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MET 330

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HW #2.1

Devon Moore: Looking at the forces due to static fluids slides, I learned forces at the bottom of a tank can be found by first finding the sum of the pressures in the tank and then dividing by the area at the bottom of the tank. Refreshers to static were also covered showing the importance of finding both the sum of forces and sum of moments when determining the reaction forces due to the force of static fluids.

Looking at the buoyancy and stability slides I learned the weight of an object is always equal to the buoyancy force if the object floats. I also learned That the meta center must be greater than the center of gravity for a floating object to be stable. The slides also explain that the center of gravity is at the centroid of an object, where ass the center of buoyancy is at the centroid of the submerged volume.

Dave Buonconsiglio: Going into the study of buoyancy and stability, I had a basic understanding of the principles, but not a true understanding of the design process. I had never even heard the term metacenter before. By going through the problems and solutions, as well as reading the chapter and working on the problems, I learned how massive ships can still maintain their buoyancy through proper design and placement of the center of gravity of the vessel. This also showed me how load masters plan the loads for those giant cargo vessels, and why it takes so long to load and unload them, the center of gravity must be carefully calculated to be below the metacenter of the mass if the vessel is to make a successful voyage. In order to do that, each container must be carefully weighed, with each cg known, and added to the overall cg of the mass. I already had a concept of this process, but now I know the math behind it, and could (with some more experience) possibly handle those calculations in the future.

Richard Harrell:

Traveon Williams:

4.2

4.2 30 in dia

14.4 psig

$F = PA$

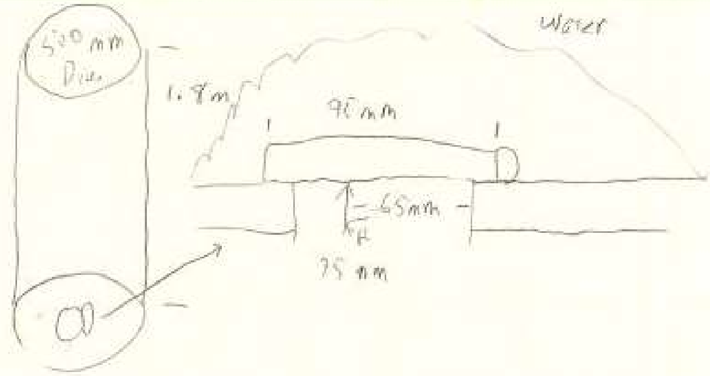
$F = 14.4 \times \frac{\pi(30)^2}{4} = \quad in \times P/in^2$

$F = 14.4 \times 706.5$

$F = 10173.6$ lbf

4.10

4-10



$$A = \frac{\pi d^2}{4} - \frac{\pi .095^2}{4} = .007088 m^2$$

Pressure of water

$$P = \gamma h = 9.81 \frac{kN}{m^3} \cdot 1.8m = 17.658 kN/m^2$$

Open Air Tank ∴ $P_{atm} = 0$ pg

Force Value

$$\frac{kN}{\frac{m^2}{m^2}} \quad \frac{17.658}{.007088} = 0.125159904 \, kN = 125.16 N$$

To find the Resultant force

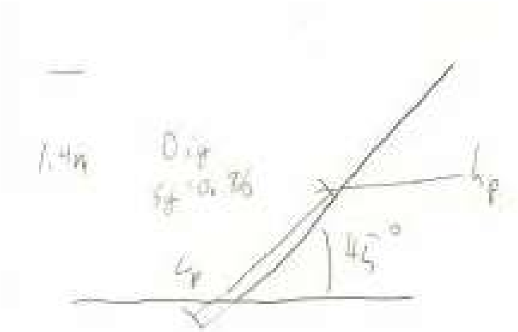
$$\Sigma M_{hinge} = 0$$

$$(125 N)(.0475m) - F_R (0.065m) = 0$$

$$(125 N)(.0475m) = F_R (0.065m)$$

$$F_R = \frac{(125 N)(.0475 m)}{.065 m} = 91.34615385 N \cong 91.3 N$$

4.17



4.17 1.4 m

O.L : Sg = 0.86

45°

P = F/A = SF = PA

hp, 45°, 1.4

$\sin\theta = 1.4/h_p$

$h_p = 1.4 / \sin(45) = 1.98$ m

Area = $h \times L = 1.98 \times 4 = 7.92$ m^2

$S_{w\,oil} = .86 \times 9.81 = 8.4$ kn/m^3

$F = 8.4 \times \frac{1.4}{2} (7.92) = 46.76$ kn = F

Loc = $h_p - h_p/3 = 1.98 - 0.66 = 1.3$ m

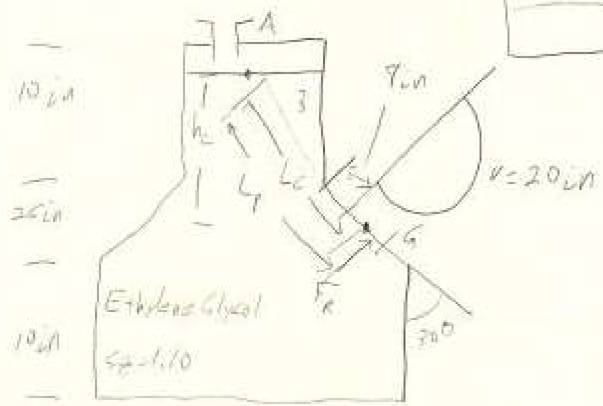
$F_v = h - h/3 = 1.4 - 0.46 = .93$ m

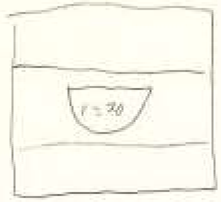
4.28

4-27

$F_R = 652\ lb$

$L_p = 31\ in$





$\gamma = sg\ \gamma_{water}$
$= 1.1\ (62.4)$
$= 68.64\ \frac{lb}{ft^3}$

$h = 2.6$

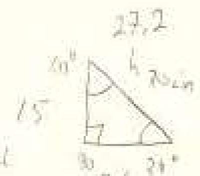
$F_R = h_c\, \gamma\, A$

$L_p = \frac{I_c}{L_c A} + L_c$

$h_p = h_c + \frac{I_c \sin^2\theta}{h_c A}$

$I = I_c + A L_c^2$

Find F_R, L_p

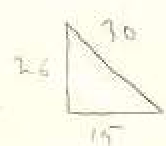


$\frac{\sin 26}{26} = \frac{\sin 30}{B}$

$B = \frac{26 \sin 30}{\sin 60} = 15.011107$

$\sqrt{26^2 + 15^2} = 30.022214$

$A_\triangle = \frac{h\,b}{2} = \frac{15 \cdot 26}{2} = 195\ in^2$



$A_\square = 10 \cdot 15 = 150\ in^2$

$A_{total} = 195 + 150 = 345\ in^2$

$2.395833333\ ft^2$

$$x\ \text{Centroid} = \frac{(7.5\times150)+(5\times195)}{345} = 6.086956522 \qquad \frac{(in\times in^2)}{in^2} = \frac{in^3}{in^2} = in$$

$$y\ \text{Centroid} = \frac{(5\times150)+(8.64\times195)}{345} = 7.05739130 4$$

$$\bar{y}_{\ominus} = .212D = .212(2r) = .212(40) = 8.48\ in$$

$8.48+8=16.48 \qquad 30-16.48=21.52$

$$\frac{\sin 30}{21.52} = \frac{\sin 60}{B}$$

$$B = \frac{21.52\sin 60}{\sin 30} = 18.63686669$$

$\frac{\sin 60}{10} = \frac{\sin 30}{B} \quad B = 5.77 \qquad L_c = 30.1638 7207\ in$

$h_c = L_c\cos\theta = 30\cos 30 = 26.14\ in$

2.178 ft

$$I_{c\ominus} = (6.86E-3)D^4 = (6.86E-3)(40)^4 = 17561.6\ in^4$$

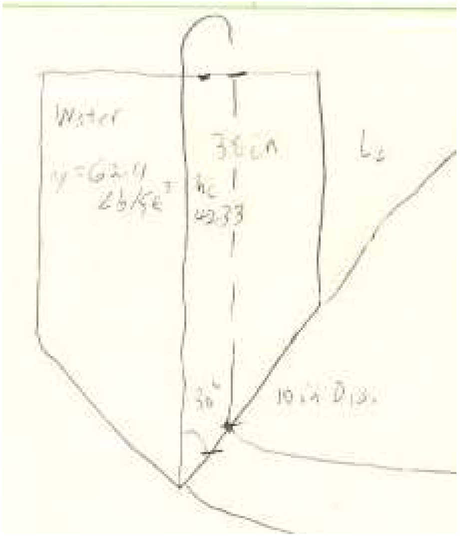
$$A_{\ominus} = \frac{\pi D^2}{8} = \frac{\pi(40^2)}{8} = 628.3185307\ in^2 = 4.36332313\ ft^2$$

$F_R = \gamma h_c A \qquad \frac{lb}{ft^3}\cdot ft\cdot ft^2 = lb$

$68.64 \cdot 2.178 \cdot 4.36 = 652.407565\ lb$

$$L_p = \frac{I_c}{L_c A} + L_c = \frac{17561.6}{(30.18)(628.3)} + 30.18 = 31.10986839 \qquad \frac{in^4}{in\cdot in^2} = in$$

4.42



42

$d = 10$ in

$h = 38 + \frac{d}{2}\cos 30$

$h = 38 + 5\cos 30$

$h = 42.33$ in

$L_g = h/\cos 30 = 42.33/\cos 30 = 48.88$ in

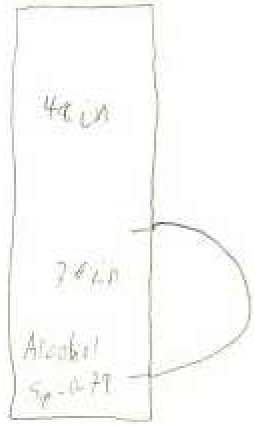
$A = \frac{\pi 10^2}{4} = 78.5$ in

$f = ma = \rho a h g = 0.036\,(42.33)\,78.5 =$

[illegible]

4.54

4.54



$h_1 = 48\,in$

$s = 36\,in$

$\gamma_{water} = 62.4\ lb/ft^3$

$\gamma_{alc} = sg\,\gamma_{water} = .79(62.4) = 49.296\ \frac{lb}{ft^3}$

$w = 60\,in$

$s = 36\,in$

$F_H = \gamma s w h_c = \frac{lb}{ft^3}\cdot ft \cdot ft \cdot ft = lb$

$(49.25)(3)(5)(5.5) = 4066.92\ lb$

$F_v = W = \gamma V = (49.296)(17.67145868) = 871.1322271\ lb$

$A_{\cap} = \frac{\pi d^2}{8} = \frac{\pi(36)^2}{8} = 508.9380099\ in^2$

$V_{\cap} = Aw = 508.9\,in^2 \cdot 60\,in = 30536.28059\ in^3 = 17.67145868\ ft^3$

$h_c = h_1 + \frac{s}{2} = 48 + \frac{36}{2} = 66\,in = 5.5\,ft$

$\bar{x}_{\cap} = .212\,D = .212(36) = 7.362\,in$

$F_R = \sqrt{F_H^2 + F_v^2} = \sqrt{4066.92^2 + 871.13^2} = 4159.17175\ lb$

$h_{p\cap} = h_c + \frac{s^2}{12 h_c} = \frac{in^2}{in} = in$

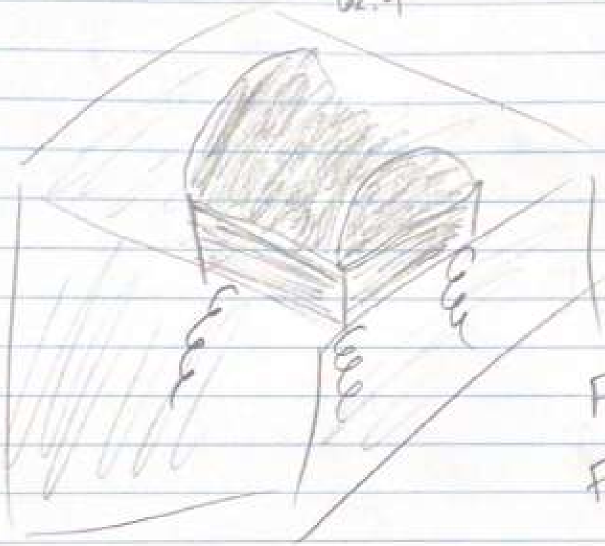
$66 + \frac{36^2}{12(66)} = 67.63636364\ in = 5.636\,ft$

$\phi = \tan^{-1}\left(\frac{F_v}{F_H}\right) = \tan^{-1}\left(\frac{871}{4066}\right) = 12.09°$

5.8

8.

$$0.9 = \frac{\gamma}{62.4}$$



$Sg = 0.9$

$\omega = 14.6\ lb$

$V = 40\ in^3$

$\gamma = 56.16\ lb/ft^3$

$F_b = \gamma_f V_d$

$F_b = 56.16\ lb/ft^3\,(0.023\ ft^3)$

$F_b = 1.29\ lb$

$F_s = 14.6\ lb - 1.29\ lb$

$= 13.3\ lbs$

5.24

24.

$F_b = \gamma_f V_d$

$9.99\ \text{kN/m}^3\,(.159 \times .75)\,\text{m}$

$F_b = 1.1315$

$\gamma_{cylinder} = \gamma_{brass} \dfrac{V_{brass}}{V_{cylinder}} = 9.07\left(\dfrac{\pi .225^2 \cdot .600}{\pi .225^2 \cdot .75}\right)$

$8.07\left(\dfrac{0.095}{.119}\right)$

$= 6.44\ \text{kN/m}^3$

$\gamma_{total} = \gamma_{water}\left(\dfrac{V_{cylinder}}{V_{brass}}\right)$

$90.44 = 9.44\left(\dfrac{\pi .225^2 \cdot .75}{\pi .225^2 \cdot t + \pi .225^2 \cdot .75}\right) = 9.58 = \dfrac{.119}{.119 + .159t}$

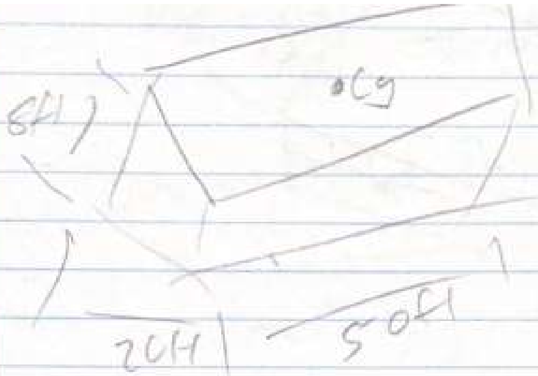
$9.58 = \dfrac{\cancel{.119}}{\cancel{.119} + .159t}$

$\dfrac{1}{.159}$

$60.25\ \text{mm} = t$

5.41

41.



$I = \frac{bh^3}{12} = \frac{(50)(20^3)}{12}$

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

$I = 33333.33 \ ft^3$

$\frac{33333.33 ft^3}{50 \times 20 \times 7.05}$

$F_w = F_B = \gamma_f V_d$

$450000 lb = 64 lb/ft^3 (50 \times 20 \times h) 4$

$h = 7.03 ft$ $\quad M_B = 4.74$

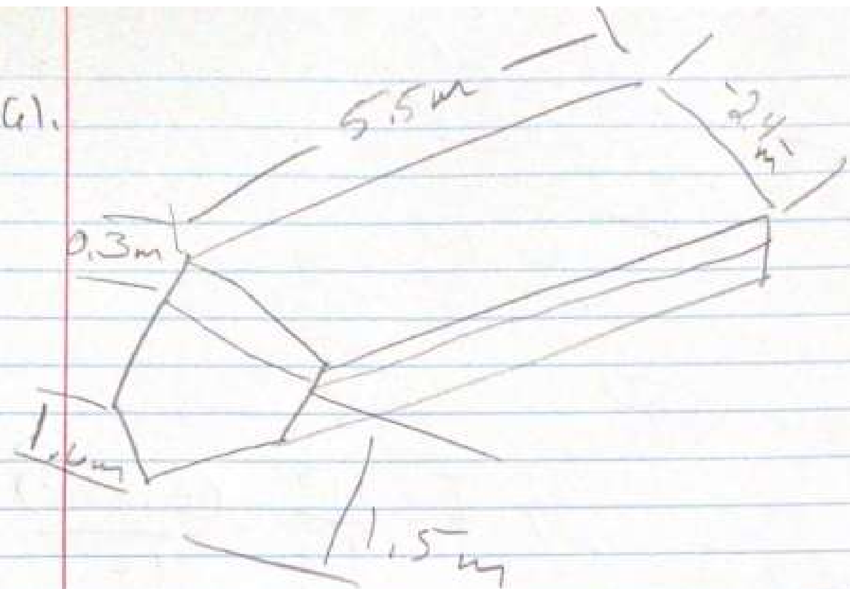
$y_b = \frac{h}{2} = \frac{7.03 ft}{2} = 3.515 ft$

$y_{mc} = 3.515 ft + 4.74 ft = \underline{8.26 ft}$

yes, it is stable

5.61

61.



$V_t = \left(\frac{1}{2} b h\right) L = \left(\frac{1}{2}(0.6)(2.4)\right) 5.5 = 3.96\ m^3$

$V_R = .9m \cdot 2.4m \cdot 5.5m = 11.88m^3$

$V_d = 15.84 =$

$y_b = \dfrac{(Ay)_{rec} + (Ay)_{tri}}{A_{total}} = \dfrac{(0.9)(2.4)\left(\frac{0.9}{2}\right) + \left(\frac{1}{2}(0.6)(2.4)\right)\left(\frac{2}{3}(0.6)\right)}{2.88}$

$y_b = \dfrac{0.248 + 0.288}{2.88} = 0.4975m$

$y_{cg} = \dfrac{(Ay)_{rec} + (Ay)_{tri}}{A_{total}} = \dfrac{(1.2)(2.4)\left(\frac{1.2}{2}+.6\right) + \left(\frac{1}{2}(0.6)(2.4)\right)\frac{2}{3}0.6}{3.6}$

$y_{cg} = \dfrac{3.456 + 0.288}{3.6} = 1.04m$

$$\frac{(5.5\,m)(2.4\,m)^3}{12} = 6.336\,m^3$$

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

$$y_{mc} = 0.4\,m + 0.8875\,m = 1.29\,m$$

$$\boxed{\begin{array}{l} y_{mc} > y_{cg} \text{ is stable} \\ 1.29\,m > 1.04\,m \end{array}}$$