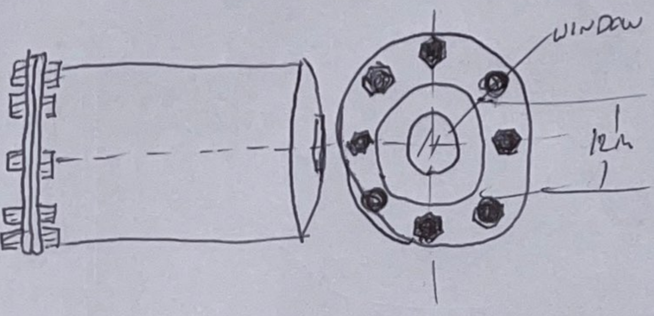
4.2) THE FLAT LEFT END OF THE TANK SHOWN IN THE FIGURE IS SECURED WITH A BOLTED FLANGE. IF THE INSIDE DIAMETER OF THE TANK IS 30 in AND THE INTERNAL PRESSURE IS RAISED TO +14.4 psig, FIND THE TOTAL FORCE THAT MUST BE RESISTED BY THE BOLTS ON THE FLANGE



GIVEN:

$$D = 30\,in = \frac{1\,FT}{12\,in} = 2.5\,ft$$

$$P = 14.4\,psig = \frac{144\,in^2}{1\,FT^2} = 2073.6\,psf$$

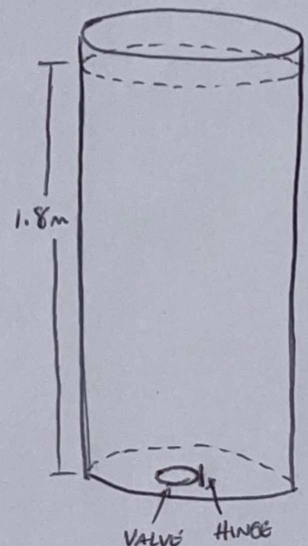
$$A = \frac{\pi}{4} D^2$$

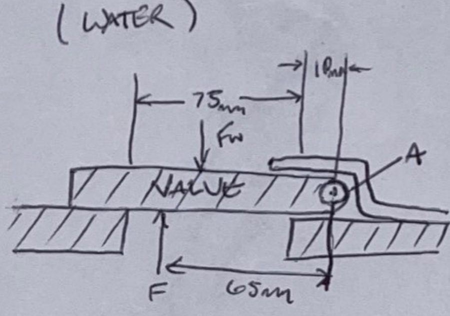
SOLUTION: $P = \frac{F}{A} \rightarrow F = P \cdot A \rightarrow F = \left(14.4 \frac{lb}{\cancel{in^2}}\right) / \frac{\pi}{4}(30 \cancel{in})^2$

$$F = 10178.8\,lb$$

TOTAL FORCE THAT MUST BE RESISTED BY BOLTS, $\underline{\underline{F = 10178.8\,lb}}$

4.10) A SHOWER FOR REMOTE LOCATIONS IS DESIGNED WITH A CYLINDRICAL TANK 500 mm IN DIAMETER AND 1.800 m HIGH AS SHOWN IN THE FIGURE. THE WATER FLOWS THROUGH A 75-mm DIAMETER OPENING. THE FLAPPER MUST BE PUSHED ~~DOWN~~ UPWARD TO OPEN THE VALVE. HOW MUCH FORCE IS REQUIRED TO OPEN THE VALVE?





GIVEN: $D_c = 500mm = 0.5m$

$h = 1.8m$

$D_V = 75mm = 0.075m$

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

$F = P A$

$P = \gamma_w h$

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

SOLUTION: $F = P \cdot A \rightarrow P = \gamma_w h = \left(9.81 \frac{kN}{m^3}\right)(1.8m) = 17.658 \frac{kN}{m^2}$

$A = \frac{\pi}{4} D^2 = \frac{\pi}{4}(0.075m)^2 = 0.004418 \, m^2$

$\rightarrow F = \left(17.658 \frac{kN}{m^2}\right)(0.004418 \, m^2)$

$F = 0.078 \, kN$

SINCE IT ROTATES CLOCKWISE, MUST SUM FORCES AND TAKE MOMENT FOR A.

$\Sigma M_A = 0 = +F(0.065m) - F_W\left(\frac{0.075m}{2}\right)$

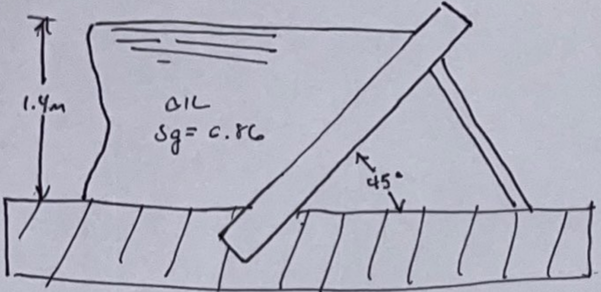
$0 = \cancel{0.078 kN(0.065m) - F_W(0.0375m)}$

$= 0.078 kN(0.065m) - F_W(0.0375m + 0.010m)$

$\underline{F_W = 0.1067 \, kN}$

IT WILL TAKE 0.1067 kN OF FORCE TO OVERCOME WATER TO OPEN VALVE

4.17) IF THE WALL IN THE FIGURE IS 4m LONG, 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



GIVEN: $H = 4m$ $\quad h = 1.4m$

$Sg = 0.86$ $\quad \theta = 45°$

$F_R = \gamma_{oil}(h/2)A$

SOLUTION:

$$F_R = \gamma_{oil}(h/2)A \rightarrow \gamma_{oil} = (0.86)(9.81\,\tfrac{KN}{m^3}) = 8.4366\,\tfrac{KN}{m^3}$$

$$\sin\theta = h/L \rightarrow L = h/\sin\theta$$

$$= 1.4m/\sin 45°$$

$$L = 1.9799\,m$$

$$A = L \cdot H = (1.9799m)(4m) = 7.9196\,m^2$$

$$F_R = (8.4366\,\tfrac{KN}{m^3})(\tfrac{1.4m}{2})(7.9196\,m^2)$$

$$\underline{F_R = 46.7701\,KN}$$

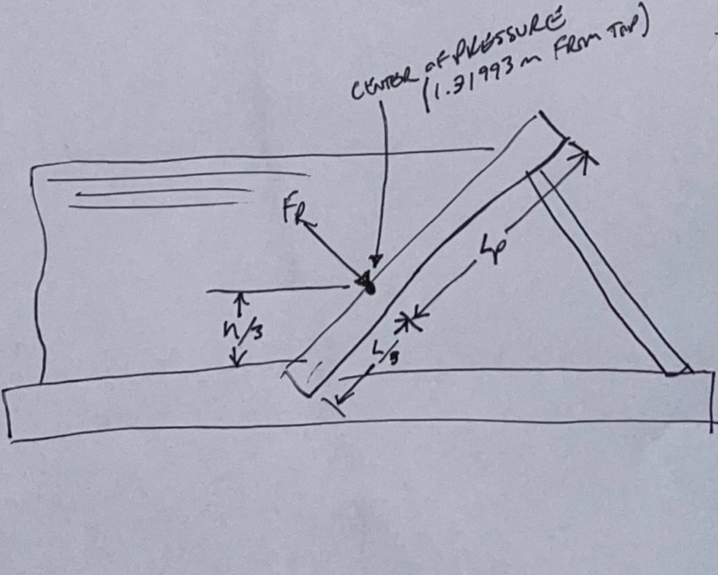
(VERTICAL CENTER OF PRESSURE) $= h/3 = 1.4m/3 = 0.4667\,m$

(FROM BOTTOM OF DAM) $= L/3 = 1.9799m/3 = 0.65997\,m$

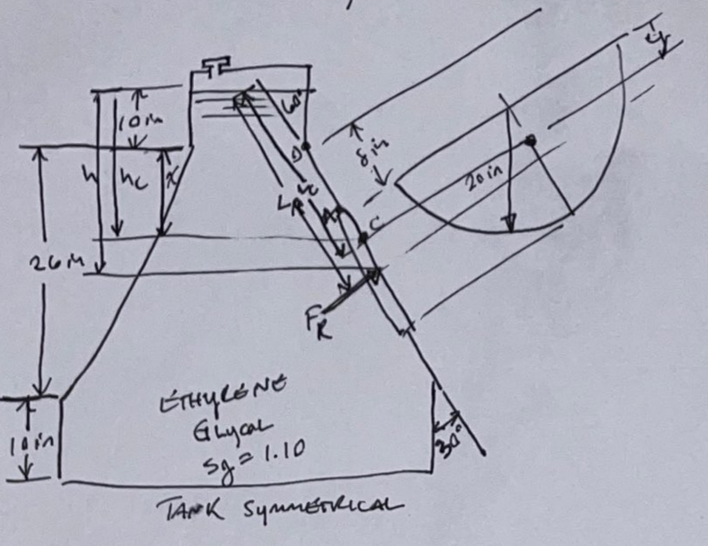
L_p = DISTANCE FROM FREE SURFACE OF FLUID TO CENTER OF P.

$$L_p = L - \frac{L}{3} \rightarrow 1.9799m - \frac{1.9799m}{3} = 1.31993\,m$$

$$\underline{L_p = 1.31993\,m}$$



4.28) COMPUTE THE MAGNITUDE OF THE RESULTANT FORCE ON THE INDICATED AREA AND THE LOCATION OF THE CENTER OF PRESSURE. SHOW THE RESULTANT FORCE ON THE AREA AND CLEARLY DIMENSION IT'S LOCATION.



GIVEN: $\theta = 70°$

$R_H = 20$ in

$sg = 1.10$

$\gamma = (1.10)(62.4 \frac{lb}{ft^3}) = 68.64 \frac{lb}{ft^3}$

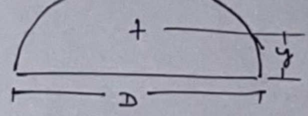
$A = \frac{\pi}{8} D^2$

$y = 0.212 D$

$I_c = (6.86 \times 10^{-3}) D^4$

$D_H = 40$ in $= 3.333$ ft

$\frac{4R}{3\pi} = AC$



SOLUTION: $F_R = \gamma h_c A \rightarrow$ ~~$h_c = L_c \sin\theta \rightarrow L_c = \frac{h_c}{\sin\theta}$~~

$\frac{4R_H}{3\pi} = AC = \frac{4(20 in)}{3\pi} = 8.49 in,$ $\overline{CD} = 8.49 + 8 = 16.49$ in

$x = 16.49 in \sin 60° = 14.28$ in

$h_c = 10 in + 14.28 in = 24.28$ in

$L_c = \frac{h_c}{\sin\theta} = L_c = \frac{24.28 in}{\sin 60°} = 28.04$ in

USE $A = \left(\frac{\pi}{8}\right) D^2 = \left(\frac{\pi}{8}\right)(40 in)^2$

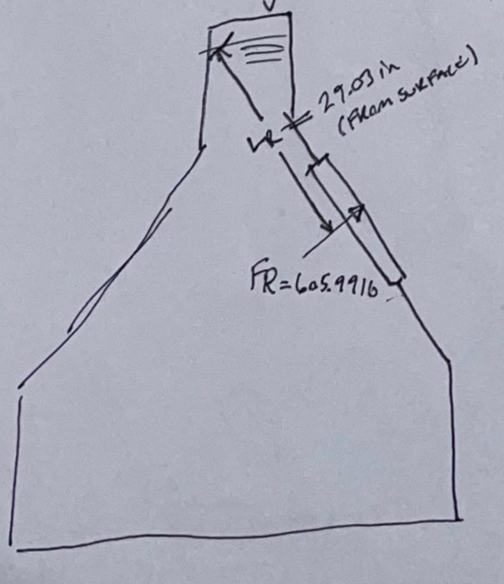
$A = 628.32 \; in^2$

$F_R = \gamma h_c A = \frac{(68.64 \frac{lb}{ft^3})}{1728 \; in^3}(24.28 in)(628.32 in^2) = \underline{\underline{605.987 \; lb = F_R}}$

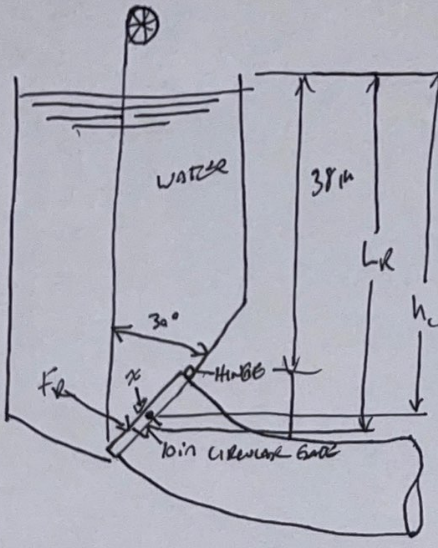
$h = \frac{I_c \sin^2\theta}{A h_c} + h_c \rightarrow I_c = (6.86 \times 10^{-3})(40)^4 = 17561.6 \; in^4$

$\rightarrow \frac{(17561.6 \; in^4)\sin^2 60°}{(628.32 \; in^2)(24.28 \; in)} + 24.28 in = 25.14$ in

$L_R = \frac{h}{\sin 60°} = \frac{25.14 in}{\sin 60°} = \underline{\underline{29.03 \; in}}$



4.42) COMPUTE THE AMOUNT OF FORCE THAT THE WINCH CABLE MUST EXERT TO OPEN THE GATE.



GIVEN: HINGED

$D = 10\,in$

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

$I_c = \frac{\pi}{64} D^4$

SOLUTION: FROM TOP OF WATER TO CENTER OF GATE.

$$h_c = 38 + \frac{d\cos 30°}{2} = \frac{38 + 10\cos 30°}{2}$$

$$h_c = 42.33\ in$$

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

$$F_R = \gamma_w A_G h = \left(\frac{62.4\,lb}{1728\,in^3}\right)(78.54\,in^2)(42.33\,in)$$

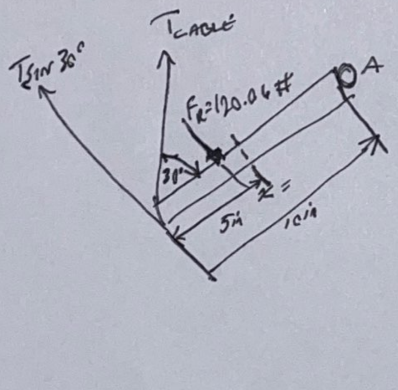
$$F_R = 120.06\ lb$$

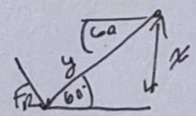
$$L_R = h_c + \frac{I_c \cdot \sin^2\theta}{A\,h_c} = \frac{\left(\frac{\pi}{64}(10)^4\right)\cdot \sin^2(60°)}{(78.54\,in^2)(42.33\,in)} + 42.33\,in$$

$$L_R = 42.44\ in$$

x (DISTANCE BETWEEN CENTER + F_R) $= L_R - h_c = 42.44\,in - 42.33\,in$

$x = 0.11\ in$





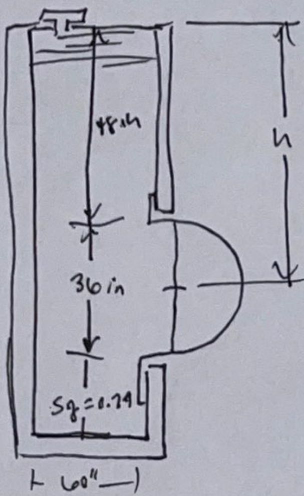
$$y = \frac{0.11\,in}{\sin 60°} = -0.1278\,in$$

$$5\,in + 0.1278\,in = 5.1278$$

$$\Sigma M_A = 0 = T_c \sin 30°(10\,in) - F_R(5.1278\,in)$$

$$\underline{\underline{T_c = 123.13\ lb}}$$

4.54) COMPUTE THE MAGNITUDE OF THE HORIZONTAL COMPONENT OF THE FORCE AND COMPUTE THE VERTICAL COMPONENT OF THE FORCE EXERTED BY THE FLUID ON THAT SURFACE. THEN COMPUTE THE MAGNITUDE OF THE RESULTANT FORCE AND ITS DIRECTION. SHOW RESULTANT FORCE ACTING ON THE CURVED SURFACE.

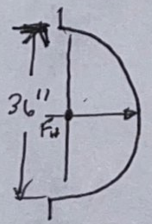


GIVEN: SURFACE IS 60 in LONG

$$\gamma_A = 0.79\left(62.4\tfrac{lb}{ft^3}\right) = 49.296\ \tfrac{lb}{ft^3} \cdot \tfrac{1\ ft^3}{1728\ in^3} = 0.028528\ \tfrac{lb}{in^3}$$

SOLUTION:

FOR HORIZONTAL $\rightarrow$ $F_H = \gamma_A A h \rightarrow h = 48\,in + 18\,in = 66\,in$



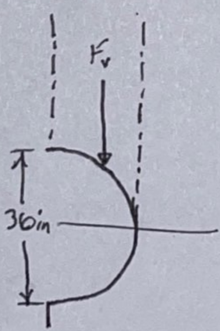
$\rightarrow$ $\cancel{A = \frac{\pi}{8}D^2 = \frac{\pi}{8}(36)^2 = 508.938\,in^2}$

$A = 36'' \times 60'' = 2160\,in^2$

$F_H = \left(0.028528\,\frac{lb}{in^3}\right)\left(\cancel{508.938\,in^2}\right)(66\,in)$

$F_H = \cancel{958.253\,lb}$ $4066.95\,lb = F_H$

FOR VERTICAL $\rightarrow$ (IMAGINE FLUID ABOVE AREA),



$F_V = \gamma_A A_V \rightarrow A_V = \frac{\pi}{8}(36)^2 = 508.938$

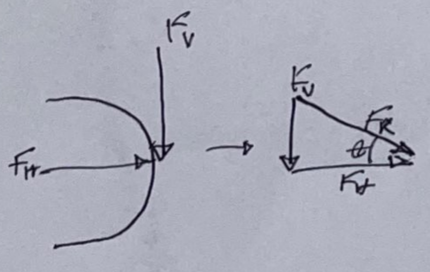
$508.938\,in^2 \cdot 60\,in = 30536.3\,in^3$

$\left(0.028528\,\frac{lb}{in^3}\right)(30536.3\,in^3)$

$F_V = 871.139\,lb$

RESULTANT FORCE $\rightarrow$ $F_R = \sqrt{F_H^2 + F_V^2} = \sqrt{4066.95^2 + 871.139^2}$

$F_R = 4159.2\,lb$

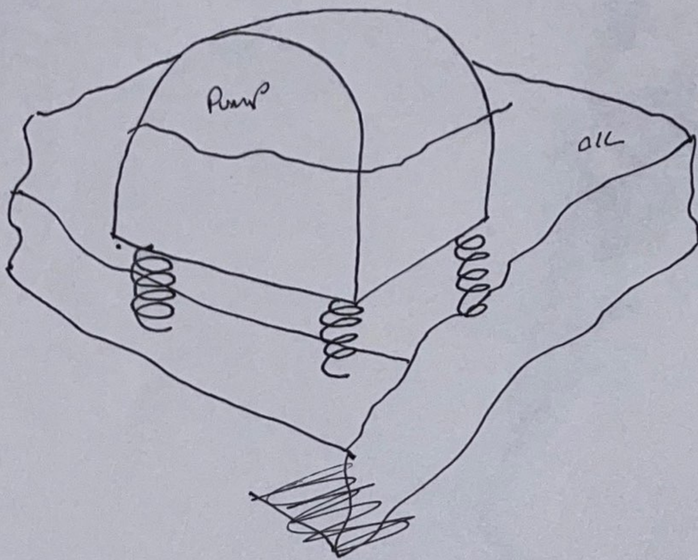


$\tan\theta = \frac{F_V}{F_H} = \frac{871.139\,lb}{4066.95\,lb} = 0.2142$

$\theta = \tan^{-1}(0.2142) = 12.09°$

$F_R = 4159.2\,lb \angle 12.09°$

5.8) THE FIGURE SHOWS A PUMP PARTIALLY SUBMERGED IN OIL ($S_g = 0.90$) AND SUPPORTED BY SPRINGS. IF THE TOTAL WEIGHT OF THE PUMP IS 14.6 lb AND SUBMERGED VOLUME IS 40 in^3, FIND SUPPORTING FORCE EXERTED BY THE SPRINGS.



GIVEN: $S_g = 0.9$

$W_p = 14.6\ \text{lb}$

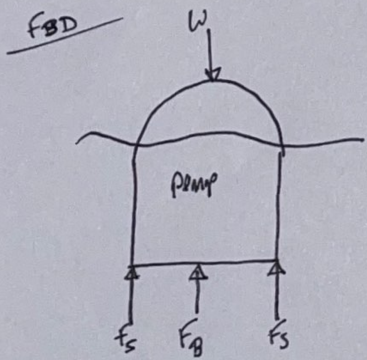
$V_d = 40\ \text{in}^3$

$\gamma_{oil} = 0.9\left(62.4\ \frac{\text{lb}}{\text{ft}^3}\right) = 56.16\ \frac{\text{lb}}{\text{ft}^3}$

$56.16\ \frac{\text{lb}}{\text{ft}^3} \cdot \frac{1\ \text{ft}^3}{1728\ \text{in}^3} = 0.0325\ \frac{\text{lb}}{\text{in}^3}$

SOLUTION:

FBD



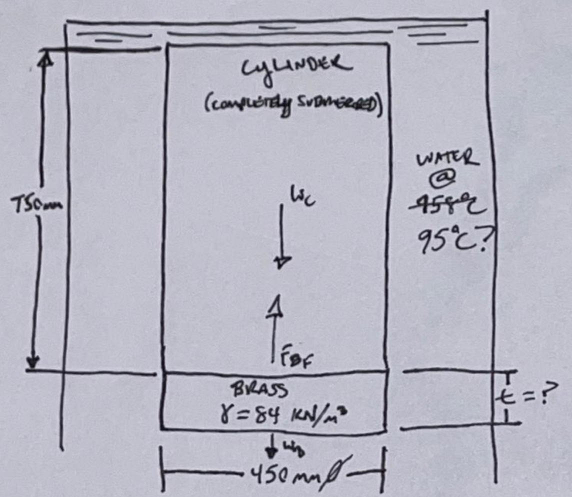
$$F_B = \gamma_{oil} V_d = \left(0.0325\ \frac{\text{lb}}{\text{in}^3}\right)\left(40\ \text{in}^3\right) = 1.3\ \text{lb}$$

$$\uparrow \Sigma F = 0 = F_B - W + F_s$$

$$= F_s = -F_B + W = -1.3 + 14.6\ \text{lb} = 13.3\ \text{lb}$$

$$F_{SPRING} = 13.3\ \text{lb} \uparrow$$

5.24) A BRASS WEIGHT IS ATTACHED TO THE BOTTOM OF A CYLINDER SO THAT THE CYLINDER WILL BE COMPLETELY SUBMERGED, AND NEUTRALLY BOUYANT IN WATER AT ~~95°C~~ 95°C? (TYPO). THE BRASS IS TO BE A CYLINDER WITH THE SAME DIAMETER AS THE ORIGINAL CYLINDER. WHAT IS THE REQUIRED THICKNESS OF THE BRASS?



GIVEN: $h_c = 750mm = 0.75m$

$D_B = 450mm = 0.45m$

$\gamma_B = 84\ \frac{KN}{m^3}$

$\gamma_w = @95°C = 9.44\ \frac{KN}{m^3}$

$V_c = \frac{\pi}{4} D^2 \cdot h_c$

$D_c = 0.4m$

$\gamma_{cyl} = 6.456\ \frac{KN}{m^3}$ (FROM PR. 5.22)

SOLUTION: Volume of cylinder, $V_c = \frac{\pi}{4} D^2 \cdot h_c$

$\rightarrow V_c = \frac{\pi}{4}(0.45m)^2 \cdot (0.75m)$

$V_c = 0.1193\ m^3$

$\overset{+}{\uparrow}\Sigma F = 0 = +F_{BF} - W_B - W_C$

$F_{BF} = W_B + W_C$ NOTE, $W = F$ (WEIGHT IS A FORCE)

REWRITE: $F_{BF} = F_B + F_C$

$F = \gamma \cdot V$

$\rightarrow \gamma_w \cdot V = \gamma_B \cdot V_B + \gamma_c \cdot V_c$

Volume of ~~cylinder~~ BRASS, $V_B = \frac{\pi}{4} D^2 \cdot t$

$\rightarrow V_B = \frac{\pi}{4}(0.45m)^2 \cdot t$

$V = V_c + V_B$ (TOTAL)

$= 0.1193\ m^3 + \left(\frac{\pi}{4}(0.45m)^2 \cdot t\right)$

$= \left(9.44\ \frac{KN}{m^3}\right)\left(0.1193m^3 + \left(\frac{\pi}{4}(0.45m)^2 \cdot t\right)\right) = \left(84\ \frac{KN}{m^3}\right)\left(\frac{\pi}{4}(0.45m)^2 \cdot t\right) + \left(6.456\ \frac{KN}{m^3}\right)(0.1193\ m^3)$

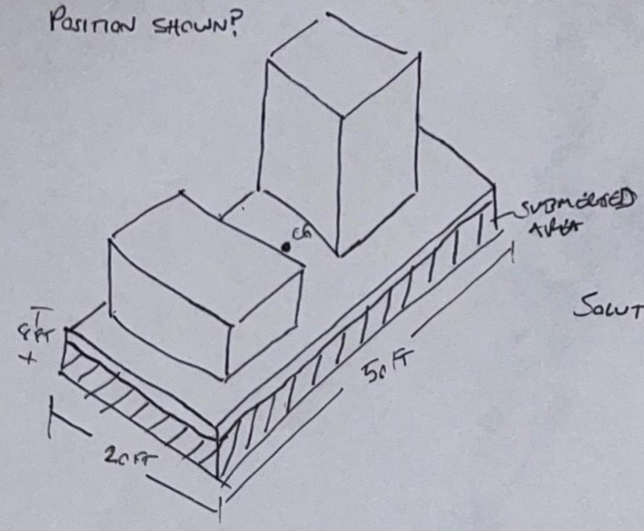
$= 1.126\ KN + \cancel{0.159t}\ 1.501t = 13.36t + 0.7702$

$=$

$.3558 = 11.859t$

$= \underline{\underline{t = 0.03\ m}}$ or 30 mm

5.41) THE LARGE PLATFORM SHOWN CARRIES EQUIPMENT AND SUPPLIES TO OFFSHORE INSTALLATIONS. TOTAL WEIGHT OF THE SYSTEM IS 450,000 lb AND IT'S CENTER OF GRAVITY IS EVEN WITH THE TOP OF THE PLATFORM, 8 FT FROM THE BOTTOM. WILL THE PLATFORM BE STABLE IN SEAWATER IN THE POSITION SHOWN?



GIVEN: $w = 450{,}000 \text{ lb}$

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

$F_B = \gamma V_D$

SOLUTION: $V_D = 50_{\text{ft}} \cdot 20_{\text{ft}} \cdot h$

$= 1000 \text{ ft}^2 \cdot h$

$F_B = \gamma V_D$

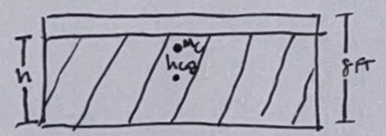
$F_B = \left(62.4 \frac{\text{lb}}{\text{ft}^3}\right)\left(1000 \text{ ft}^2 \cdot h\right)$

$F_B = w = 450000 \text{ lb}$

$450{,}000 \text{ lb} = \left(62.4 \frac{\text{lb}}{\text{ft}^3}\right)\left(1000 \text{ ft}^2 \cdot h\right)$

$7031.25 = 1000 \text{ ft}^2 \cdot h$

$7.03125 \text{ ft} = h \rightarrow V_D = 1000 \text{ ft}^2 (7.03125 \text{ ft}) = 7031.25 \text{ ft}^3$



$h_{cb} = \frac{h}{2} = \frac{7.03125 \text{ ft}}{2} \approx 3.51 \text{ ft}$

$F_B = \left(62.4 \frac{\text{lb}}{\text{ft}^3}\right)\left(1000 \text{ ft}^2 (7.03125 \text{ ft})\right)$

$F_B = 438750 \text{ lb}$

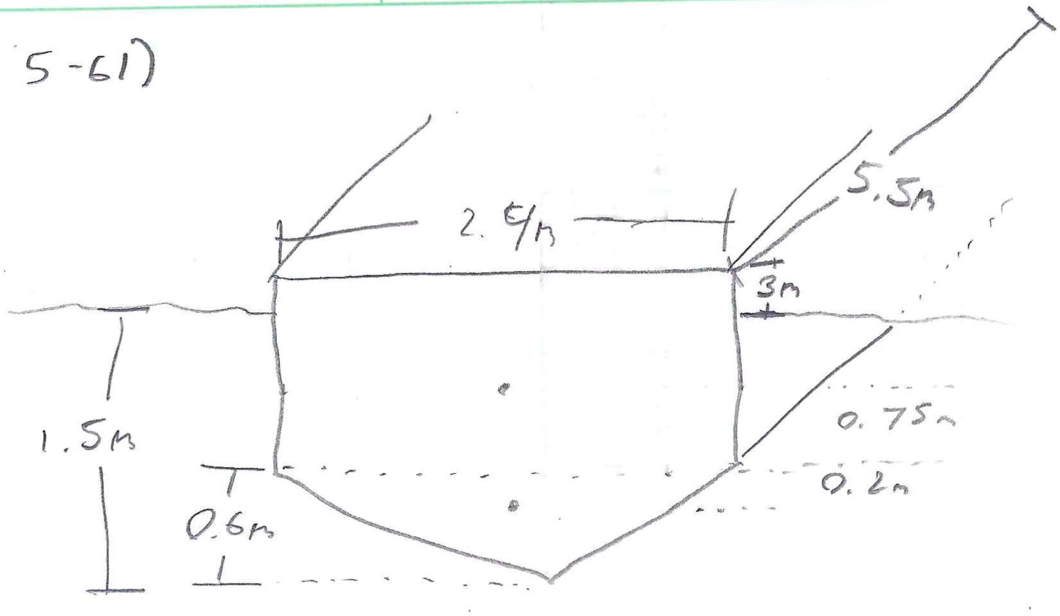
$M_c = \frac{I}{V_D} = \frac{\frac{BH^3}{12}}{V_D} = \frac{\frac{(50)(20)^3}{12}}{7031.25 \text{ ft}^3} = 4.741 \text{ ft}$

$h_{cb} + M_c = 3.51 \text{ ft} + 4.741 \text{ ft} \approx 8.251 \text{ ft}$

8.251 FT IS MORE THAN 3.51 FT

IT WILL BE STABLE.

5-61)



$$MB = \frac{I}{V_d} \qquad V_d = (1.5-0.6)\cdot(2.4)\cdot 5.5) + \frac{(0.6\cdot 2.4\cdot 5.5)}{3}$$

$$V_d = 14.52\,m^3$$

$$I = I_1 + I_2 = \frac{BH^3}{12} + \frac{BH^3}{36}$$

$$I = \frac{(2.4)(0.9)^3}{12} + \frac{(2.4)(0.6)^3}{36} = 0.1602\,m^4$$

$$MB = 0.1039\,m$$