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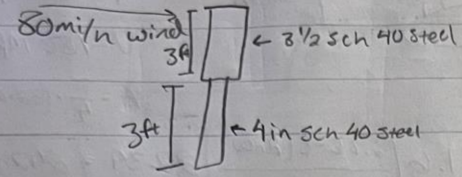
Test 3 MET330 Nicholas Albano

1.



$\rho = .07496$ lb/ft^3

$T = 71°F, \rho = 2.33E-3$ slug/ft^3

$3\,1/2 = D_o = 4in, D_i = 3.55$, flow $= .06868$ ft^2

$4 = D_o = 4.5in, D_i = 4.026in$, flow $= .0884$ ft^2

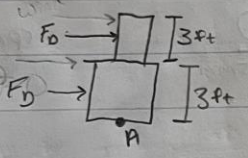
$V = 80$ mi/h $= 117.33$ ft/s

4in = .33ft

4.5in = .375ft

$A_{bottom} = .33ft \times 3ft\ .99ft^2$

$A_{Top} = .375\,ft \times 3ft = 1.125ft^2$



$\Sigma M_A = 0 = F_{D_b}(1.5) + F_{D_T}(4.5)$

$Top \rightarrow F_D = C_D\left(\frac{\rho v^2}{2}\right)A = 0.3\left(\frac{.0749(117.33)^2}{2}\right)1.125 = 173.99\ lb$

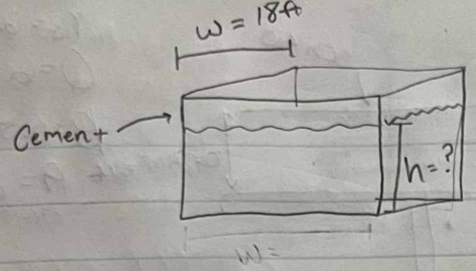
$bot \rightarrow F_D = C_D\left(\frac{\rho v^2}{2}\right)A = 0.3\left(\frac{.0749(117.33^2)}{2}\right).99 = 153.118\ lb$

$R_e = 2.3E6,\ C_D = 0.3$

$\Sigma M_A = 153.118(1.5) + 173.99(4.5) = \boxed{1012.63\ lb}$

Table 9:

2.



$n = .015$

Slope $= .001$

$Q = 350\,ft^3/s$

$A = W \cdot \Theta$, $WP = W + 2h$, $R = \frac{W \cdot h}{W + 2 \cdot h}$

$\text{Tan}\,\Theta = \frac{h}{L_2}$

$$Q = \frac{1.49}{n} A S^{1/2} R^{2/3}$$

$A = 18 \cdot h$, $WP = 18 + 2h$,

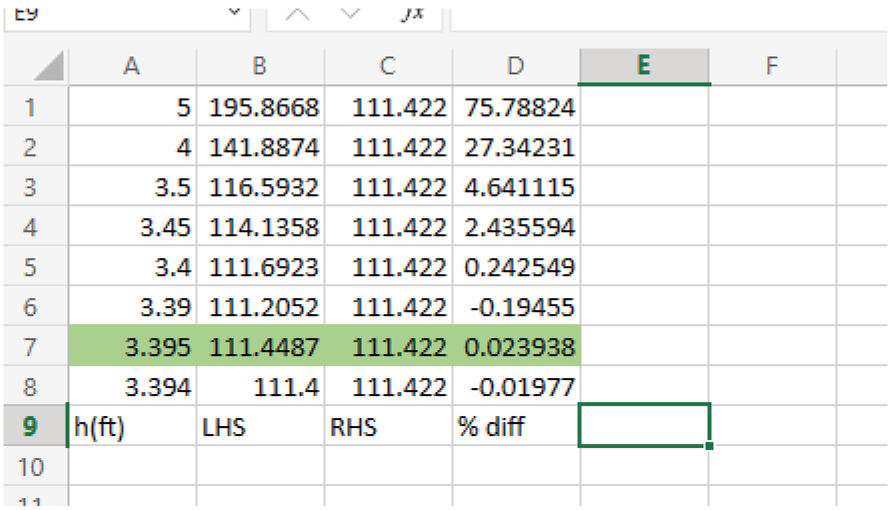
$$\downarrow$$

$$AR^{2/3} = \frac{nQ}{1.49 S^{1/2}} \rightarrow \frac{.015(350\,ft^3/s)}{1.49(.001)^{1/2}} \rightarrow AR^{2/3} = 111.422$$

$$R = \frac{A}{WP} = \frac{18 \cdot h}{18 + 2h}$$

$$18 \cdot h \left(\frac{18 \cdot h}{18 + 2n}\right)^{2/3} = 111.422$$

$$\boxed{\text{From Excel} \quad h = 3.395\,ft}$$



	A	B	C	D	E	F
1	5	195.8668	111.422	75.78824		
2	4	141.8874	111.422	27.34231		
3	3.5	116.5932	111.422	4.641115		
4	3.45	114.1358	111.422	2.435594		
5	3.4	111.6923	111.422	0.242549		
6	3.39	111.2052	111.422	-0.19455		
7	3.395	111.4487	111.422	0.023938		
8	3.394	111.4	111.422	-0.01977		
9	h(ft)	LHS	RHS	% diff		
10						

Table 5:

$\nu_w = 9.83E-6$

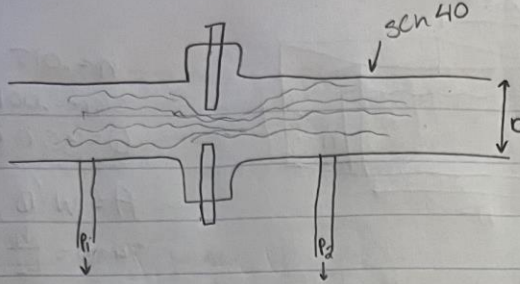
$\gamma_m = 844.9\ lb/ft^3$

$\gamma_w = 62.4\ lb/ft^3$

$Q = 6000\ Gpm = 13.37\ ft^3/s$

$\beta = 0.5$

3.



$D = 24in = 2ft$ $A = 2.792\ ft^2$

Find ΔP:

$V = \frac{Q}{A} \rightarrow \frac{13.37\ ft^3/s}{2.792\ ft^2} = 4.78\ ft/s$, $Re: \frac{VD}{\nu} = \frac{4.78 \cdot 2}{9.83E-6} = 972533.06$

$\beta = \frac{d}{D} \rightarrow d = \beta \cdot D \rightarrow d = 1ft$, $A_2 = .777 ft^2$ $C = .992$

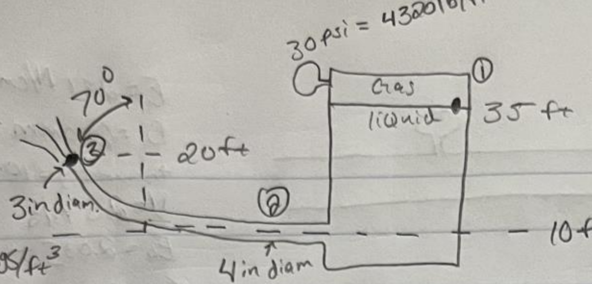
$\frac{P_1}{\gamma} + \frac{V_1^2}{2g} + \cancel{z_1}^0 = \frac{P_2}{\gamma} + \frac{V_2^2}{\gamma} + \cancel{z_2}^0 \rightarrow \frac{P_1}{\gamma} + \frac{V_1^2}{2g} = \frac{P_2}{\gamma} + \frac{V_2^2}{2g} \rightarrow P_1 - P_2 = \left(\frac{V_2^2}{2g} - \frac{V_1^2}{2g}\right)\gamma$

$\Delta P = \left(\frac{Q/A^2}{2g} - \frac{4.78^2}{2g}\right)\gamma \rightarrow \Delta P = \left(\frac{17.207^2}{2g} - \frac{4.78^2}{2g}\right)\gamma_m/\gamma_w \rightarrow \boxed{\Delta P = 57.44\ KPA}$

If height is = needed, $\boxed{h = .342ft = 4.104\ in}$

Table 7

4.



$\rho = 1.945 \text{ slugs}/\text{ft}^3$

$L_{curved} = 40 \text{ ft}$

$\gamma = 55 \text{ lb}/\text{ft}^3$

$A_1 = \frac{\pi}{4}(.33)^2 = .0855 \text{ ft}^2$

$A_2 = \frac{\pi}{4}(.25)^2 = .049 \text{ ft}^2$

$\Delta p = \gamma \cdot h$

$P_2 = 55 \text{ lb}/\text{ft} \cdot 25 \text{ ft} + 4320 \text{ lb}/\text{ft}^2 = 5695 \text{ lb}/\text{ft}$

$P_1 = 4320 \text{ lb}/\text{ft}^2$

using Bern eQ: $$\frac{P_1}{\gamma} + \frac{\overset{0}{\cancel{V_1^2}}}{2g} + z_1 = \frac{\overset{0}{\cancel{P_2}}}{\gamma} + \frac{V_2^2}{2g} + z_2$$

$$\frac{4320}{55} + 35 = \frac{V_2^2}{2g} + Z_2$$

$$\sqrt{(113.54) - 20) \cdot 2 \cdot 32.2} = V_3 = 77.616 \text{ ft/s}$$

$V = \frac{Q}{A} \rightarrow Q = V \cdot A \rightarrow 77.616 \text{ ft/s} \cdot .049 \text{ ft}^2 = 3.803 \text{ ft}^3/\text{s}$

$V_2 = \frac{Q}{A} = \frac{3.803}{.0855} = 44.48 \text{ ft/s}$

$F_x = \rho Q(V_2 - V_1) \rightarrow F_x = P_1A_1 - P_2A_2 \cos 20 - \rho Q V_2 \cos 20 + \rho Q V_1$

$F_x = 276.044$

$F_y = \rho Q(V_2 - V_1) \rightarrow F_y = P_2A_2 \sin 20 + \rho Q V_2 \sin 20$

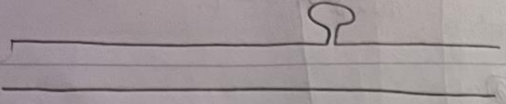
$F_y = 196.195$

$\boxed{\text{Mag} = \sqrt{F_x^2 + F_y^2} = 338.664 \text{ lb}}$

$\boxed{\text{Direction} = 35.402°}$

Table 0:

5.



$E = 2E7\ N/cm^2 = 2E11\ N/m^2$

$D_i = 600mm = 0.6\ m$

thickness(δ) = 10mm = .01 m

$V = 2.5\ m/s$

$E_0 = 2.03E5\ N/cm^2 = 2.03E\ 9\ N/m^2$

$\rho = 997\ kg/m^3$

Find p inrease: $\boxed{\Delta p = \rho C V}$

$$C = \frac{\sqrt{E_0/\rho}}{\sqrt{1+\frac{E_0 D}{E\delta}}} = \frac{\sqrt{2.03E9/997}}{\sqrt{1+\left(\frac{2.03E9 \cdot 0.6}{2E11 \cdot .01}\right)}} = .6054$$

$$\Delta p = \rho C V = \overset{kg/m^{\cancel{3}2}}{(997)} \cdot (.6054) \cdot \overset{m/s}{(2.5)} = \boxed{1508.9595\ kg/m_3^2}$$