Test 1 MET330 HUNTER LINKER ①

PURPOSE:

DESIGN A LAZY RIVER THAT is Able To Fit AT LEAST Two Tubes with an outside diameter of 95cm and an INSIDE DIAmeter OF 35cm. THe water depth should be adiquite enough For a 3-year-old girl can stand without Danger. The slope should be 0.1%. Determine the Flow rate required, Drag Force on a 5 year old child, How Deep and How stable will a tube be carrying a 250 lb person, and Finally the Force magnitude on a 1 m long section with its location on the wall.

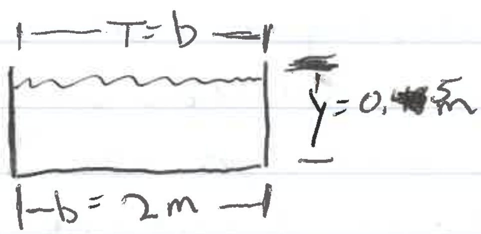
Sources:

Mott, R, UNTEnor, J.A., "Applied Fluid mechanics", 7th edition, Pearson education inc (2015)

Design considerations:

- CONSTANT properties
- INcompressible Fluid
- Open-CHANNEL

DRAwings and DIAgrams:



MATERIALS
- Smooth concreate
- WATER
- AIR

DATA & VARIABLES
- $b = 2m$
- $y = 0.5m$
- Average Height of 3 year old girl = 40"
- $\rho_{@25C} = 997\ kg/m^3$

- $n = 0.013$
- Slope = 1% → 0.01 = (S)
- $C_D \approx 1.17$
- $\gamma_{water\ @25°} = 9.78$
- $w = 250\ lb$

Procedure:

Using the given variables and the discharge equation calculate Q of the river. Using mannings equation solve for velocity. Then plug in those values for the Drag Force equation. To find Boyancy you will need volume and the specific weight of the fluid. Then find W by using the specific weight of the object times its volume. Now to find stability subtract the two numbers. For part D you take the force equation given in the book and your flow, density and velocity to find the magnitude. Question 5 uses previous values from the last test, using those values you find the sum of the forces in both x and y directions. Question 6 uses the flow equation to solve this you will need to calculate C for that you will also need β and the reynolds number then you can simplify your equation and solve for flow

CALCULATIONS

1) $Q = \left(\frac{1}{n}\right) A (R)^{2/3} (S^{1/2})$ $\quad n = 0.013 \quad A = 0.5(2) = 1$

$R = A/wp \quad wp = 2+.5+0.5 = 3$

↳ $R = 1/3 \quad S = 0.01$

$Q = \frac{1}{0.013}(1)(1/3)^{2/3}(0.01)^{1/2} = 3.698$

$\boxed{Q = 3.698\ M/s}$

2) $F_D = C_D(\rho V^2/2)A$ $\quad A = 1\,m^2 \quad \rho_{a\,25°} = 997$

$V = \left(\frac{1}{n}\right)(R^{2/3})(S^{1/2}) \quad CD = 1.17$

$V = \left(\frac{1}{0.013}\right)(1/3)^{2/3}(0.01)^{1/2} = 3.698 \quad V = 3.698$

$F_D = (1.17)(997(3.698)^2/2)(1) = 7975.9$

$\boxed{FD = 7975.9}$

3) $F_b = \gamma_f V d$ $\quad \gamma_f = 9.78 \quad V = 1.81 \times 10^5\ cm^3$

$w = 250 lb \rightarrow 113.39\ kg$

$V_{cyl} = \pi r^2 h = \pi(.48)^2(.5) = 0.36\,m^3$

$F_b = 9.78(0.36) = 3.52$

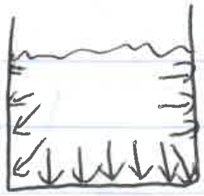
$w = 1.9(0.36) = 0.684$

$f_e = Fb - w = 3.52 - 0.684 = \boxed{2.836}$

STABLE

4) $L = 1m \quad F = MA \quad Q = 3.698\ m/s \quad \Delta V = V - 0$

$\Delta V = V$



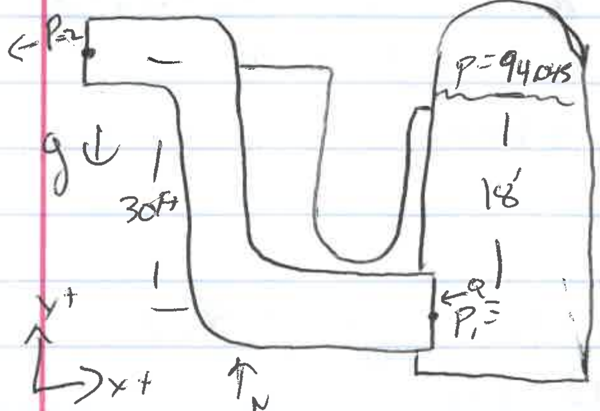
$F = \rho Q \Delta V$

$F = 997\ kg/m^3 \cdot 3.698\ m/s\ (\Delta V)$

$F = 3{,}686.9N\ (\Delta V) \quad \Delta V = 0$

$F/\Delta V = 3{,}686.9 \quad \boxed{F = 3{,}686.9N}$

5) $Q = 100$ gpm $\quad \gamma_{alc} = 49.0\,lb/ft^3 \quad D_{alc} = 1.37\times10^{-5}$



$\Sigma F_x = \rho Q(v_2 - v_1) \quad v = 23.875$

$\Sigma F_x = 0$

$\Sigma F_x = -Q - P_2(30)(23.875)$

$\Sigma F_x = -100(-40(30))(23.875)$

$\Sigma F_x = -100(-1200)(23.875$

$\Sigma F_x = -100(-28650) = 2{,}865{,}000$

$\Sigma F_y = 0$

$\Sigma F_y = -9.78(N) = 0 = -9.78N$

6) $v_1 = C\sqrt{\dfrac{2gh(\gamma_m/\gamma_f) - 1}{(A_1/A_2)^2 - 1}}$ $\quad g = N/A \quad \gamma_f = N/A$

$h = 0$ change $\quad A_1 = 0.0233$

$C = 0.9975 - 6.53\sqrt{\beta/N_R}$ $\quad \gamma_m = N/A \quad A_2 = 0.00582$

$C = 0.9975 - 6.53\sqrt{0.5/3237452.38}$ $\quad \beta = d/D = 0.0816/0.1723\,ft = 0.5$

$C = 0.99493$ $\quad N_R = \dfrac{vD\rho}{\eta} = \dfrac{(23.875)(0.1723)(787)}{1.00\times10^{-3}}$

$A_1 = 0.0233$

$A_2 = \pi R_2^2 = \pi(0.043075)^2$ $\quad N_R = 3237452.38$

$A_2 = 0.00582$

$v_1 = 0.99493\sqrt{\dfrac{-1}{\left(\dfrac{0.0233}{0.00532}\right)^2 - 1}}$

$\boxed{v_1 = 0.25665\ ft/s}$

Calculations cont. (5)

7) $t = \frac{PD}{2(SE + pY)}$

Design pressure = 94.045 E_p = 1.00

OD = 0.1733

(S) Allowable stress = 20.0

(Y) correction Factor = 0.40

$t = \frac{(94.045)(D)}{2(20(1) + (94.045)(0.4))} = \frac{94.045(D)}{115.236} = \frac{94.045(0.1733)}{115.236}$

$\boxed{t = 0.1406''}$

$c = \frac{\sqrt{E_0/D}}{\sqrt{1 + \frac{E_0 D}{E S}}}$

E = 200 GPA

$C = \frac{\sqrt{1.00/787}}{\sqrt{1 + \frac{(1.00)(0.1733)}{200(20)}}} = \frac{\sqrt{0.00127}}{\sqrt{1.000043325}} = \frac{0.03563}{1.00002}$

$\boxed{C = 0.03562}$

Summary

With this Design of the lazy river the tube selected will be stable. Also because the thickness of the pipe in the second question is 0.1406" the pipe should Not fail when referenced to the pipe selected.

Analysis

Because of the lazy river design the tube selected Should be stable and the ride will be safe for the average 3 year old girl. The pipe in question two should not fail because the design thickness is less then the actual thickness