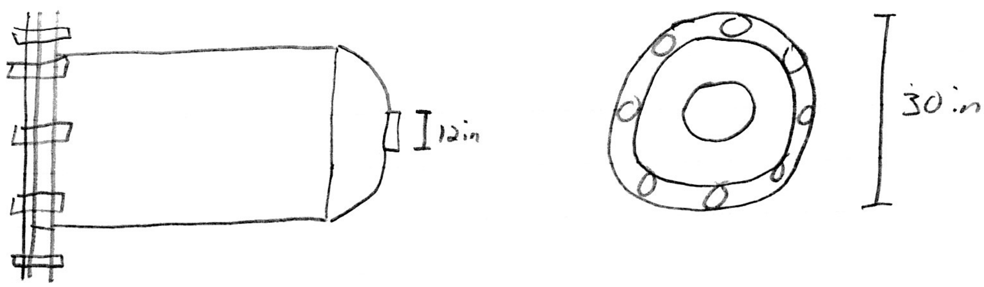
Homework 1.6 Chapter 4 — Giant Falcon

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




We know that $P = \frac{F}{A} \rightarrow F = P \cdot A$

Then $A = \frac{\pi (30in)^2}{4} = 706.86\,in^2$

So $F = (14.4\,lb/in^2)(706.86\,in^2) = \boxed{10178.8\,lb}$

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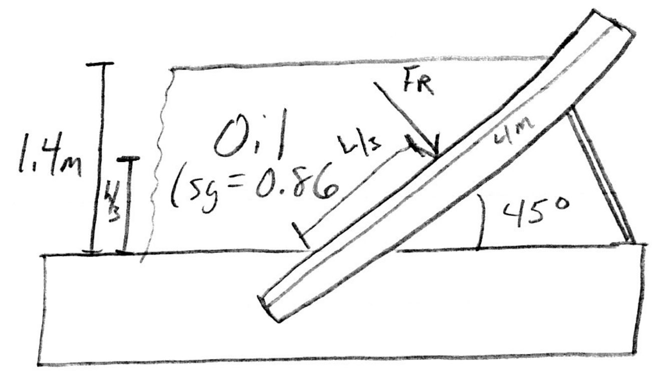
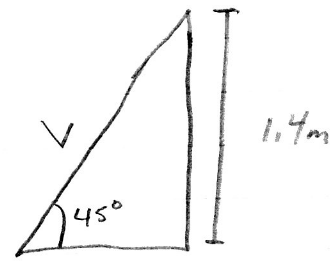
4.17 If the wall in the figure is 4m long, calculate the total force on the wall due to the oil pressure. Also, determine the location of the center of pressure and show the resultant force on the wall.




We know that $h_c = \frac{h}{2}$ so $P_{Avg} = \gamma_{oil}\left(\frac{h}{2}\right)$

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

We know that $\sin(45°) = \frac{1.4m}{L} \rightarrow L = \frac{1.4m}{\sin(45°)} = 1.980m$

Then $A = (1.980m)(4m) = 7.92m^2$

So $sg_{oil} = \frac{\gamma_{oil}}{\gamma_{H_2O\,@4°C}} \rightarrow \gamma_{oil} = (0.86)(9.81\,kN/m^3) = 8.437\,kN/m^3$

Then $F_R = (8.437\,kN/m^3)\left(\frac{1.4m}{2}\right)(7.92m^2) = \boxed{46.77\,kN}$

We know vertical center of pressure is $\frac{h}{3}$ from bottom

We know center of pressure along face is $\frac{L}{3}$ from bottom

Then $L_P = L - \frac{L}{3} = 1.980m - \frac{1.980m}{3} = \boxed{1.32m}$

Then $h_P = h - \frac{h}{3} = 1.4m - \frac{1.4m}{3} = \boxed{0.933m}$

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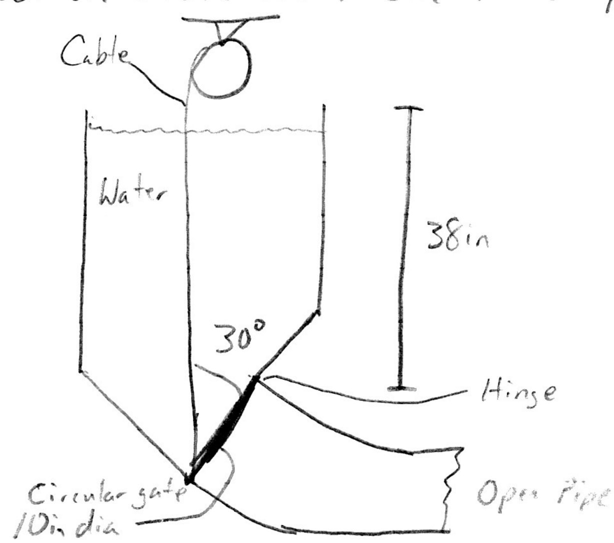
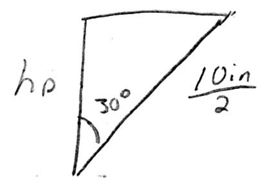
4.42 The figure shows a tank of water with a circular pipe connected to its bottom. A circular gate seals the pipe opening to prohibit flow. To drain the tank, a winch is used to pull the gate open. Compute the amount of force that the winch cable must exert to open the gate.




We assume force from water is acting at center of the gate

So $h_p = \cos(30°) \cdot \frac{10in}{2} = 4.33in$

Then $h_c = 38in + h_p = 42.33in$

So $L_c = \frac{h_c}{\cos(30°)} = \frac{42.33in}{\cos(30°)} = 48.88in$

We know $A = \frac{\pi D^2}{4} = \frac{\pi(10in)^2}{4} = 78.54in^2$

Then $F_R = \gamma_{H_2O} h_c A = (62.4\,lb/ft^3)(42.33in(\frac{1ft}{12in}))(78.54in^2(\frac{1ft^2}{144in^2}))$

$F_R = 120.05\,lb$

Then $I_c = \frac{\pi D^4}{64} = \frac{\pi(10in)^4}{64} = 490.87in^4$

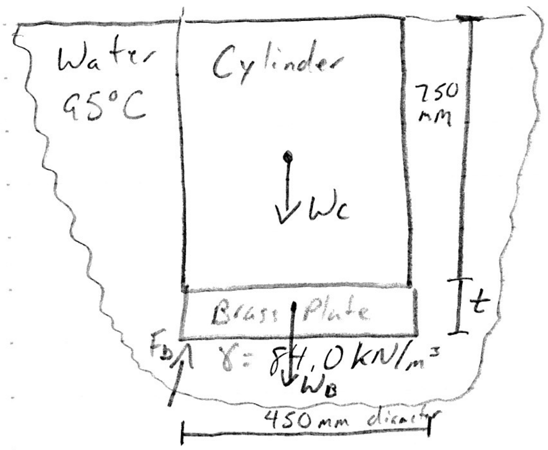
We know $L_p = L_c + \frac{I_c}{L_c A} \rightarrow L_p = 48.88in + \frac{490.87in^4}{(48.88in)(78.54in^2)} = 49.01in$

Then $\Sigma M_H = 0 \rightarrow F_R(\frac{D}{2} + (L_p - L_c)) - F_c(\frac{D}{2}) = 0$

$\rightarrow 120.05lb(\frac{10in}{2} + (0.1279in)) = F_c(5in) \rightarrow \boxed{F_c = 123.12\,lb}$

Homework 1.6 Chapter 5 Giant Falcon

5.24 A brass weight is to be attached to the bottom of the cylinder in the figure, 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. What is the required thickness of the brass?




From 5.22 it was determined that $\gamma_{cyl} = 6.45\ kN/m^3$

$\gamma_{H_2O}$ @ 95°C $= 9.44\ kN/m^3$

We know $F_b = \gamma_{H_2O} \cdot V_d$ and $W = \gamma_{obj} \cdot V_{obj}$

Then $W_c = \gamma_{cyl} \cdot V_{cyl} = (6.45\ kN/m^3)\left(\frac{\pi(0.45m)^2}{4}\right)(0.75m)$

$W_c = 0.7694\ kN$

Then $W_B = \gamma_B \cdot V_B = (84.0\ kN/m^3)\left(\frac{\pi(0.45m)^2}{4}\right)(t\ m)$

$W_B = (13.36\ kN/m)\,t\ m$

Then $F_b = (9.44\ kN/m^3)\left(\frac{\pi(0.45m)^2}{4}(0.75m) + \frac{\pi(0.45m)^2}{4}(t\ m)\right)$

$F_b = 1.126\ kN + (1.501\ kN/m)\,t\ m$

So $\Sigma F_y = 0 \rightarrow F_b - W_c - W_B = 0$

$\rightarrow 1.126kN + (1.501\ kN/m)t - 0.769\ kN - (13.36\ kN/m)t = 0$

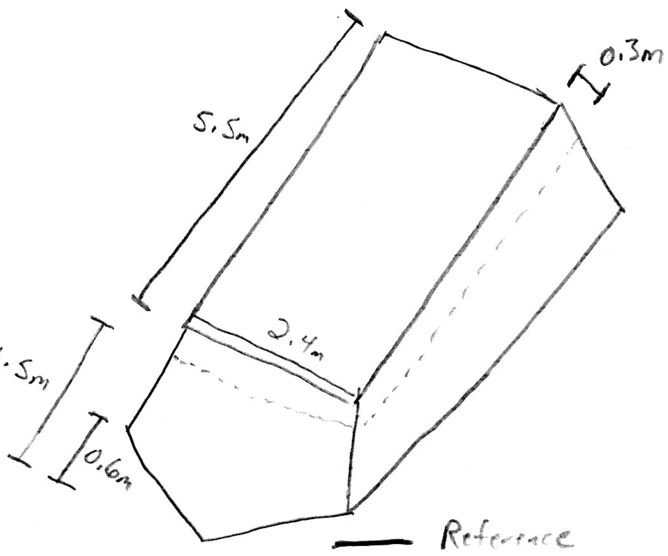
$\rightarrow (11.859\ kN/m)t = 0.357\ kN$

$\rightarrow t = 0.0301\ m$

**$t = 30.1\ mm$**

Homework 1.6 Chapter 5 Giant Falcon

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?




We know that a floating body is stable if the center of gravity is below the metacenter.

UW - underwater

$$A_{Boat} = A_{Rec} + A_{Tri} = (1.5m + 0.3m - 0.6m)(2.4m) + (\tfrac{1}{2}\cdot(2.4m)(0.6m))$$
$$A_{Boat} = 3.6m^2$$

$$A_{UW} = A_{REC} + A_{Tri} = (1.5m - 0.6m)(2.4m) + (\tfrac{1}{2}\cdot(2.4m)(0.6m))$$
$$A_{UW} = 2.88m^2$$

$$V_d = (1.5m - 0.6m)(2.4m)(5.5m) + (\tfrac{1}{2}(2.4m)(0.6m))(5.5m)$$
$$V_d = 15.84m^3$$

We know $I = \frac{LB^3}{12} = \frac{(5.5m)(2.4m)^3}{12} = 6.336m^4$

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

Submerged Then $y_{CB} = \frac{y_{REC}\cdot V_{REC} + y_{Tri}\cdot V_{Tri}}{V_d} = \frac{(0.6m + 0.9m/2)(11.88m^3) + (2/3\cdot(0.6m))(3.96m^3)}{15.84m^3}$

$$y_{CB} = 0.8875m$$

Total Then $y_{CG} = \frac{y_{REC}\cdot V_{REC} + y_{Tri}\cdot V_{Tri}}{V_{Boat}} = \frac{(0.6m + 1.2m/2)(15.84m^3) + (2/3(0.6m))(3.96m^3)}{19.8m^3}$

$$y_{CG} = 1.04m$$

So $y_{MC} = y_{CB} + MB = 0.8875m + 0.4m =$ $\boxed{1.2875m > 1.04m \quad \text{Yes}}$