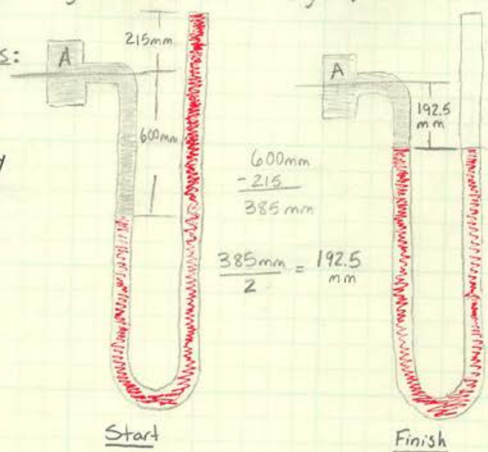
Problem 1 | Test 1 | Dezmond Banks

Purpose:

Determine what the pressure would be at "A" if the Mercury/water interface in the left leg and the Mercury surface on the right leg are the same height.

Drawings:

- Water
- Mercury



Sources:

Mott, R. Untener, J.A "Applied Fluid Mechanics", 7th edition
Pearson Education, Inc, (2015) pg. 46

Design Considerations:

- Mercury and water dont mix
- Assuming there are no leaks in the system
- Mercury never leaves the system
- incompressible fluids

Data and Variables:

- γ_{water} - 9.81 KN/m³
- $\Delta P = \gamma h$
- $\gamma_{mercury}$ = 132.83 KN/m³
- P_1 = 102.4 KPa (gage)

Procedure:

For this problem, the first thing I did was re-illustrate the problem to help me better understand what was happening. Second I began moving the mercury by Subtracting 215 from the right side of the manometer and subtracting 215mm from the left side. (Figure 1) After doing this my distance 600mm was now 385mm. I then moved the mercury half of the 385mm distance making the mercury equal on both sides. My new distance from the Merc/water interface to "A" was then 192.5mm. After getting my new height, I then converted it from mm to m. I then used formula $\Delta P = \gamma h$ to find the pressure.

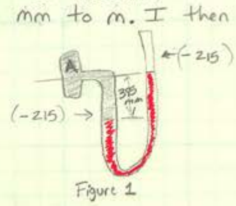


Figure 1

Calculations:

$\gamma_{water} = 9.81 \, KN/m^3$

$h = 600 - 215 = 385mm$

$h = \frac{385}{2} = 192.5 \cancel{mm} \times \frac{.001m}{1\cancel{mm}} = .1925m$

$\Delta P = \gamma h$

$\Delta P = (9.81 KN/m^3)(.1925m)$

$\Delta P = 1.89 \, KN/m^2$ or KPa

Summary:

By understanding that the only way for the mercury to move was for the water to move I was able to clearly illustrate the change in height and calculate the new pressure.

Materials:

- Manometer
- Pipe
- Water
- Mercury

Analysis:

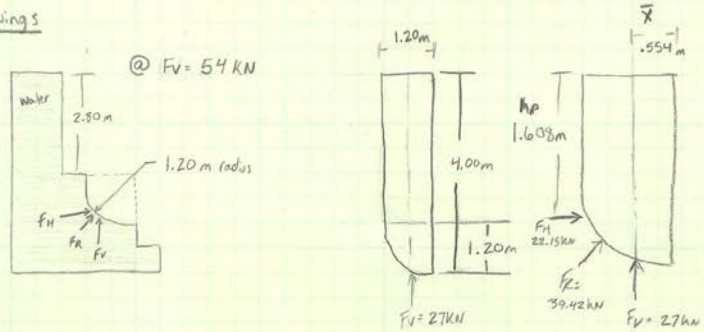
The main point to recognize in this problem is how the mercury and water move throughout the system. Once that is understood and your adjustments have been made the last thing to do is use the $\Delta P = \gamma h$ Formula to find pressure.

Problem 2 | Test 1 | Dezmond Banks

Purpose:

Determine the resultant force @ 27 KN, Also the resultant force direction and the location of the new vertical and horizontal forces.

Drawings



Sources:

Mott, R. Untener, J.A "Applied Fluid Mechanics", 7^{th} edition, Pearson Education, INC, (2015)

Design Considerations:

- No leaks
- 54 KN to 27KN
- Force exerted on curved surface by Fluid

Data and Variables

- $F_V = \gamma A w$ - $F_H = \gamma s w h_c$
- $h_c = h_1 + s/2$ - $F_R = \sqrt{F_V^2 + F_H^2}$
- $V = Aw$ - $\theta = \tan^{-1}(F_V/F_H)$
- $\bar{X} = \dfrac{A_1 X_1 + A_2 X_2}{A_1 + A_2}$
- $A = A_1 + A_2 = h_1 \cdot R + \dfrac{\pi r^2}{4}$
- $h_p = h_c + s^2/(12 h_c)$
- $\gamma_{water} = 9.81\ KN/m^3$

- $F_{V_1} = 54KN$ - $R = 1.20$ - $\bar{X}$ = location of centroid
- $F_{V_2} = 27KN$ - @ 54KN $h_1 = 2.80$ - θ = angle of inclination
- $S = 1.20$ - h_p = depth of centroid

Problem 2 Continued | Test 1 | Dezmond Banks

Procedure:

- First I found Area @ $F_V = 54kN$ using $A = A_1 + A_2 = h_1 \cdot R + \frac{\pi r^2}{4}$
- Second I found the width using $\frac{F_V}{\gamma A} = w$
- Third I found Area @ $F_V = 27kN$ using $\frac{F_V}{\gamma w} = A$
- Fourth I found A_1 using $A = A_1 + A_2$ and then I solved for h_1 using $A_1 = h_1 \cdot R$
- Fifth I solved for h_c using $h_c = h_1 + S/2$
- Sixth I solved for F_H using $F_H = \gamma_s w h_c$
- Seventh I solved for F_R using $F_R = \sqrt{F_V^2 + F_H^2}$
- 8th I solved for θ using $\theta = \tan^{-1}(F_V/F_H)$
- 9th I solved for h_p using $h_p = h_c + S^2/(12 h_c)$
- 10th I solved for x_1 and x_2 using formulas from back of book
- 11th I solved for $\bar{X}$ using $\bar{X} = \frac{A_1 x_1 + A_2 x_2}{A_1 + A_2}$

Calculations:

@ $F_V = 54kN$ $\quad A = A_1 + A_2 = h_1 \cdot R + \frac{\pi r^2}{4}$

$$A = (2.80)(1.20) + \frac{\pi (1.20)^2}{4}$$
$$A = 3.36m^2 + 1.13m^2$$
$$A = 4.49m^2$$

$\frac{F_V}{\gamma A} = w$

$$\frac{54}{(9.81)(4.49)} = w$$
$$w = 1.23m$$

@ $F_V = 27kN$ $\quad \frac{F_V}{\gamma w} = A$

$$\frac{27}{(9.81)(1.23)} = A$$
$$A = 2.24m^2$$

$A = A_1 + A_2$

$$2.24m^2 = A_1 + 1.13m^2$$
$$-1.13 \qquad -1.13$$
$$A_1 = 1.11m^2$$
$$A_1 = h_1 \cdot R$$
$$\frac{1.11}{1.2} = \frac{h_1 \cdot (1.2)}{1.2}$$
$$h_1 = .93m$$

$$h_c = h_1 + S/2$$
$$h_c = .93m + 1.20m/2$$
$$h_c = 1.53m$$

$$F_H = \gamma_s w h_c$$
$$F_H = (9.81)(1.20)(1.23)(1.53)$$
$$F_H = 22.15 KN$$

$$F_R = \sqrt{F_V^2 + F_H^2}$$
$$F_R = \sqrt{27^2 + 22.15^2}$$
$$F_R = \sqrt{1219.6}$$
$$F_R = 34.92$$

$$\theta = \tan^{-1}(27/22.15)$$
$$\theta = 50.64°$$

$$h_p = h_c + S^2/(12h_c)$$
$$h_p = (1.53) + (1.2)^2/12(1.53)$$
$$h_p = 1.53m + \frac{1.44m^2}{18.36m}$$
$$h_p = 1.53m + .0784m$$
$$h_p = 1.608m$$

$$x_1 = 1.20/2$$
$$x_1 = .6m$$

$$x_2 = .424R$$
$$x_2 = .424(1.2)$$
$$x_2 = .5088$$

$$\bar{X} = \frac{A_1 x_1 + A_2 x_2}{A_1 + A_2} = \frac{(1.11m^2)(.6m) + (1.13m^2)(.5088m)}{1.11m^2 + 1.13m^2}$$
$$\bar{X} = \frac{1.241m^3}{2.24m^2}$$
$$\bar{X} = .554m$$

Problem 2 continued | Test 1 | Dezmond Banks

Summary:

After finding the W of the tank @ 54 KN I was able to put my Calculation into formulas to find my resultant force, its direction and the location of FH and Fv. The FR was 34.92 @ 50.64° inclination. FH was located at the depth of the centroid: 1.608m and Fv was located at the location of the Centroid: .554m

Materials:

- Water
- tank

Analysis:

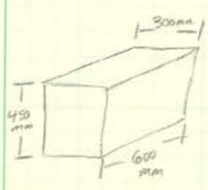
When analyzing the problem I had to pretend there was fluid on the otherside of the curve to figure out the forces of the water.

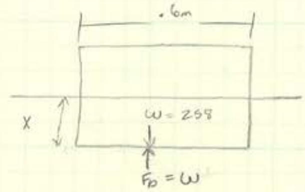
Problem 3 - Test 1 Dezmond Banks

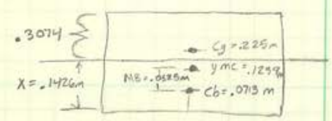
Purpose:

Determine if the package will be stable while floating in its current orientation.

Drawings:







Sources:

Mott, R. Untener, J.A "Applied Fluid Mechanics" 7th edition, Pearson Education, INC (2015) Pg. 103–106

Design Considerations:

- After cable break package will float
- Some of the package will be out of the water
- if the package is floating $F_b = W$
- Package is a rectangular prism
- Package weight is evenly distributed

Data and Variables:

- $\gamma_{sea\ water} = 10.05\ kN/m^3$
- $F_b = W = 258N$
- $F_b = \gamma_f V_d$
- distance between cb + mc = MB
- $MB = I/V_d$
- $I = \frac{LB^3}{12}$
- $y_{cb} = \frac{X}{2}$
- $C_g = \frac{H}{2}$
- $y_{mc} = y_{cb} + MB$
- $\frac{F_b}{\gamma_f * B * L} = X$

Procedure:

First I assumed part of the package was out of the water and the other part was submerged. Then I stated that $F_b = W$ because the package was floating. Next I converted 258N to .258kN
- Next I found V_d using $\frac{F_b}{\gamma_f} = V_d$
- Next I solved for "X" using $\frac{F_b}{\gamma_f * B * L} = X$
- Next I solved for I using $I = \frac{Lb^3}{12}$
- Then I solved for MB using $MB = I/V_d$
- Next I found y_{cb} using $y_{cb} = \frac{X}{2}$
- Next I found C_g using $C_g = \frac{H}{2}$
- Then I found y_{mc} using $y_{mc} = y_{cb} + MB$

Problem 3 (continued) | Test 1 | Desmond Banks

Calculations:

$W = 258N = .258 kN$

$\gamma_{sea\ water} = 10.05 kN/m^3$

$Fb = W$

$B = .3m$

$L = .6m$

$Fb = \gamma_f Vd$

$\frac{Fb}{\gamma_f} = Vd$

$Vd = \frac{.258 kN}{10.05 kN/m^3} = .0257m^3$

$Vd = .0257m^3$

$\frac{Fb}{\gamma_f \cdot B \cdot L} = X$

$\frac{.258 kN}{(10.05 kN/m^3)(.3m)(.6m)} = X$

$X = .1426m$

$I = \frac{LB^3}{12}$

$I = \frac{(.6m)(.3m)^3}{12}$

$I = .00135m^4$

$MB = I/vd$

$MB = \frac{.00135m^4}{.0257m^3}$

$MB = .0525m$

$ycb = \frac{X}{2}$

$ycb = \frac{.1426m}{2}$

$ycb = .0713m$

$Cg = \frac{H}{2}$

$Cg = \frac{.45m}{2}$

$Cg = .225$

$ymc = ycb + MB$

$ymc = (.0713m) + (.0525m)$

$ymc = .1238$

Not stable

Summary:

By knowing that the object was floating I knew that Fb=W. Once I knew Fb=W I was able to use seperate formulas to find the metacenter, center of gravity, center of boyancy etc. Once I know the position of the center of gravity and the metacenter I was able to confirm that the object would not be stable because the center of gravity was higher than the metacenter of the package.

Materials:

- Sea water
- Package
- broken cable

Analysis:

When dealing with a problem like this the key is to not focus on the formulas, but to focus on what is actually happening to the package. This gave me a clear understanding of what was happening and what to do next.