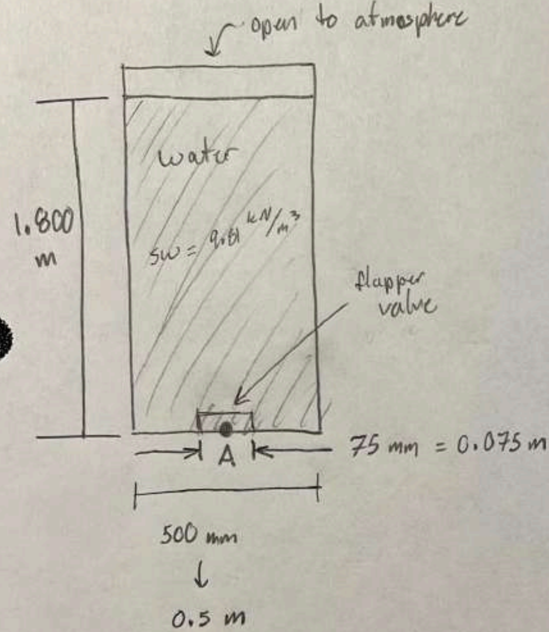
John Barresi
MET 330
HW 2.1

4.10) 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.
The flapper must be pushed upward to open the valve.
How much force is required to open the valve?



$P_A = P_{atm} + \gamma_{water}(1.8\,m)$

$= 0\ Pa_{gage} + (9.81\ kN/m^3)(1.8\ m)$

$P_A = 17.658\ kN/m^2$

$F = P_A A$

$F_{total} = (17.658\ kN/\cancel{m^2})(0.196\ \cancel{m^2})$

$F_{total} = 3.461\ kN$

$kN/m^2 = kPa$

$F_{flapper} = (17.658\ kN/\cancel{m^2})(0.00442\ \cancel{m^2})$

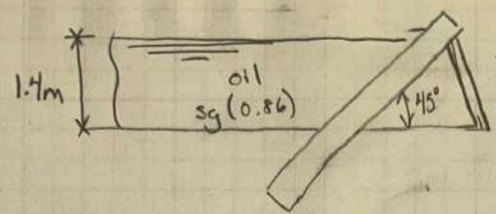
$A_{total} = \dfrac{\pi(0.5\,m)^2}{4} = 0.196\ m^2$

$\boxed{F_{flapper} = 0.078\ kN = 78\ \text{Newtons}}$

$A_{flapper} = \dfrac{\pi(0.075\,m)^2}{4} = 0.00442\ m^2$

4 - 17 | HW 2.1 | Noel T

$F_R = ?$
$h_p = ?$
$L_p = ?$



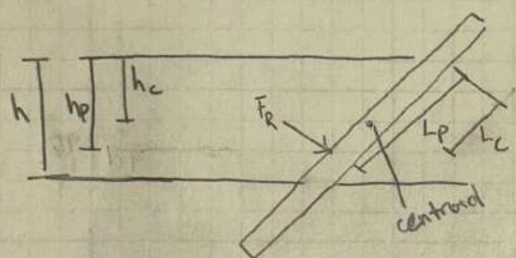
$F_R = P_{avg} A$

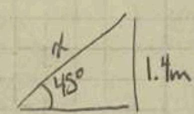
$F_R = \gamma_{oil} h_c A$

$sg = \frac{\gamma_o}{\gamma_w}$

$\gamma_o = 0.86(9.81 kN/m^3)$

$\gamma_o = 8.44 kN/m^3$





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

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

$x = \frac{1.4}{\sin 45}$

$x = 1.98m$

$A = (1.98m)(4m)$

$A = 7.92m^2$

$h_c = h/2 = 1.4/2 \ m$

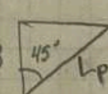
$F_R = (8.44 kN/\cancel{m^3})(\frac{1.4\cancel{m}}{2})(7.92\cancel{m^2})$

$F_R = 46.79 kN$

$h_p = h - h/3$

$h_p = 1.4 - 1.4/3$

$h_p = 0.93 m$



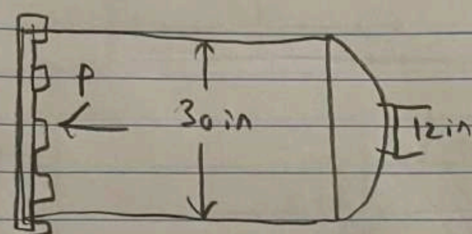
$\cos\theta = \frac{h_p}{L_p}$

$L_p = \frac{h_p}{\cos\theta}$

$L_p = \frac{0.93}{\cos 45}$

$L_p = 1.32 m$

4.2)



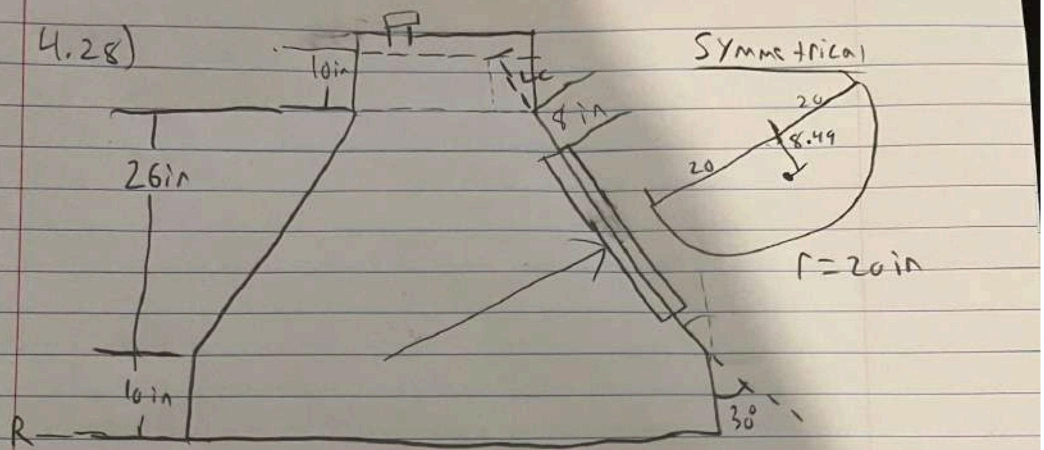
$P = 23.6\,\text{psi}$

$F = PA$

$A = \frac{\pi D^2}{4} = \frac{\pi (30\,\text{in})^2}{4} = 706.9\,\text{in}^2$

$F = 23.6\,\frac{\text{lb}}{\cancel{\text{in}^2}} \times 706.9\,\cancel{\text{in}^2} = \boxed{16.7 \times 10^3\,\text{lb}}$

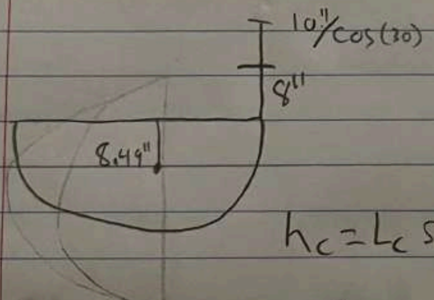
4.28)



$F = \gamma \times h_c \times A \qquad L_p = L_c + \frac{I_c}{L_c \times A}$

Centroid of semicircle: $\frac{4r}{3\pi} = 8.49$ in.

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



$L_c = 8.49 + 8 + \left(\frac{10}{\cos(30)}\right) \qquad A = 628.3\ in^2$

$L_c = 28''$

$h_c = L_c \sin\theta = (28)(\sin(30)) = 14''$

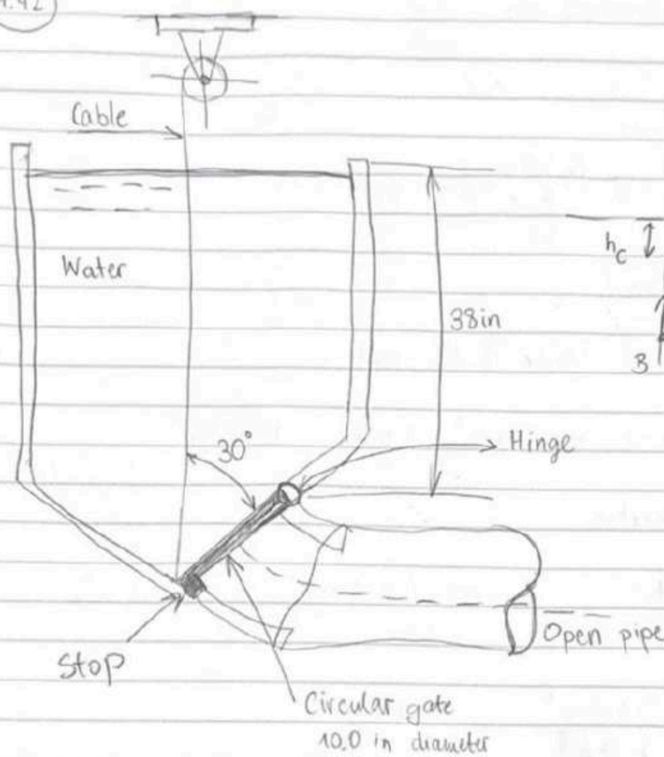
$F = \gamma h_c A = (1.10)(14in)(628.3\ in^2)\left(\frac{1ft}{12in}\cdot\frac{1ft}{12in}\cdot\frac{1ft}{12in}\right) = \boxed{5.6\ lb}$

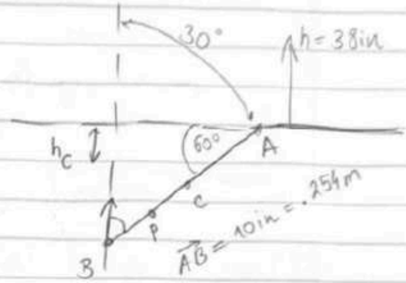
$I_c = \frac{1}{8}\pi(20)^4 = 62832\ in^4$

$L_p = 28 + \frac{62832}{(28 \times 628.3)} = 31.6\ in.$

$h_p = L_p \sin(30) = 15.8\ in.$

(4.42)





(*) C = center of circular gate

$A_c = y_c$

$h_c = A_c \cdot \sin\theta$

$h_c = \frac{0.254}{2} \cdot \sin 60°$

$h_c = 0.11 m$

(*) $h = 0.9652 m$

$F_R = \rho g (h + h_c) \cdot A$

$= 1000 \cdot 9.81 (0.9652 + 0.11) \cdot \frac{\pi}{4} (0.254)^2$

$F_R = 534.45 N$

→ center of pressure

$y_p = y_c + \frac{I}{\left(y_c + \frac{P_0}{\rho g \sin\theta}\right)}$ $P_0 = 0$ $I = \frac{\pi d^4}{64}$

$y_c = \frac{d}{2}$

$y_p = y_c + \frac{I}{y_c \cdot A} = \frac{d}{2} + \frac{\cancel{\pi} d^4}{64 \cdot \frac{d}{2} \cdot \frac{\cancel{\pi} d^2}{4}}$

$y_p = \frac{d}{2} + \frac{d^{\cancel{4}\,1}}{\cancel{64}\,8 \cdot \frac{d^3}{\cancel{8}\,1}}$

$y_p = \frac{d}{2} + \frac{d}{8} = \frac{5d}{8}$

$\Sigma M_A = 0$

$-F_R \cdot y_p + F \sin 30^\circ \cdot d = 0$

$F \cdot \frac{\cancel{d}}{\cancel{2}} = 534.45 \cdot \frac{5\cancel{d}}{\cancel{8}\,4}$

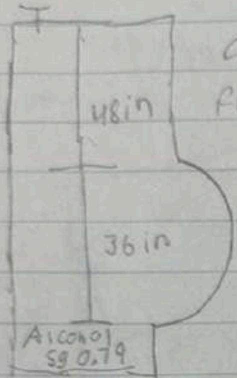
$F = 534.45 \cdot \frac{5}{4}$

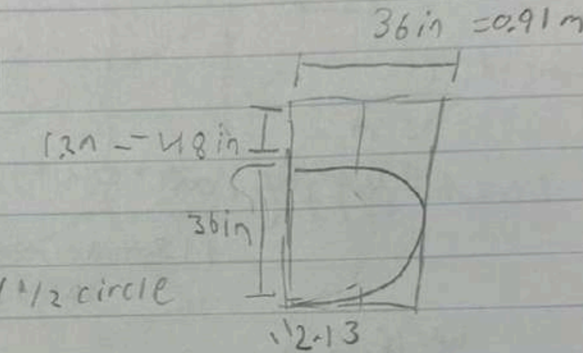
$\boxed{F = 668.0625 N}$

Fluid mechanics HW 2.1 Ben 4.56 & 5.8

4.54 pg 90 and practice

compute magnitude of horizontal component of the force exerted by the fluid. compute resultant force





$F_v = \gamma (V_{rectangle} - V_{1/2\ circle}$

$F_h = \gamma \cdot h_c \cdot A$

$$F_v = 9.81 \frac{kN}{m^3} \cdot \left[(2.13) \cdot 0.91\,m - \frac{\pi \cdot 0.91^2}{2}\right] \cdot 0.91$$

$F_v = 5.69\,kN$

$A \cdot x_v = A_{rec} \cdot x_{rec} - A_{1/2\ circle} \cdot x_{1/2\ circle})$

$$x_v = \frac{[(2.13) \cdot 0.91] \cdot \frac{0.91}{2} - \frac{\pi \cdot 0.91^2}{2} \cdot (0.79 \cdot 0.91)}{(2.13 \cdot 0.91) \cdot 0.91 - \frac{\pi \cdot 0.91^2}{2}}$$

$= 0.1148\,m$

$F_h = \gamma \cdot h_c \cdot A$

$F_h = 9.81 \cdot \left(1.2 + \frac{0.91}{2}\right) \cdot (0.91 \cdot 0.91)$

$F_h = 13.44\ kN$

$h_p = h_c + \frac{I_c}{h_c \cdot A}$

$h_p = \left(1.2 + \frac{0.91}{2}\right) + \left(\frac{(0.91 \cdot 0.91^2)/12}{(1.2 + 0.91/2) \cdot (0.91 + 0.91)}\right)$

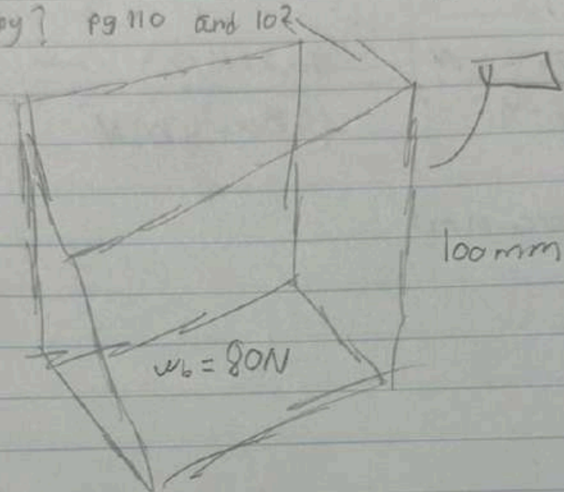
$h_p = 16.25\ m$

$F_r = \sqrt{F_v^2 + F_h^2} = \sqrt{5.69^2 + 16.25^2} = 17.21\ kN$

$\theta = \tan^{-1} \frac{F_v}{F_h} = \tan^{-1}\left(\frac{5.69}{16.25}\right) = 19^\circ$

Fluid mechanics Hw 2.1 Ben Smithson

5.8 A steel cube 100mm on a side weighs 80N we want to hold the cube in equilibrium under water with a bboy that weighs 470 N/m³ minimum volume of bboy? pg 110 and 102



$\Sigma F_V = 0$

$0 = F_{bB} + F_{bF} - W_B - W_F$

$W_B = 80N =$

$F_{bB} = \gamma_f V_{dB} = \left(\frac{9790\ N}{m^3}\right) 100mm^3 \left(\frac{m^3}{1{,}000{,}000{,}000mm^3}\right) = 9.79$

$F_{bB} + F_{bF} - W_B - W_F = 0$

$9.79\ N + \gamma_f V_F - 80N - \gamma_F V_F = 0$

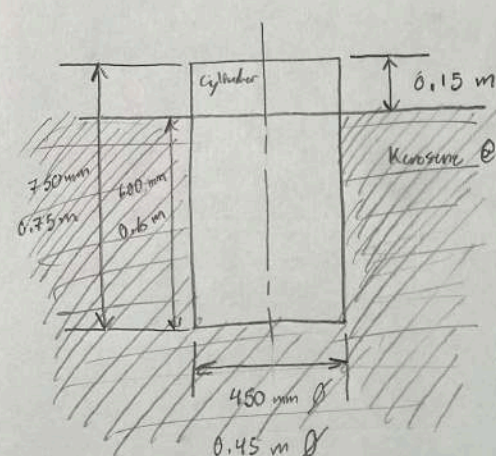
$\gamma_F V_P - \gamma_F V_F = 80N - 9.79N = 70.21\ N$

$V_F(\gamma_P - \gamma_F) = 70.21\ N$

$$V_F = \frac{70.21\ N}{\gamma_F - \gamma_F} = \frac{70.21\ N/m^3}{(9790 - 470)\ N} = 0.0075\ m^3$$

or $7{,}500{,}000\ mm^3$

5.22) The cylinder shown is made of a uniform material. What is its specific weight (γ)?



$$\gamma_{kerosene} = 8.07 \text{ kN/m}^3$$

$$(\gamma_{kerosene})(V_{kerosene}) = (\gamma_{cylinder})(V_{cylinder})$$

$$\gamma_{cylinder} = (\gamma_{kerosene})\left(\frac{V_{kerosene}}{V_{cylinder}}\right)$$

$$= (8.07 \text{ kN/m}^3)\left(\frac{\frac{\pi (0.45\text{ m})^2 (0.6\text{ m})}{4}}{\frac{\pi (0.45\text{m})^2 (0.75\text{m})}{4}}\right)$$

$$\boxed{\gamma_{cylinder} = 6.456 \text{ kN/m}^3}$$

5.23) If the cylinder from 5.22 is placed in fresh water at 95°C, how much of its height would be above the surface?

$\gamma_{cylinder} = 6.456\ kN/m^3$

$\gamma_{water\ @\ 95C} = 9.44\ kN/m^3$

$$Weight = \gamma V$$
$$= (6.456\ kN/m^3)\left(\frac{\pi (0.45\ m^2)(0.75\ m)}{4}\right)$$
$$W_{cylinder} = 0.77\ kN$$

$$\Sigma F_v = 0 = F_b - w$$
$$w = F_b$$
$$V_d = \frac{\pi d^2}{4}(h)$$
$$F_b = \gamma_f V_d = (\gamma_f)\left(\frac{\pi d^2}{4}\right)(h)$$
$$w = F_b = (\gamma_f)\left(\frac{\pi d^2}{4}\right)(h)$$
$$h = \frac{w}{\left(\frac{\pi d^2}{4}\right)(\gamma_f)}$$

$$h_s = \left(\frac{0.77\ kN}{\left(\frac{\pi (0.45\ m)^2}{4}\right)}\right)\left(\frac{m^3}{9.44\ kN}\right)$$
$$h_s = \left(\frac{0.77\ \cancel{kN}}{0.16\ \cancel{m^2}}\right)\left(\frac{m^{\cancel{3}}}{9.44\ \cancel{kN}}\right)$$
$$h_s = 0.509\ m \quad \text{submerged}$$

$$h_A = h_T - h_s$$
$$= 0.75\ m - 0.509\ m$$
$$\boxed{h_A = 0.241\ m = 241\ mm}$$

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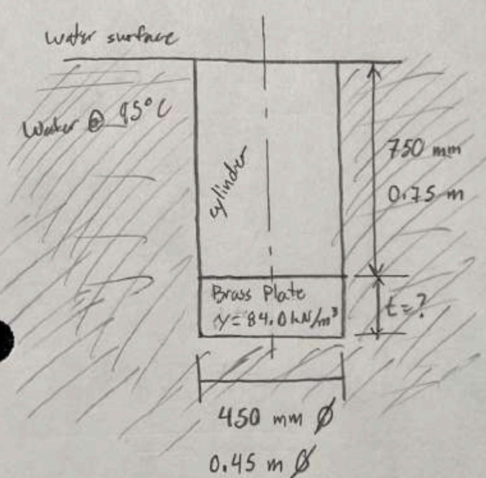
MET 330
HW 2.1

5.24) A brass weight is to be attached to the bottom of the cylinder described in problems 5.22 and 5.23, so that the cylinder will be completely submerged and neutrally buoyant in water at 95°C. The brass is to be a cylinder with the same diameter as the original cylinder as shown in Fig P5.24. What is the required thickness of the brass?



$\gamma_{cylinder} = 6.456\ kN/m^3$

$\gamma_{water @ 95°C} = 9.44\ kN/m^3$

$\gamma_{brassplate} = 84.0\ kN/m^3$

$w_{cylinder} = 0.77\ kN$

$V_{cylinder} = 0.1193\ m^3$

$\Sigma F_v = 0$

$0 = F_b - w_c - w_B$

$F_b = w_c + w_B$

$\gamma_{water} V = \gamma_c V_c + \gamma_B V_B$

$(\gamma_c + \gamma_B)(V_c + V_B) = (\gamma_{water 95})(V_{water 95})$

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

$V_B = 0.159t\ m^3$

$V = V_c + V_B = 0.1193\ m^3 + 0.159t\ m^3$

(over →)

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HW 2.1

5.24 continued)

$$\gamma_{water} V = \gamma_c V_c + \gamma_B V_B$$

$$(9.44\ kN/\cancel{m^3})(0.1193\ \cancel{m^3} + 0.159t\ \cancel{m^2}) = (6.456\ kN/\cancel{m^3})(0.1193\ \cancel{m^3}) + (84.0\ kN/\cancel{m^3})(0.159t\ \cancel{m^2})$$

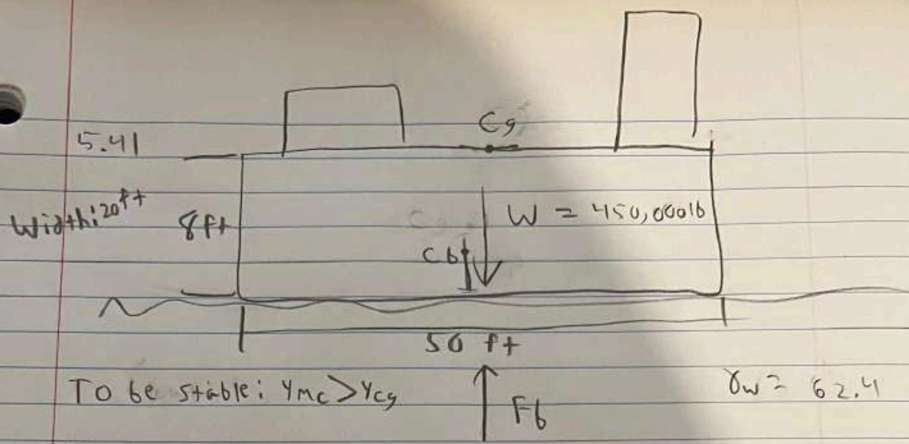
$$1.13\ kN + 1.501t\ kN = 0.77\ kN + 13.356t\ kN$$

$$\underset{kN}{13.356t - 1.501t} = \underset{kN}{1.13 - 0.77}$$

$$11.855t\ kN = 0.36\ kN$$

$$t = \frac{0.36}{11.855}$$

$$\boxed{\begin{aligned} t &= 0.0304\ m \\ &= 30.4\ mm \end{aligned}}$$



To be stable: $y_{mc} > y_{cg}$

$\gamma_w = 62.4$

To float: $F_b = W$

$F_b = \gamma_w \cdot B \cdot L \cdot X = (62.4)(20)(50)\,X$

$\frac{450000}{62400} = \frac{\cancel{62400}\,x}{\cancel{62400}}$ $\quad X = 7.2$ ft

$y_{cb} = \frac{7.2}{2} = 3.6$ ft $\quad V_d = BLX = 7200\ ft^3$

$I = \frac{LB^3}{12} = \frac{(50)(20^3)}{12} = 33{,}333\ ft^4$

$MB = \frac{I}{V_d} = \frac{33{,}333}{7200} = 7.63$ ft

$y_{mc} = y_{cb} + MB = 3.6 + 7.63 = 11.23$ ft

$11.23 > C_g$

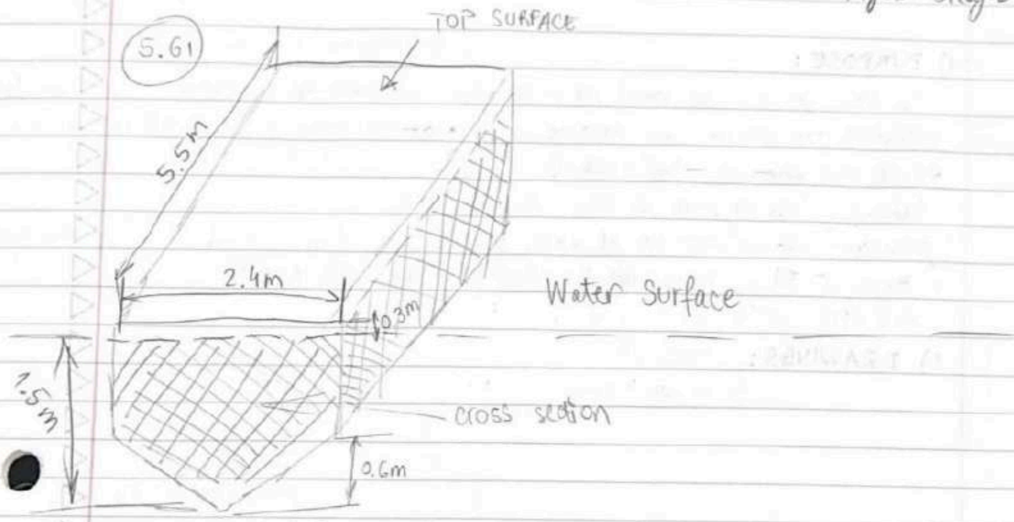
STABLE

4.42
5.61

HW 2.1 – MET 330

02/15/2024
Angela Sicaja

(5.61)



Total height (h) of boat = 1.8m
Width of the boat = 2.4m
Leught of the boat = 5.5m
Displaced boat height = 1.5m

(*) $Area_{submerged} = A_{\square} + A_{\triangle} = (0,9 \cdot 2,4) + \left(\frac{1}{2} \cdot 2.4 \cdot 0.6\right) = 2.88m^2$ //

(*) Centroid area = y_{cg}

$$y_{cg} = \frac{A_1 y_1 + A_2 y_2}{A_{total}}$$

$$y_{cg} = \frac{\left(\frac{1}{2} \cdot 2.4 \cdot 0.6\right) \cdot \frac{2h}{3} + (1.2 \cdot 2.4) \cdot \left(0.6 + \frac{1.2}{2}\right)}{3.6} =$$

$$y_{cg} = \frac{\left(\frac{1}{2} \cdot 2.4 \cdot 0.6\right) \cdot \left(\frac{2 \cdot 0.6}{3}\right) + (1.2 \cdot 2.4) \cdot 1.2}{3.6}$$

$y_{cg} = 1.04m$ //

Centroid of submerged area $= y_{cs}$

$$y_{cs} = \frac{A_1 y_1 + A_2 y_2}{A_{submerged}}$$

$$y_{cs} = \frac{\left(\frac{1}{2}\cdot 2.4\cdot 0.6\right)\cdot\left(\frac{2\cdot 0.6}{3}\right) + (0.9\cdot 2.4)\cdot 1.05}{2.88}$$

$$\boxed{y_{cs} = 0.8875\,m}$$

Total displaced volume of the boat

$$V_d = A_{submerged}\cdot L = 2.88\,m^2 \cdot 5.5\,m = 15.84\,m^3$$

Moment of Inertia

$$I = \frac{L\cdot(width)^3}{12} = \frac{5.5\,m\cdot(2.4\,m)^3}{12} = 6.336\,m^4$$

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

The center distance from the base of the boat is:

$$\therefore y_{mc} = y_{cs} + MB = 0.8875\,m + 0.4\,m = \boxed{1.2875\,m}$$

$$\left.\begin{array}{l} y_{mc} = 1.2875\,m \\ y_{cs} = 0.8875\,m \end{array}\right\} y_{mc} > y_{cs}$$

The boat is stable when it is placed in the water.