y}_{2_2} = 0.4\,m$ $\qquad A_{2_2} = 0.72\,m^2$

$$\bar{Y}_{1_1} A_{1_1} = 2.27\,m^3$$
$$\bar{Y}_{2_2} A_{2_2} = +\,0.288\,m^3$$
$$\frac{+\,2.56\,m^3}{A_1 A_{22}}$$
$$C_b = 0.8\,m$$

$$V_d = (0.9 \cdot 2.4 \cdot 5.5) + (0.5 \cdot 0.6 \cdot 2.4 \cdot 5.5)$$
$$V_d\ 15.84\,m^3$$

$$I_z = \frac{bh^3}{12} = \frac{5.5 \cdot 2.4^3}{12}$$
$$I_z = 6.34\,m^4$$

$$MB = I_z / V_d = 6.34\,m^4 / 15.84\,m^3$$
$$MB = 0.40\,m$$

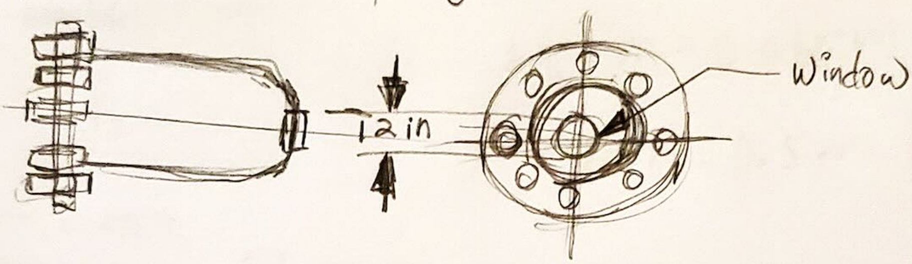
$$M_c = MB + C_b$$
$$= 0.8\,m + 0.4\,m$$
$$= 1.2\,m$$

$$\boxed{\begin{array}{l} \text{Stability} = M_c > cg \\ \quad 1.2\,m > 1.12\,m \\ \text{Staple} \end{array}}$$

(Ch. 4.2)

Given:
Inside diameter of the tank = 30 in
Internal pressure is raised to +14.4 psig

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



$P = +14.4$ psig
$D = 30$ in

$$P = \frac{F}{A}$$

$$A = \frac{\pi D^2}{4}$$

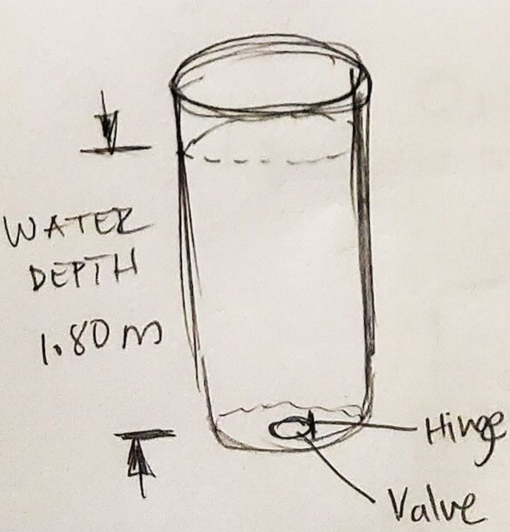
$$F = PA = P\left(\frac{\pi D^2}{4}\right)$$

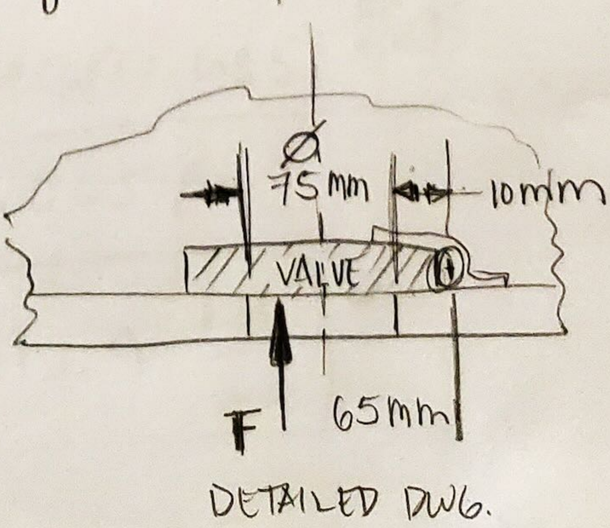
$$= 14.4\left[\frac{lb}{in^2}\right]\left(\frac{\pi\,(30\,in)^2}{4}\right)$$

$$\boxed{F_{TOTAL} = 10178.7602\ lb}$$

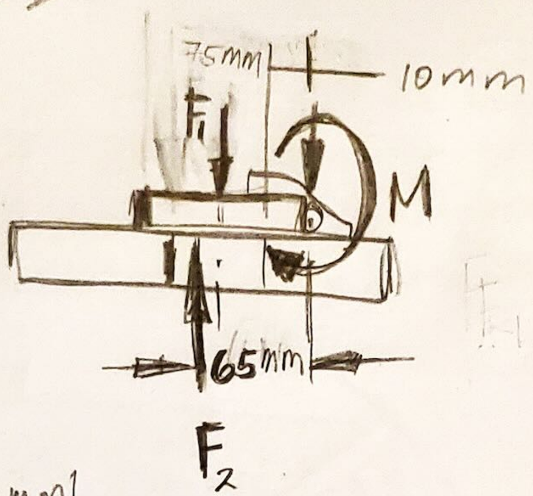
(Ch 4.10) Given: A simple shower for remote locations is designed with a cylindrical tank 500 mm in diameter and 1.800 m high. The water flows through a flapper valve in the bottom through a 75-mm-diameter opening.

Problem: How much force is required to open the valve?





FBD



10 mm = 0.01 m

75 mm = 0.075 m

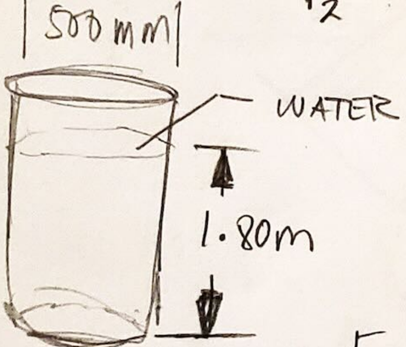
65 mm = 0.065 m

500 mm = 0.5 m

$\gamma_w = 9.81 \frac{kN}{m^3}$

$P = \frac{F}{A}$, $F = PA$

$A = \frac{\pi D^2}{4}$



$$P = \gamma_w (1.80 m)$$

$$= \left(9.81 \left[\frac{kN}{m^3}\right]\right)(1.80 [m])$$

$$F_1 = P = 17.685 \left[\frac{kN}{m^2}\right]$$

$$\overset{+}{\circlearrowleft} M = F_2 (0.065 [m]) - F_1 \left(0.01 [m] + \frac{0.075}{2} [m]\right) = 0$$

$$= 0.065 F_2 - .0475 F_1$$

$$\frac{\cancel{0.065} F_2}{\cancel{0.065}} = \frac{0.0475 F_1}{0.065}$$

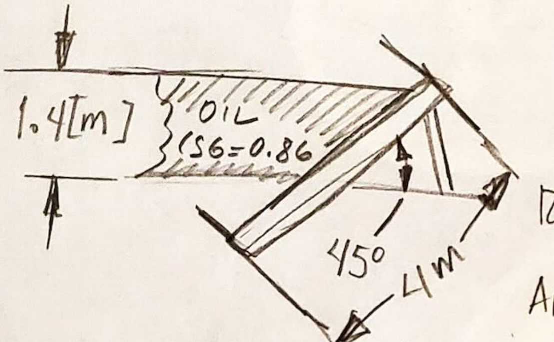
$$F_2 = \frac{0.0475 [m] \left(17.685 \left[\frac{kN}{m^2}\right]\right)}{0.065 [m]} = 12.9 \frac{kN}{m^2}$$

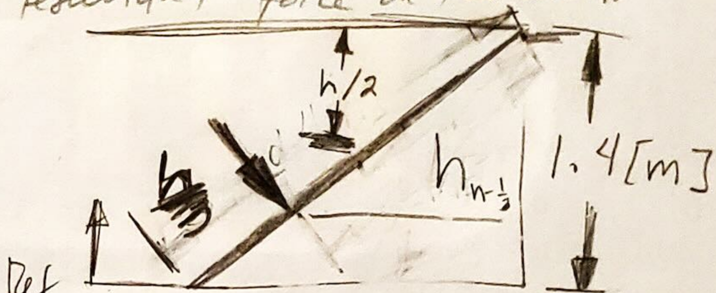
$$\boxed{F_2 = 12.9 \frac{kN}{m^2}}$$

Ch 4.17

GIVEN: Wall = 4 m long

Problem: Calculate the total Force on the wall due to the oil pressure. Also, determine the location of the center of pressure and show the resultant force on the wall.





$$\text{Area} = L\,d = (4m)\left(\frac{1.4[m]}{\sin 45}\right)$$

$$L = \frac{h}{\sin\theta}$$

$$\sin\theta = \frac{h}{L}$$

Step 1: $F_R = \gamma_{oil}\left(\frac{h}{2}\right)A$

$$= \left((0.86)\left(9.81\left[\frac{kN}{\cancel{m^3}}\right]\right)\right)\left(\frac{1.4\cancel{[m]}}{2}\right)\left((4\cancel{[m]})\left(\frac{1.4\cancel{[m]}}{\sin 45}\right)\right) \qquad F_R = \gamma\left(\frac{h}{2}\right)A$$

$$\boxed{F_R = 46.77\ \text{KN}}$$

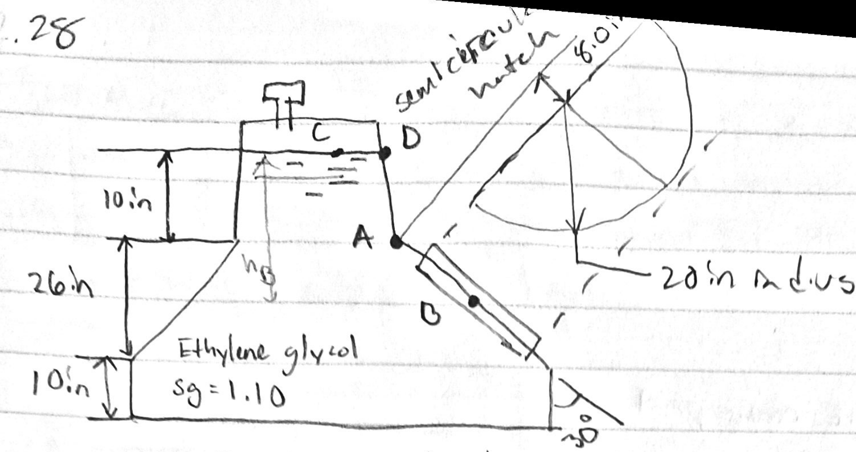
Step 2: * The center of pressure is at a distance of

$$\frac{h}{3} = \frac{1.4}{3} = .466[m]$$

$$h_{h-\frac{h}{3}} = h - \frac{h}{3} = 1.4 - .466 = .934[m]$$

$$\boxed{h_1 = .934[m]}$$

4.28



Tank is symmetrical

Centroid of hatch

$\bar{y} = \frac{4R}{3\pi}$

$= \frac{4(20in)}{3\pi}$

$\bar{y} = 8.5$ in

length from A → B

$AB = 8in + \bar{y}$

$= 8in + 8.5in$

$AD = 16.5$ in

Length A → C

$\cos 30° \doteq AD/AC$

$AC = AD/\cos 30°$

$AC = 10in/\cos 30°$

$AC = 11.55$ in

verticle distance from centroid

$h_B = L_{CB}(\cos 30°)$

$= (AC + AB)(\cos 30°)$

$= (11.55in + 16.5in)(\cos 30°)$

$h_B = (28.05in)(\cos 30°)$

$h_B = 24.29$ in

specific weight of Ethylene glycol

$\gamma_{EG} = sg(\gamma_{H_2O})$

$= 1.10(64.43\ lbf/ft^3)$

$\gamma_{EG} = 70.87\ lbf/ft^3$

Resultant force on hatch

$F_{Hatch} = p(A)$

$= (\gamma h_B)(\frac{\pi}{2}(R^2))$

$= (70.87\ lbf/ft^3)(24.29in(\frac{1ft}{12in}))[(\pi/2)(20in(\frac{1ft}{12in}))^2]$

$= (143.45\ lb/ft^2)(4.36\ ft^2)$

$= 625.44\ lb$

Moment about centroid

$$I = \left(\frac{\pi}{8} - \frac{8}{9\pi}\right)(R^4)$$

$$= (0.1098)(20in^4)$$

$$= 17561.11\ in^4$$

Dist fr surface to pressure center point

$$L_{pr} = L_{CB} + \frac{I}{L_{CB} A}$$

$$= 28.05in + \frac{17561.11in^4}{28.05in\left(\frac{\pi}{2}(20in^2)\right)}$$

$$= 28.05in + \frac{17561.11in^4}{28.05in(628.32in^2)}$$

$$= 28.05in + \frac{17561.11in^4}{17624.38in^3}$$

$$= 28.05in + 0.996in$$

$$\boxed{L_{pr} = 29.046\ in}$$

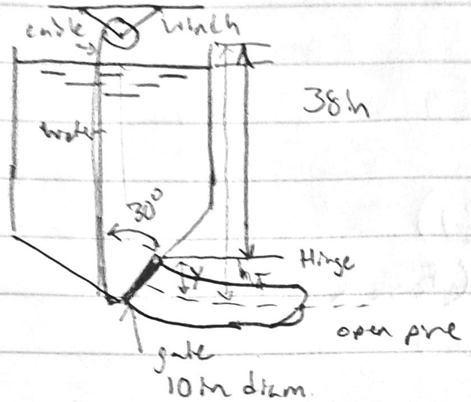
Dist fr $L_{pr} \rightarrow L_{CB}$

$$L_{pr} - L_c = 29.046in - 28.05in$$

$$\boxed{= 0.996\ in}$$

4.42

Figure 4.46 shows a tank of water w/ a circular pipe connected to its bottom. A circular gate seals the pipe opening to prohibit flow. To drain tank, a winch is used to pull gate open. Compute amount of force that which the ~~gate~~ winch cable must exert to open the gate



height of gate fr hinge (centroid)

$y = \frac{D}{2}(\cos\theta)$

$y = \frac{10\text{ in}}{2}(\cos 30°)$

$y = 4.33 \text{ in}$

dist. from centroid to ...

$L = h_T / \cos\theta$

$L = (38 \text{ in} + 4.33 \text{ in}) / \cos 30°$

$L = 42.33 \text{ in} / \cos 30°$

$L = 48.88 \text{ in}$

Area of gate

$A = \frac{\pi}{4}(D^2)$

$= \frac{\pi}{4}(10^2_{in})$

$= 0.785(100 \text{ in}^2)$

$A = 78.54 \text{ in}^2$

Resultant force

$F = \gamma h_T A$

$= 62.43 \text{ lbf/ft}^3 \left(\frac{42.33 \text{ in}}{1}\left(\frac{1 \text{ ft}}{12 \text{ in}}\right)\right)\left(\frac{78.54 \text{ in}^2}{1}\left(\frac{1 \text{ ft}}{12^2 \text{ in}^2}\right)\right)$

$= 62.43 \text{ lbf/ft}^3 (3.53 \text{ ft})(0.545 \text{ ft}^2)$

$= 120.20 \text{ lbf}$

Moment about gate

$I = \frac{\pi}{64}(D^4)$

$= \frac{\pi}{64}(10^4 \text{ in})$

$= 490.87 \text{ in}^4$

Dist from

$$L_A \rightarrow L = I / L(A)$$

$$= \frac{490.87\,in^4}{(48.88\,in)(78.54\,in^2)}$$

$$= \frac{490.87\,in^4}{3839.035\,\cancel{in^3}}$$

$$= 0.13\ in$$

Moment of equilibrium   Force on cable

$$\Sigma M = 0;\quad 0 = F\left(\frac{D}{2} + (L_{pr} - L)\right) - \left(F_{cable}\left(\frac{D}{2}\right)\right)$$

$$0 = 120.2\ lbf\left(\frac{10\,in}{2} + 0.13\,in\right) - \left(F_{cable}\left(\frac{10\,in}{2}\right)\right)$$

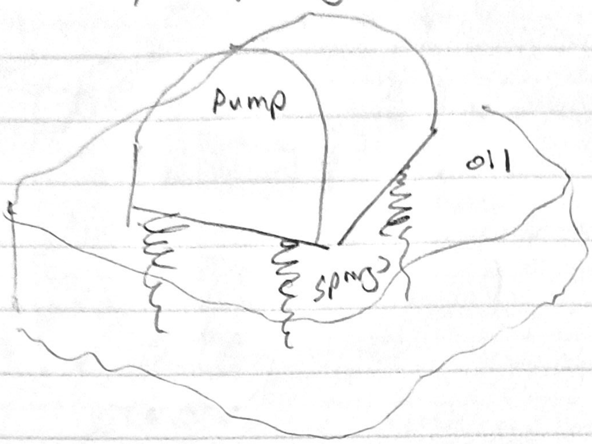
$$0 = 616.63\ lbf/in - 5\,in(F_{cable})$$

$$\frac{5\,in(F_{cable})}{5\,in} = \frac{616.63\ lbf/\cancel{in}}{5\,\cancel{in}}$$

$$\boxed{F_{cable} = 123.33\ lbf}$$

5.8

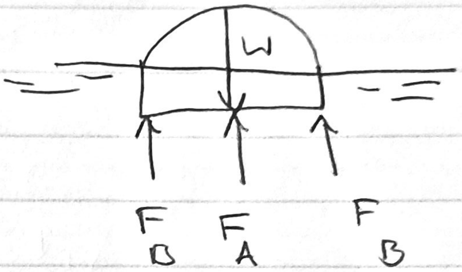
Figure 5.19 shows a pump partially submerged in oil (sg = 0.90) and supported by springs. If total weight of pump is 14.6 lb and the submerged volume is 40 in³, calculate the supporting forces exerted by springs



sg = 0.90

W = 14.6 lb

V = 40 in³



Buoyant force

$$F_A = \gamma_{oil}(V)$$

$$= 0.9(62.43\ \text{lbf/ft}^3)(40\ \text{in}^3)\left(\frac{5.8(10^{-4})\ \text{ft}^3}{1\ \text{in}^3}\right)$$

$$F_A = 56.19\ \text{lbf/ft}^3\ (0.0232\ \text{ft}^3)$$

$$F_A = 1.304\ \text{lb}$$

Equilibrium

$$\Sigma F = 0\ ;\ 0 = F_A - W + F_B$$

$$0 = 1.304\ \text{lb} - 14.6\ \text{lb} + F_B$$

$$F_B = 13.296\ \text{lb}$$

$$\boxed{F_B = 13.3\ \text{lb}}$$

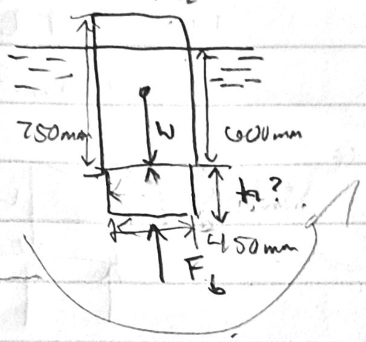
5.24

Brass weight attached to bottom of cylinder, cylinder completely submerged & neutrally buoyant in H_2O @ ~~95°C~~ 95°C. Brass to be cylinder w/ same diameter as original cylinder. What is req'd thickness of brass?

Diameter (D) = 450 mm = 0.45 m   Temp (T) = 95°C γ_{brass} = 85.8 kN/m³ fr google

Height (H) = 750 mm = 0.75 m $\gamma_{H_2O} = 9.6$ kN/m³ @ 95°C fr google chart

specific weight of cyl.



$W = \gamma_{cyl}(V)$

$V_{cyl} = \frac{\pi}{4}(D^2)(H)$

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

$= 0.12\ m^3$

$V_{depth} = \frac{\pi}{4}(0.45^2\,m)(0.6\,m)$

$V_{depth} = 0.159\,m^2(0.6\,m)$

$V_d = 0.0954\ m^3$

$\gamma_{cyl} = \dfrac{\gamma_{H_2O} V_d}{V_{cyl}}$

$\gamma_{cyl} = \dfrac{9.6\,kN/m^3\,(0.0954\,m^3)}{0.12\,m^3}$

$\gamma_{cyl} = 7.63\ kN/m^3$

$V_{brass} = \frac{\pi}{4}(0.45^2\,m)(H\,m)$

$= 0.159 H\ m^3$

$V = V_{cyl} + V_{brass}$

$V = 0.12\,m^3 + 0.159 H\,m^3$

$\Sigma F = 0;\ 0 = F_b - W_{cyl} - W_{brass}$

$F_b = W_{cyl} + W_{brass}$

$\gamma_{H_2O} V = \gamma_{cyl} V_{cyl} + \gamma_{brass} V_{brass}$

$9.6\,kN/m^3(0.12\,m^3 + 0.159(H)\,m^3) = 7.63\,kN/m^3(0.12\,m^3) + (85.8\,kN/m^3)\,0.16 H\ m^3$

$1.152\,kN + 1.526 H = 0.916 + 13.73 H$

$0.236 = 12.204 H$

$H = 0.02\ m = \boxed{20\ mm}$