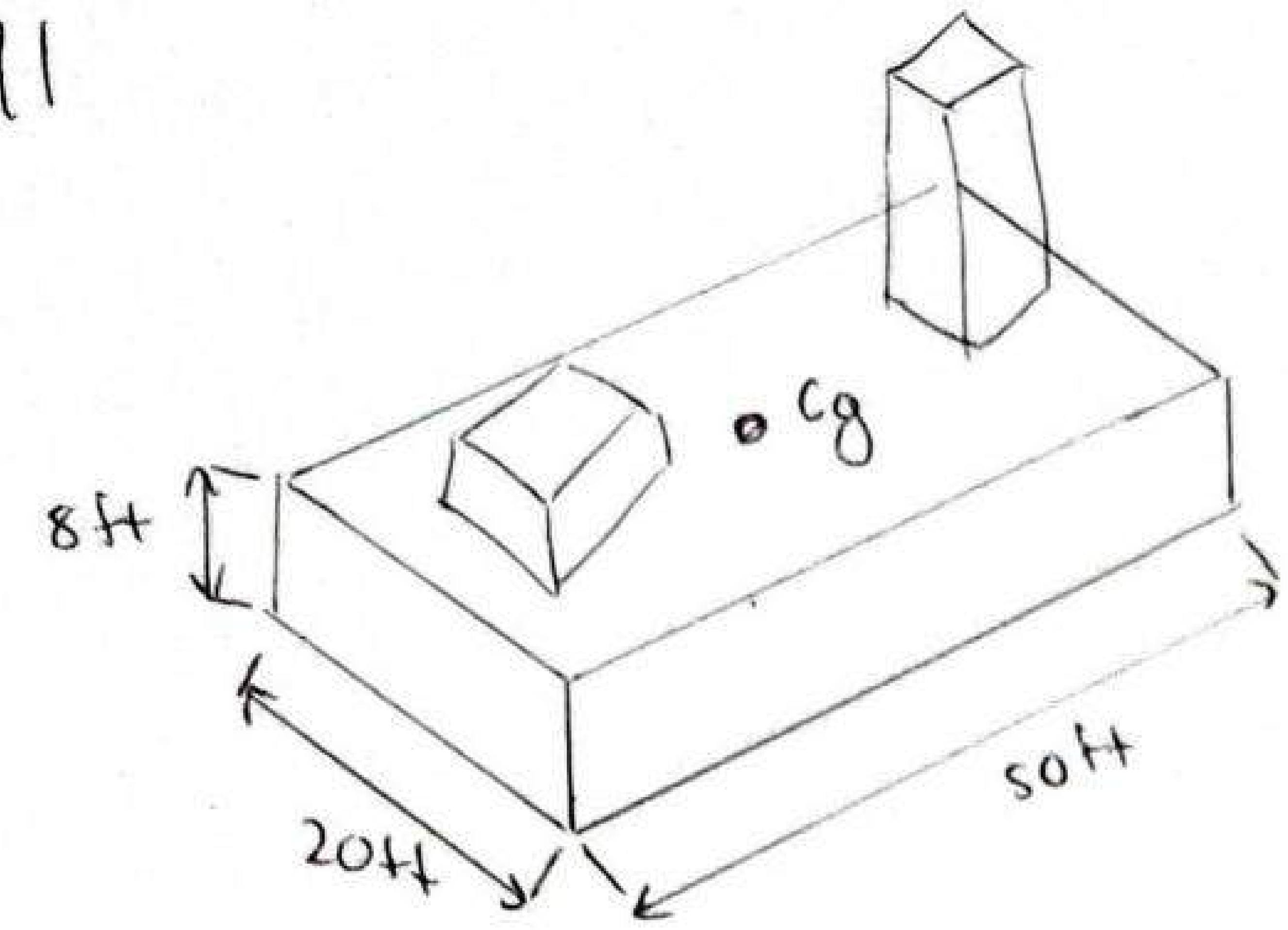
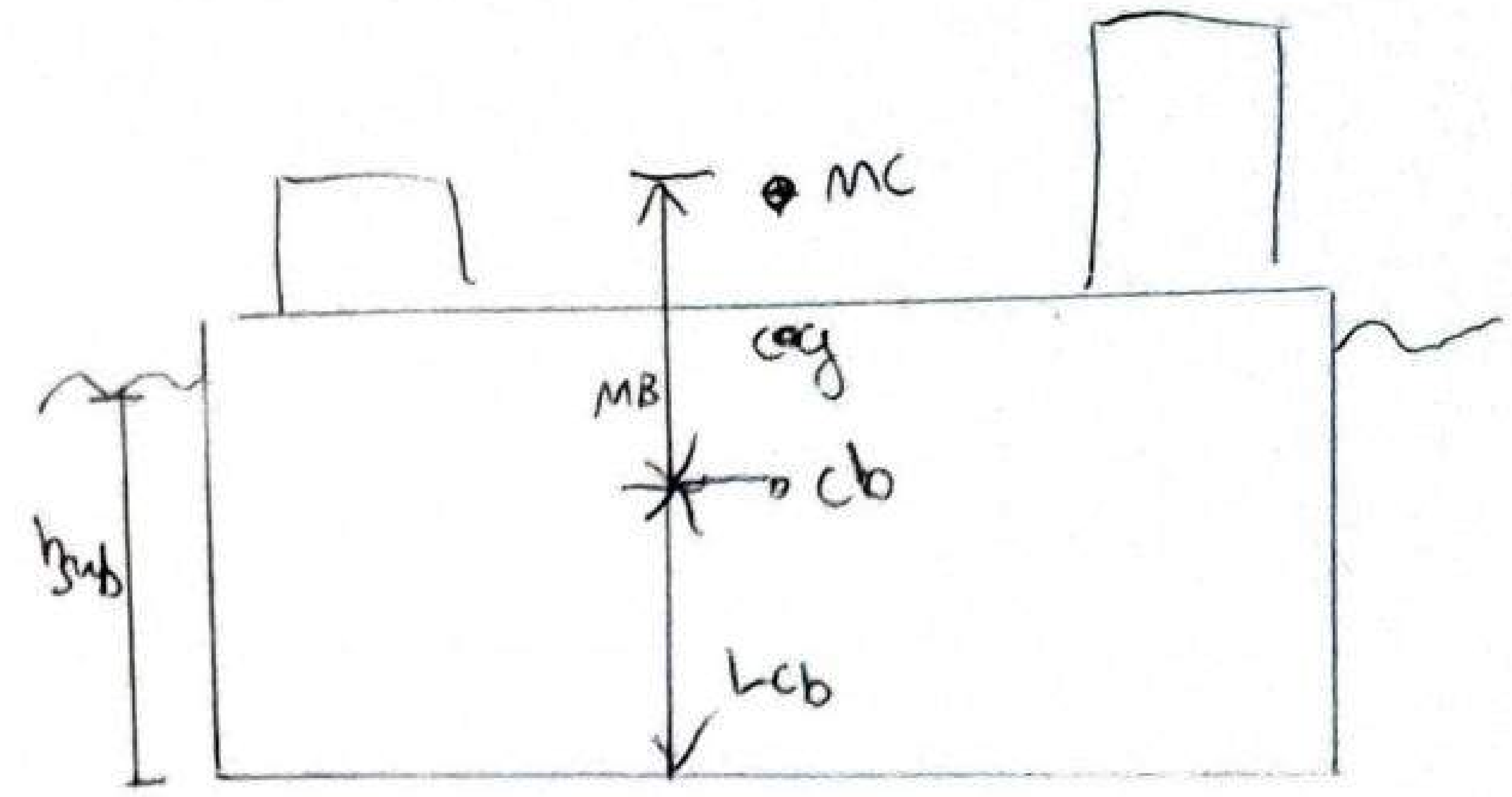
41





- $H_{platform} = 8\,ft$, $Width_{plat} = 20ft$, $L_{plat} = 50ft$, $L_{cg} = 8ft$, $\gamma_{sw} = 64 \frac{lb}{ft^3}$
- Floating $\therefore F_b = W$

$$F_b = \gamma_f \cdot V_d$$

$$V_d = L \cdot B \cdot h_{sub} = 50\,ft \cdot 20ft \cdot h_{sub}$$

$$V_d = 1000\,(h_{sub})\,ft^3$$

$$F_b = \gamma_f \cdot V_d = 64 \frac{lb}{ft^3} \cdot 1000 ft^3 = 64{,}000 (h_{sub})\, lb$$

$$W = 450{,}000 lb \; \therefore \; 450{,}000 lb = 64{,}000 (h_{sub})\, lb$$

$$\hookrightarrow h_{sub} = 7.03125\,ft$$

$$L_{cb} = \frac{h_{sub}}{2} = 3.515625\,ft$$

$$F_b = 64{,}000 \cdot (7.03125) = 45{,}000 lb$$

$$M_B = \frac{I}{V_d}, \quad I = \frac{L \cdot B^3}{12} = \frac{50(20)^3}{12} = 33333.\overline{33}\,ft^4$$

$$V_d = 1000\,ft^2\,(7.03125ft)$$

$$V_d = 7031.25\,ft^3$$

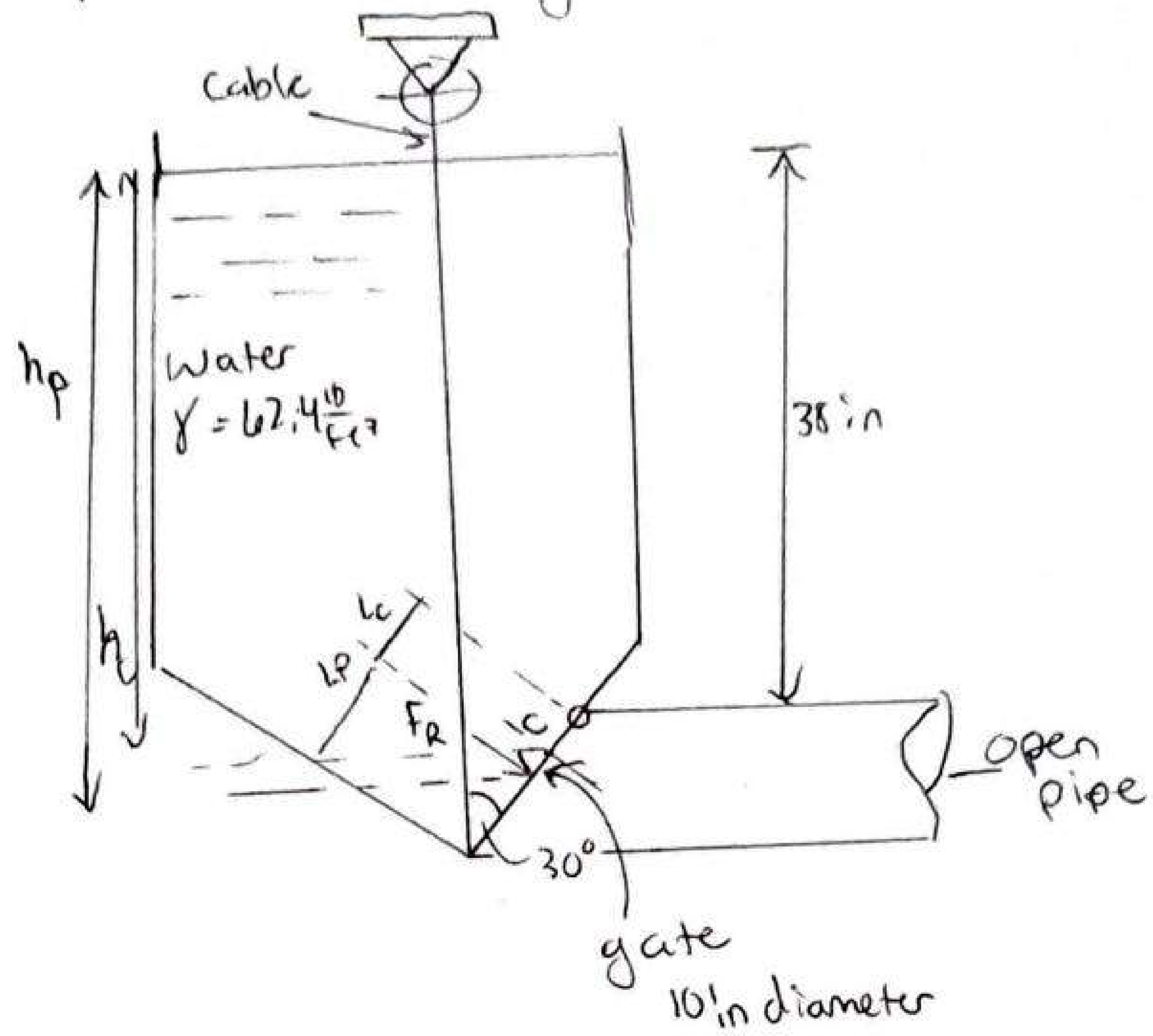
$$M_B = \frac{33333.\overline{33}\,ft^4}{7031.25\,ft^3} \therefore M_B = 4.740740741\,ft$$

$$L_{MC} = L_{CB} + MB = 3.515625 + 4.740 = 8.2563657$$

Purpose: CH.4 # 42

Compute the force that the wench cable must exert to open the gate.

Drawing:



Data: $\gamma_w = 62.4 \frac{lb}{ft^3}$

Calculations:

$$\Delta y = \bar{y} \cdot \cos(30) = 5\,in \cdot \frac{\sqrt{3}}{2} = 4.330127019\,in$$

$$A = \frac{\pi D^2}{4} = 78.53981634\,in^2$$

$$h_c = 38\,in + \Delta y = 42.33012702\,in$$

$$F_R = \gamma \cdot h_c \cdot A = 62.4 \frac{lb}{ft^3} \cdot \frac{42.33012702\,in}{} \Big| \frac{1\,ft}{12\,in} \cdot \frac{78.53981634\,in^2}{} \Big| \frac{1\,ft^2}{144\,in^2}$$

$$F_R = 120.0550145\,lb$$

$$I_c = \frac{\pi D^4}{64} = \frac{\pi \cdot 10^4}{64} = 490.8738521\,in^4$$

$$L_c = \frac{h_c}{\cos\theta} = \frac{42.33012702\,in}{\cos\theta} = 48.87862046\,in$$

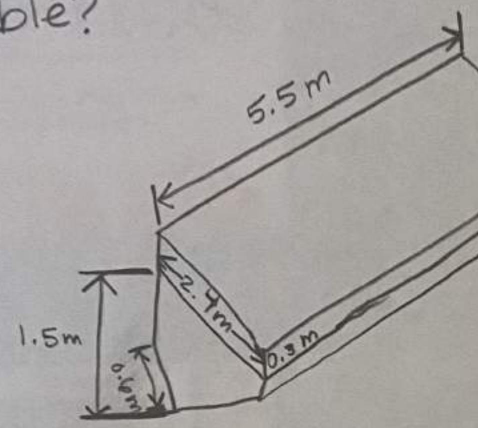
$$L_p = L_c + \frac{I_c}{L_c A} \therefore L_p - L_c = \frac{I_c}{L_c A} = \frac{490.8738521\,in^4}{48.87862046\,in \cdot 78.53981\,in^2} = 0.1278677766\,in$$

$$\circlearrowleft + \sum M_{Hinge} = F_R \cdot (r + 0.1278677766\,in) = F_{cable} \cdot (10)$$

$$\Rightarrow F_{cable} = \frac{F_R \cdot (5 + 0.1278677766\,in)}{10} = \boxed{61.5626\,lb}$$

Tai Booker
HW 2.1
Chapter 5

61. A boat is shown in the figure. Its geometry at the water line is the same as the top surface. The hull is solid. Is the boat stable?



$h = 1.8$ m
width $= 2.4$ m
(B) $l = 5.5$ m
displaced $h = 1.5$ m

$$A_{total} = (1.2\times 2.4) + (\tfrac{1}{2}\times 2.4\times 0.6) = 3.6\ m^2$$

$$A_{submerged} = (0.9\times 2.4) + (\tfrac{1}{2}\times 2.4\times 0.6) = 2.88\ m^2$$

$$Y_{cg} = \frac{A_1 Y_1 + A_2 Y_2}{A_{total}} = \frac{(\frac{1}{2}\times 2.4\times 0.6)\times \frac{2h}{3} + (1.2\times 2.4)\times(0.6\times \frac{1.2}{2})}{3.6}$$

$$Y_{cg} = \frac{(\frac{1}{2}\times 2.4\times 0.6)\times(\frac{2\times 0.6}{3}) + (1.2\times 2.4)\times 1.2}{3.6} = 1.04\ m$$

$$Y_{cb} = \frac{A_1 Y_1 + A_2 Y_2}{A_{submerged}} = \frac{(\frac{1}{2}\times 2.4\times 0.6)\times \frac{2h}{3} + (0.9\times 2.4)\times(0.6\times \frac{0.9}{2})}{2.88}$$

$$Y_{cb} = \frac{(\frac{1}{2}\times 2.4\times 0.6)\times(\frac{2\times 0.6}{3}) + (0.9\times 2.4)\times 1.05}{2.88} = 0.8875\ m$$

$$V_d = A_{submerged}\times B = 2.88\times 5.5 = 15.84\ m^3$$

$$I = \frac{Bh^3}{12} = \frac{5.5\times 2.4^3}{12} = 6.336\ m^4$$

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

$1.2875 > 1.04$

$Y_{mc} > Y_{cg}$

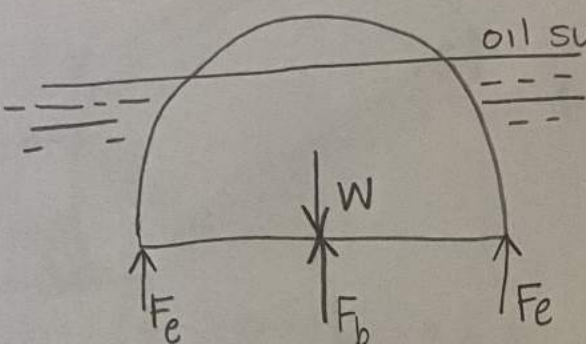
$$Y_{mc} = Y_{cb} + MB = 0.8875\ m + 0.4\ m$$

$$Y_{mc} = 1.2875\ m$$

$\boxed{\therefore \text{the boat is stable when placed in the water}}$

Tai Booker
HW 2.1
Chapter 5

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



$sg = 0.90$
$W = 14.6 \text{ lb}$
$V_d = 40 \text{ in}^3$

$1 \text{ in}^3 = 0.00058 \text{ ft}^3$

$\therefore V_d = 40 \text{ in}^3 \times \frac{0.00058 \text{ ft}^3}{1 \text{ in}^3}$

$V_d = 0.0232 \text{ ft}^3$

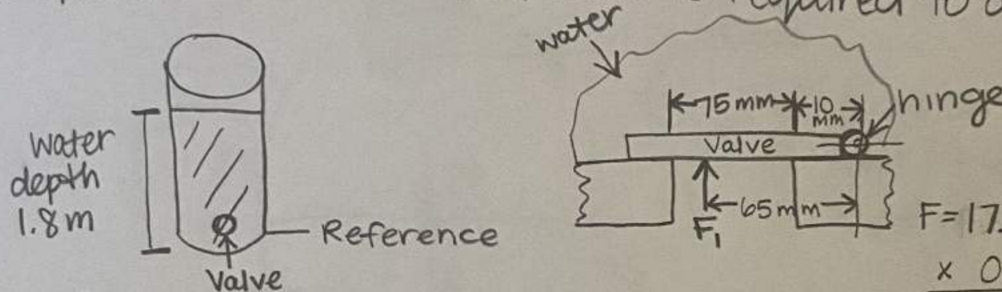
$\gamma_f = 0.90 \times 62.4 \text{ lb/ft}^3$
$\gamma_f = 56.16 \text{ lb/ft}^3$

$F_b = \gamma_f \times V_d$
$F_b = (56.16)(0.0232)$
$F_b = 1.3029 \text{ lb}$

$\sum F_v = 0$
$F_b - W + F_e = 0$
$F_e = W - F_b$
$F_e = 14.6 - 1.3029$
$\boxed{F_e = 13.297 \text{ lb}}$

Tau Booker
HW 2.1
Chapter 4

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



$F = pA$
$F = 17.658\ kN/m^2 \times 0.0071\ m^2$
$F = 0.125\ kN$ @ Point 1

diameter of tank = 500 mm or 0.5 m
$h = 1.8\ m$
diameter of opening = 75 mm
diameter of valve = 10 mm + 75 mm + 10 mm = 95 mm or 0.095 m

Area of valve $\Rightarrow A = \frac{\pi d^2}{4} = \frac{\pi (0.095)^2}{4} = 0.0071\ m^2$

$P = \gamma_{H_2O} \times h = 9.81\ kN/m^3 \times 1.8\ m = 17.658\ kN/m^2$ @ Point 1

$\Sigma M_{hinge} = 0$

$F\left(\frac{d_{valve}}{2}\right) - F_1$ (distance from hinge to F_1) $= 0$

$125N\left(\frac{0.095\ m}{2}\right) - F_1(0.065\ m) = 0$

$F_1(0.065\ m) = 5.94\ N/m$

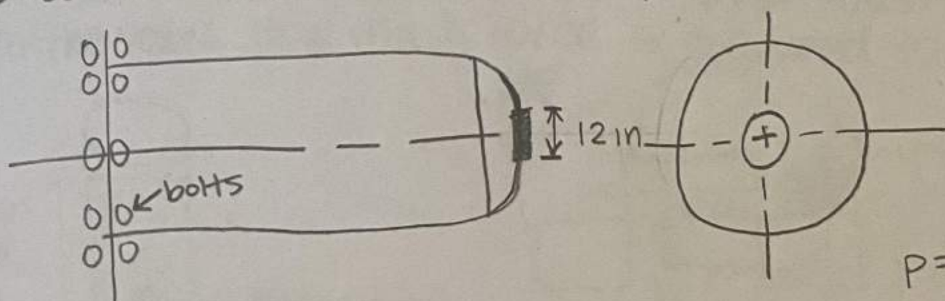
$\boxed{F_1 = 91.35\ N}$

Tai Booker 2 & 10 Chapter 5 (8 & 61)

HW 2.1

Chapter 4

2. The flat left end of the tank shown in the figure is secured with a bolted flange. If the inside diameter of the tank is 30 in & the internal pressure is raised to +14.4 psig, calculate the total force that must be resisted by the bolts in the flange.



$d = 30 \text{ in}$

$p = 14.4 \text{ psig}$

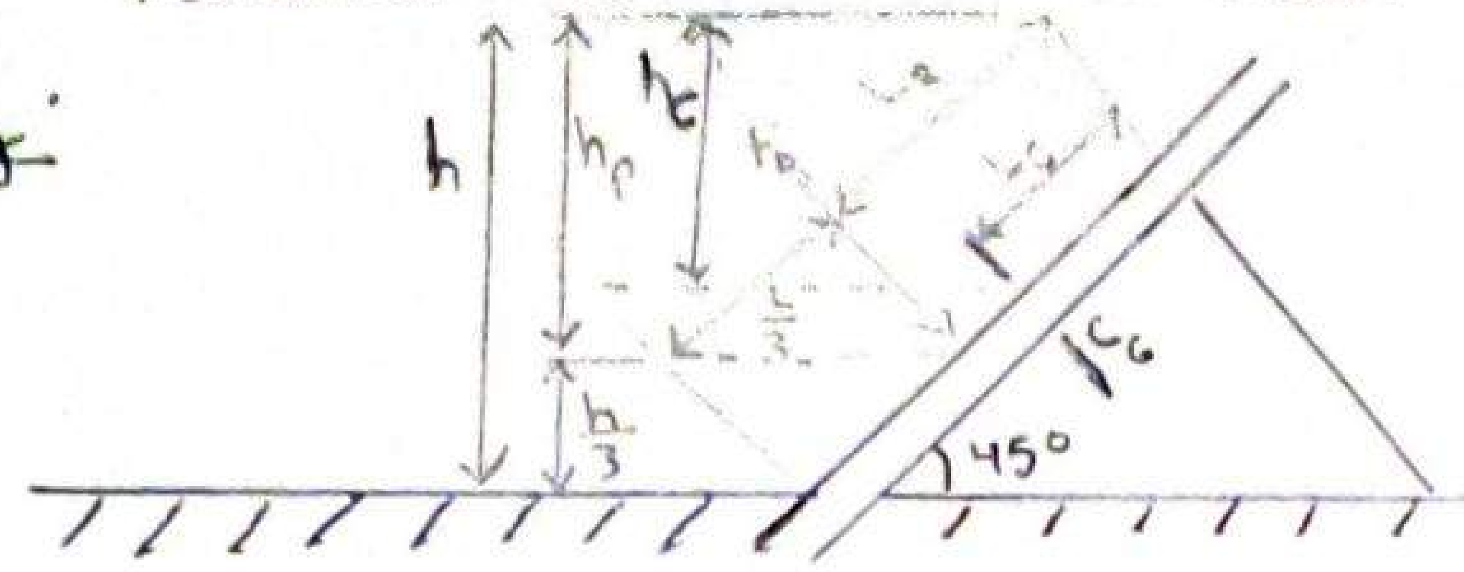
$p = \frac{F}{A} \quad F = pA$

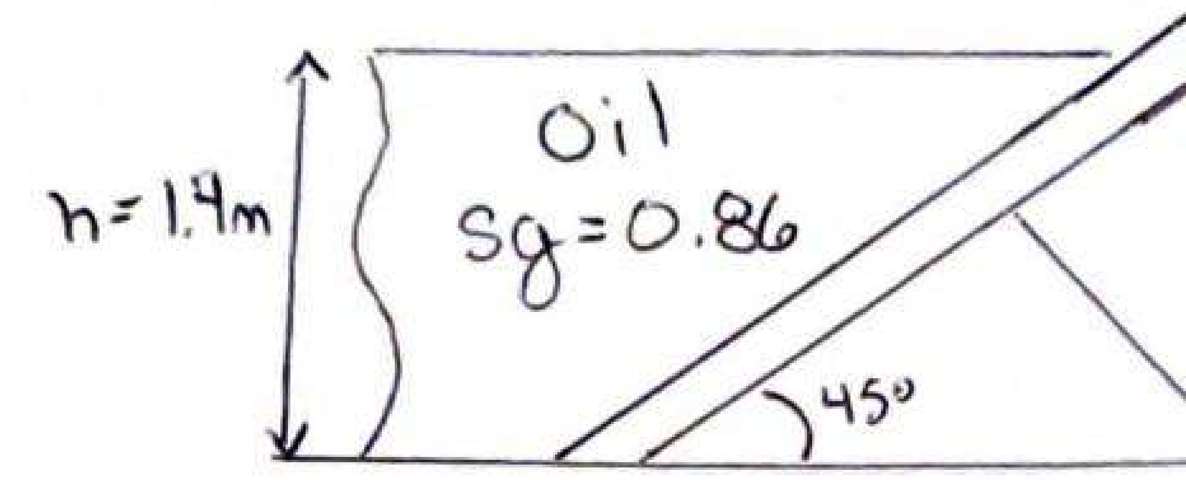
$$A = \frac{\pi d^2}{4} = \frac{\pi (30)^2}{4} \Longrightarrow A = 706.858 \text{ in}^2$$

$$F = pA = (14.4)(706.858) \Longrightarrow \boxed{F = 10{,}178.755 \text{ lb}}$$

17. __Purpose:__ Calculate the total force on the wall. Also determine the location of the center of pressure & show the resultant force on the wall.

__Drawing:__





__Data & Variables:__ $\cdot\, sg = 0.86 \therefore \gamma_o = sg \cdot \gamma_w = 0.86 \cdot 9.81 \frac{KN}{m^3} = 8.4366 \frac{KN}{m^3}$

$\cdot\, h = 1.4m \quad \cdot\, \theta = 45° \quad \cdot\, L_w = 4m$

$h_c = \frac{h}{2} = 0.7m$

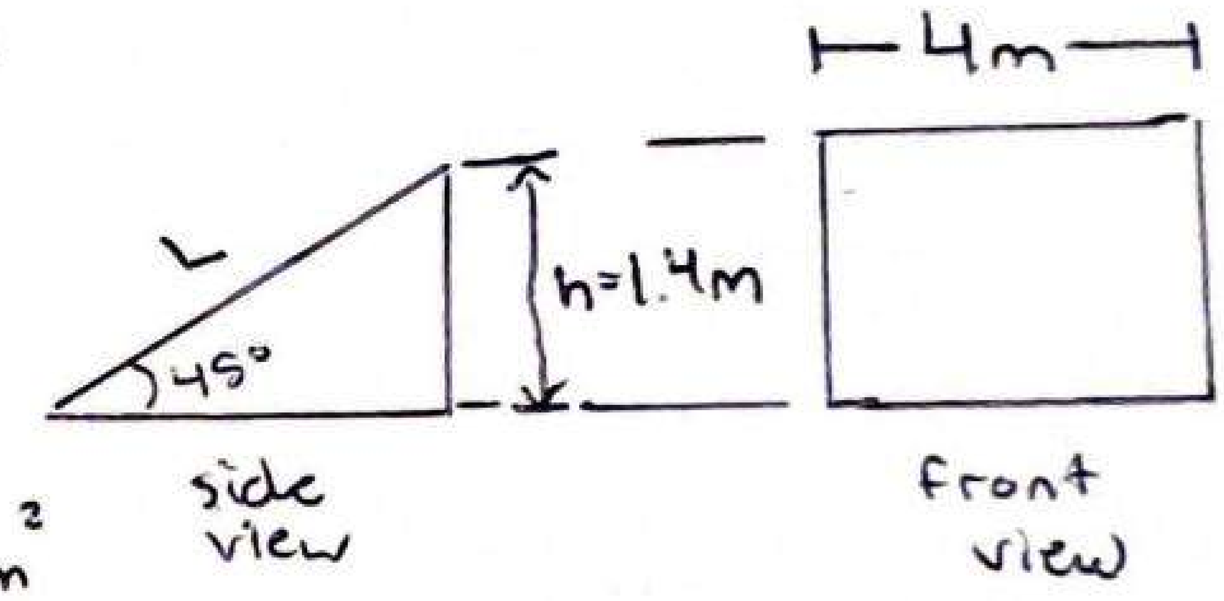
__Procedure__

- Force due to pressure: $F_R = \gamma_o \cdot h_c \cdot A$
  - Find the area: $L = \frac{h}{\sin\theta}$

    $L = \frac{1.4m}{\sin 45°}$

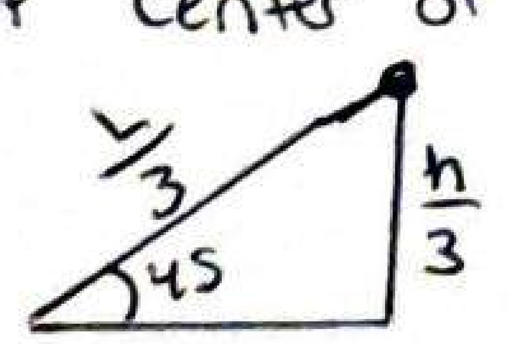
    $L = 1.979\overline{8}\ m$

    $A = L \cdot h = 7.91959\,m^2$



$F_R = 8.4366 \frac{KN}{m^3} \cdot 0.7m \cdot 7.91959\,m^2 = \boxed{46.77\ kN}$

- Find location of center of pressure: $h_p = h - \frac{h}{3} = 1.4m - \frac{1.4m}{3} = \boxed{0.9\overline{3}\,m}$



$\frac{L}{3} = \frac{1.979\overline{8}\,m}{3} = 0.659964329\,m$

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

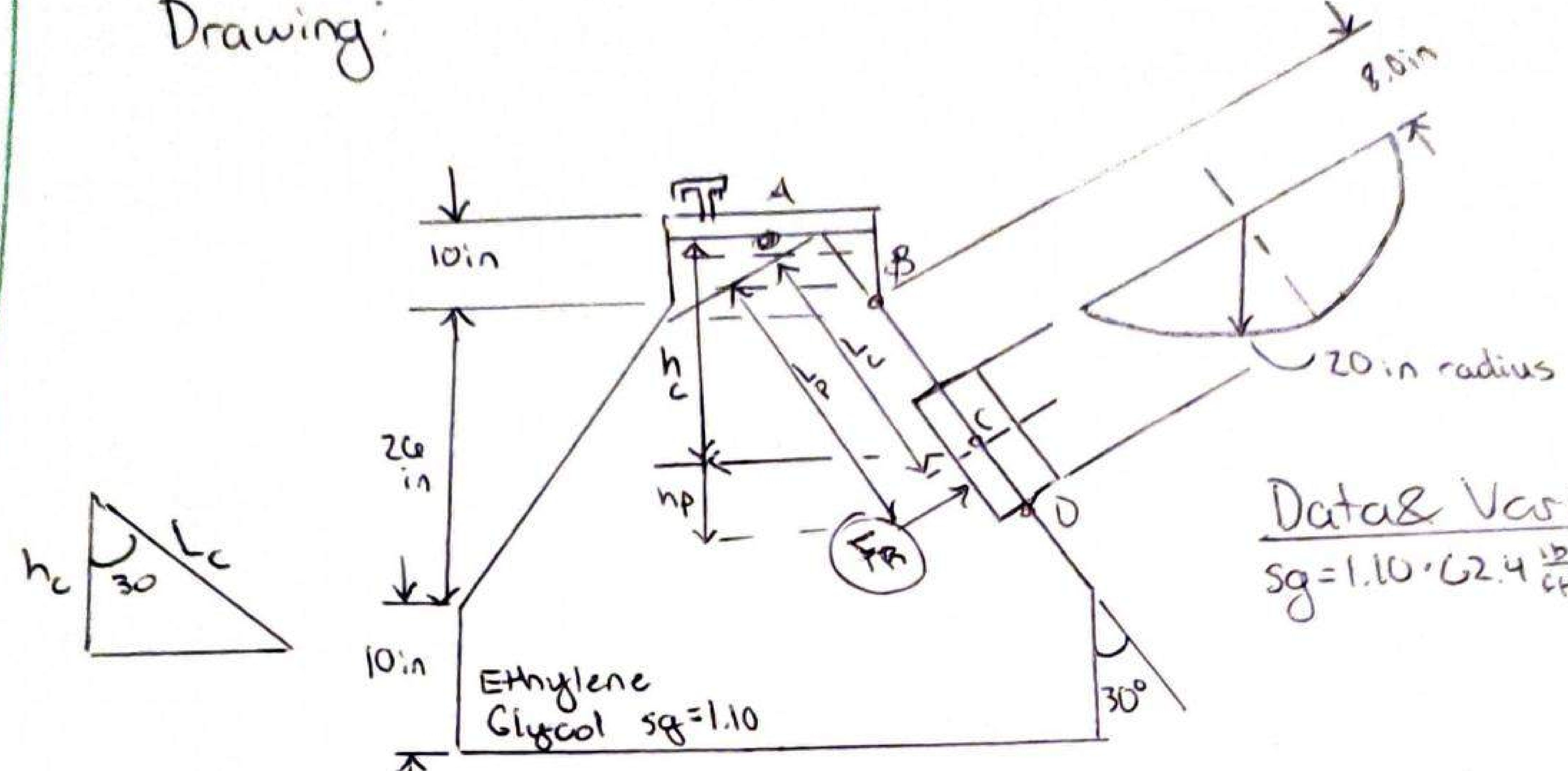
$= 1.979\overline{8}m - 0.65996m$

$= \boxed{1.32m}$

$\boxed{F_R = 46.8KN @ \text{ Location: } h_p = 0.93\,m \quad L_p = 1.32\,m}$

28. Purpose: Compute the magnitude of F_R on the area & the location of the center of pressure.

Drawing:



Data & Variables

$sg = 1.10 \cdot 62.4 \frac{lb}{ft^3} = 68.64 \frac{lb}{ft^3} = \gamma_{EG}$

$\bar{y} = 0.212 \cdot D = 0.212 \cdot 40 = 8.48 in$

$h_c = L_c \cdot \cos 30 = 28.027 in \cdot \cos 30 = 24.2721 in$

$A = \frac{\pi \cdot d^2}{8} \cdot \left(\frac{1 ft}{12 in}\right)^2 = 4.363 ft^2$

$L_c = L_{AB} + L_{BC} = 11.547 in + 16.48 in$

$\cos 30 = \frac{10 in}{L_{AB}} \therefore L_{AB} = \frac{10 \cdot 2}{\sqrt{3}} = 11.547 in$

$L_{BC} = 8 in + \bar{y} = 16.48 in$

$L_c = 28.027 in$

$F_A = \gamma_{EG} \cdot h_c \cdot A$

$F_R = 68.64 \frac{lb}{ft^3} \cdot \frac{24.272 in}{12 in} ft \cdot 4.363 ft^2$

$\boxed{F_R = 605.74 lb}$

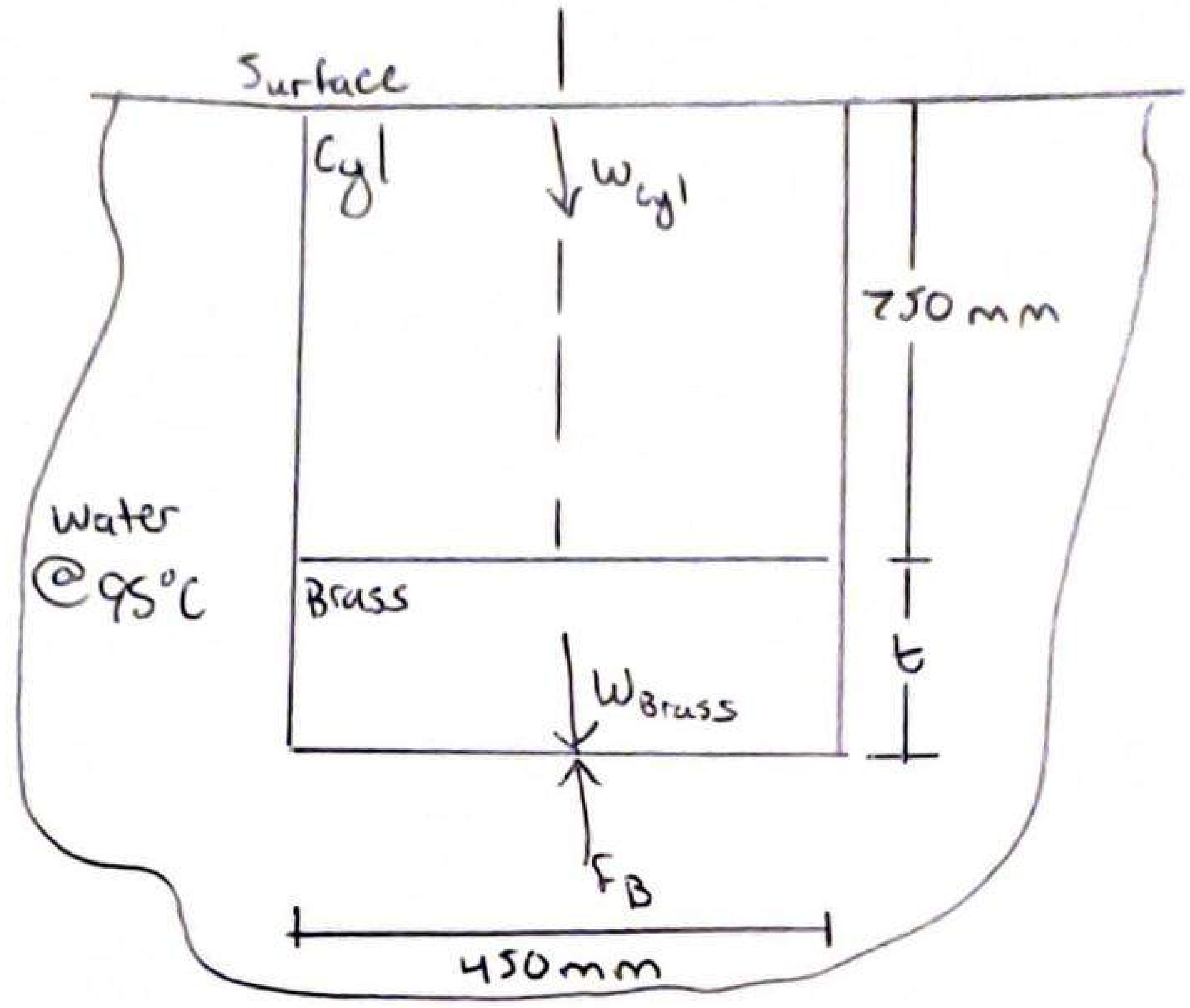
$I_c = 6.68 \times 10^{-3}(D^4) = 17561.6 in^4$

$L_p = L_c + \frac{I_c}{L_c \cdot A} = 28.027 in + \frac{17561.6 in^4}{28.027 in \cdot 4.363 ft^2} \cdot \frac{ft^2}{144 in^2} = \boxed{29.02 in}$

$\boxed{F_R = 605.74 lb @ L_p = 29.02 in}$

24 Purpose: Find the thickness of the brass

Drawing:



Data & Variables: $\gamma_w @ 95°C = 9.44 \frac{kN}{m^3}$ (From append A); $\gamma_{cyl} = 6.45 \frac{kN}{m^3}$ (From #22), $\gamma_{brass} = 84.0 \frac{kN}{m^3}$

Calculations:

Completely submerged $\Rightarrow F_B = W_{cyl} + W_{brass}$

$F_B = \gamma_f \cdot V_d$, $W_{brass} = \gamma_{brass} \cdot V_{brass}$, $W_{cyl} = \gamma_{cyl} \cdot V_{cyl}$

$V_{cyl} = \frac{\pi D^2 H}{4} = \frac{\pi(.45)^2 \cdot .75}{4} = 0.119282346\, m^3$ $\quad V_{brass} = \frac{\pi D^2 H}{4} = \frac{\pi(.45)^2 \cdot t}{4}$

$V_d = V_{cyl} + V_{brass} = (0.119... + 0.159(t)) \cdot m^3$ $\quad V_{brass} = 0.159(t) m^3$

$F_B = W_{cyl} + W_{brass} \therefore \gamma_f \cdot V_d = \gamma_{cyl} \cdot V_{cyl} + \gamma_{brass} \cdot V_{brass}$

$9.44(.119282346 + 0.159(t)) = 6.45(.11928...) + (84)(.159(t))$

$1.065053 + 1.50096(t) = 0.7693 + 13.356(t)$

$11.85504\, t = 0.2957$

$\boxed{t = 0.03 m = 30 mm}$

While reviewing the solved example problems in the lecture notes, I learned many things. When determining the resultant force acting on a surface, the magnitude of the force is dependent on the height of the static fluid applying the force & the geometry of the surface.

I also learned that a force applied to a curved surface can be seperated into vertical & horizontal components. The resultant force can then be calculated using the pythagorean theorm.

When solving questions related to bouyancy it is important to note whether or not the object is floating, sinking, rising or submerged and stable. If the object is floating the bouyant force is equal to the weight of the object. In regard to floating objects, the metacenter of the object is always below the center of gravity.