Test 1

terça-feira, 24 de setembro de 2024 14:23

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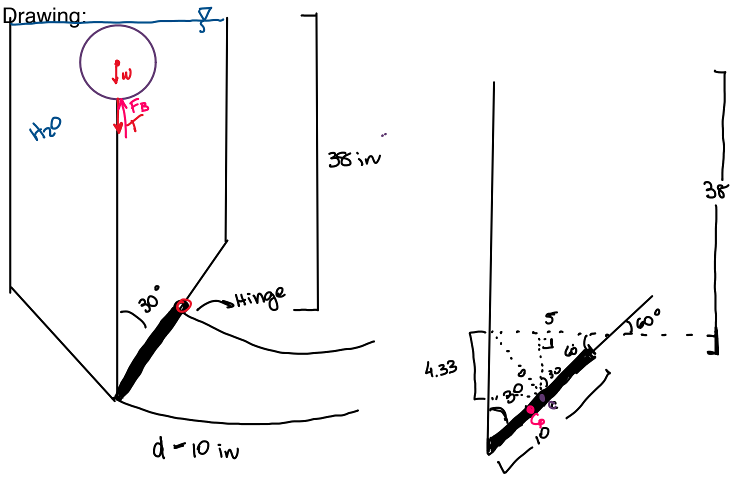
Part a)

F: the puropose of part A of the problem, consist in using the information provited in the drawing to calculate the size of the bouy by using the formulas learned in class; find the stability of the bouy to pull the gate. With those information, make the calculations through excel, after doing the excel sheet, change the values to find out the smallest diameter of the bouy possible, plotting the values in it.

Drawing:



Source: Robert Mott & Joseph Untener. Applied Fluid Mechanics, 8th edition. Person

Design Considerations:
- Constant properties
- Incompressible fluids
- Isothermal conditions

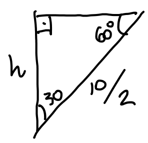
Materials:
- Water @60F
- Air @ 60F
- Bouy (no defined material)

Data and Variables:
- Mass flow = 3.387 ft3/s
- L suction pipe= 11in
- L discharge pipe = 2500 feet
- D hinge to top = 38in
- Gama Water= 62.4 lb/ft3

Procedures:
Calculate hc, A, Ic , with that you're able to find Fr in the gate
Calculate Lc, Lp, hp,
Use the sum of momentum to find tension
With tension calculate the force of bouyancy, finding the Radius of bouy, volume and mass of the bouy
Find the stability
Plug the formular in excel, find new angles and diameters.
first I had to calculate the h_c the area of the gate

Calculations:

and the moment of inertia of the gate



$$\sin 30^\circ = \frac{w}{10} \rightarrow \sin 30^\circ \times 10 = w$$

$$w = 5 \text{ in}$$

$$\cos 30^\circ = \frac{h}{5}$$

$$h = 5 \cos 30^\circ$$

$$h = 4.33 \text{ in}$$

$$h_c = h + 38 = 4.33 + 38$$

$$h_c = 42.33 \text{ in} = 3.53 \text{ ft}$$

$$A = \frac{\pi}{4} D^2 = \frac{10^2 \pi}{4} = 78.54 \text{ in}^2 = 0.54 \text{ ft}^2$$

$$I_c = \frac{\pi}{32} D^4 = \frac{\pi}{32} \cdot 10^4 = 981.75 \text{ in}^4 = 0.0473 \text{ ft}^4$$

After having those I can use it to calculate the force being made in the middle of the gate (F_R)

$$F_R = \gamma h_c A \qquad \gamma_w = 62.4 \text{ lb/ft}^3$$

$$F_R = 62.4 \times 3.53 \times 0.54$$

$$F_R = 118.95 \text{ lb}$$

calculating then the L_c, L_p and h_p value by using the h_c and cosine of the angle

$$\cos 30^\circ = \frac{h_c}{L_c} \rightarrow L_c \cos 30^\circ = h_c$$

$$L_c = \frac{h_c}{\cos 30^\circ} = \frac{3.53 \text{ ft}}{\cos 30^\circ} \rightarrow L_c = 4.08 \text{ ft}$$

$$L_p = \frac{I_c}{L_c A} + L_c \qquad L_p = \frac{0.0473 \text{ ft}}{4.08 \cancel{\text{ft}} \times 0.54 \cancel{\text{ft}^2}} + 4.08 \text{ ft}$$

$$L_p = 4.10 \text{ ft}$$

$$h_p = h_c + \frac{I_c \sin^2\theta}{h_c A} = 3.53\,ft + \frac{0.0973\,\cancel{ft^4} \times \sin^2 30^\circ}{3.53\,\cancel{ft} \times 0.59\,\cancel{ft^2}} = 3.54\,ft$$

distance c_p from hinge

$= 3.54\,ft - 38\,in$

$\quad \hookrightarrow 3.17$

$= 3.54 - 3.17 = 0.37\,ft$ or $4.44\,in$