Homework #1.5

Ch 14 Open Channel

MET 330 Virginia Beach Distance Learning WC2 and Campus

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Due Date: 10/3/19

Zach Hollifield

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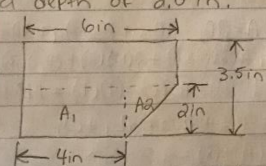
Homework 1.5

1) During the solved problems, we learned the cross-sectional area of an open channel is important in determining the hydraulic radius "R". The hydraulic radius is the area divided by the wetted perimeter. It is not possible to solve for the height after plugging in the area and hydraulic radius. Excel is used to determine values in which the percent difference is closest to zero. The new h value can be used in the next iteration. This method does not always work due to equations that are mathematically unstable.

Chapter 14 6,15,21,36,42

6) Compute the hydraulic radius for the section if water flows at a depth of 2.0 in.



$A_1 = (4 \times 2) = 8\,in^2$

$A_2 = \frac{1}{2}(2)(2) = 2\,in$

$A = 8 + 2 = 10\,in^2$

$L = \sqrt{x^2 + D^2} = \sqrt{2^2 + 2^2} = 2.8\,in$

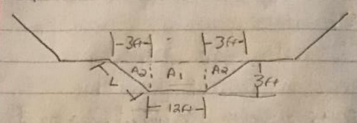
$WP = D + B + L = 2 + 4 + 2.8 = 8.8\,in$

$R = \frac{A}{WP} = \frac{10\,in^2}{8.8\,in}$

$\boxed{R = 1.13\,in}$

15) Figure represents the approximate shape of a natural stream channel with leeves built on either side. The channel is earth with grass cover. Use $n = 0.04$. If the average slope is 0.000 15 determine the normal discharge for depth of 3ft and 6ft

depth at 3 ft



$A_1 = (12 \times 3) = 36\ ft^2$

$A_2 = \frac{1}{2}(3)(3) = 4.5 \times 2 = 9\ ft^2$

$A = 36 + 9 = 45\ ft^2$

$L = \sqrt{x^2 + y^2} = \sqrt{(3)^2 + (3)^2} = 4.24\ ft$

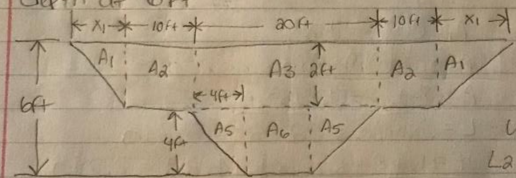
$WP = 2L + W = 2(4.24) + 12 = 20.48\ ft$

$R = \frac{A}{WP} = \frac{45\ ft^2}{20.48\ ft} = 2.2\ ft$

$Q = \left(\frac{1.49}{n}\right) A R^{2/3} S^{1/2} \rightarrow Q = \left(\frac{1.49}{0.04}\right) \times (45) \times (2.2)^{2/3} \times (0.00015)^{1/2}$

$\boxed{Q = 34.72\ ft^3/s \ @\ 3ft}$

depth at 6ft



$A = 2A_1 + 2A_2 + A_3 + A_4 + 2A_5$

$A = 2(\frac{1}{2})(2)(2) + 2(10)(2) + (20)(2) + (12)(4) + 2(\frac{1}{2})(4)(4) = 148\ ft^2$

$WP = 2L_2 + 2W_2 + 2L_1 + W_1$

$L_2 = \sqrt{(2)^2 + (2)} = 2.8\ ft^2$

$L_1 = \sqrt{(4)^2 + (4)^2} = 5.6\ ft^2$

$WP = (2)(2.8) + (2)(10) + (2)(5.6) + 12 = 4.8\ ft$

$R = \frac{A}{WP} = \frac{148\ ft^2}{48.8\ ft} = 3.03\ ft$

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

$Q = \left(\frac{1.49}{0.04}\right)(148)(3.03)^{2/3}(0.00015)^{1/2}$

$\boxed{Q = 141.4\ ft^3/s \ @\ 6\ ft}$

Zach Hollifield

21) The flow from two of the troughs passes into a sump, from which a round common clay drainage tile carries it to a storm sewer. Determine the size of tile required to carry the flow (500 gal/min) when running half full. The slope is 0.1 percent.

$Q = \left(\frac{1.49}{n}\right) AR^{2/3} S^{1/2}$

$AR^{2/3} = \frac{Qn}{1.49 S^{1/2}}$ $\qquad A = \frac{\pi D^2}{8}$ $\qquad R = \frac{A}{WP}$

$WP = \frac{\pi D}{2}$

$A = \frac{\frac{\pi D^2}{8}}{\frac{\pi D}{2}} = \frac{D}{4}$ $\qquad AR^{2/3} = \frac{\pi D^2}{8}\left(\frac{D}{4}\right)^{2/3} = \frac{\pi D^2}{8}\left(\frac{D^{2/3}}{2.519}\right)$

$AR^{2/3} = \frac{500\ \text{gal/min} \times \frac{1\ \text{ft}^3/\text{s}}{449\ \text{gal/min}} \times 0.013}{1.49(0.001)^{1/2}} = 0.3056$

$AR^{2/3} = \frac{\pi D^{8/3}}{20.158} = 0.1558 D^{8/3}$

$0.1558 D^{8/3} = 0.3056$ $\qquad D^{8/3} = \frac{0.3056}{0.1558} = 1.961$

$D = (1.961)^{3/8}$ $\qquad \boxed{D = 1.28\ \text{ft}}$

36) It is desired to carry 1.25 ft³/s of water at a velocity of 2.75 ft/s. Design the channel cross-section for each shape. $Q = 1.25\ \text{ft}^3/\text{s}$ $\quad v = 2.75\ \text{ft/s}$

$Q = AV \rightarrow A = \frac{Q}{V} = \frac{1.25}{2.75} = 0.4545\ \text{ft}^2$

$y = \frac{A}{b} \rightarrow y = \frac{A}{2y} \rightarrow y = \sqrt{\frac{A}{2}} = \sqrt{\frac{0.4545}{2}} = 0.476\ \text{ft}$ $\qquad b = 2y \rightarrow b = 2(0.476) = 0.953\ \text{ft}$

$\boxed{\text{Rectangle: } A = 0.4545\ \text{ft}^2,\ b = 0.953\ \text{ft},\ y = 0.476\ \text{ft}}$

$A = \frac{1}{2}(2y)(y) \rightarrow A = y^2 \rightarrow y = \sqrt{A} \rightarrow y = \sqrt{0.4545} = 0.6741\ \text{ft}$

$T = 2y \rightarrow T = 2(0.6741) = 1.348\ \text{ft}$

$\boxed{\text{Triangle: } A = 0.4545\ \text{ft}^2,\ T = 1.348\ \text{ft},\ y = 0.6741\ \text{ft}}$

$A = 1.73y^2 \rightarrow y = \sqrt{\frac{A}{1.73}} \rightarrow y \sqrt{\frac{0.4595}{1.73}} = 0.5125\ \text{ft}$

$b = 1.155y \rightarrow b = 1.155(0.5125) = 0.592\ \text{ft}$

$T = 2.309(y) \rightarrow T = 2.309(0.5125) = 1.183\ \text{ft}$

$\boxed{\text{Trapezoid: } A = 0.4545\ \text{ft}^2,\ b = 0.592\ \text{ft},\ T = 1.183\ \text{ft},\ y = 0.5125\ \text{ft}}$

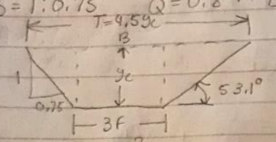
$y = \sqrt{\frac{2a}{\pi}} \rightarrow y = \sqrt{\frac{2(0.4545)}{\pi}} \rightarrow y = 0.537\ \text{ft}$

$D = 2y \rightarrow D = 2(0.537) \rightarrow 1.075\ \text{ft}$

$\boxed{\text{Semicircle: } A = 0.4545\ \text{ft}^2,\ y = 0.537\ \text{ft},\ D = 1.075\ \text{ft}}$

42) A trapezoidal channel with a bottom width of 3.0 ft and side slopes having a ratio of 1:0.75 carries 0.80 ft³/s of water and is made from trowel-finished concrete. Use y=0.05 ft in (d)

$S = 1:0.75 \qquad Q = 0.8\ ft^3/s$



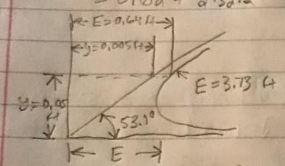
$A = \frac{3+4.5y_c}{2}(y_c) = 1.5y_c + 2.25y_c^2$

$\frac{A}{T} = \frac{Q^2}{g} \rightarrow \frac{1.5y_c + 2.25y_c^2}{4.5y_c} = \frac{Q^2}{32.2}$

$\boxed{y_c = 0.62\ ft \text{ critical depth}}$

$E_{min} = y + \frac{v^2}{2g} \qquad V = \frac{Q}{A} = \frac{0.8}{1.5(0.62) + 2.25(0.62)^2} = 0.44\ ft/s$

$= 0.62 + \frac{0.44^2}{2 \cdot 32.2} \qquad \boxed{E_{min} = 3.73\ ft}$



$E = 0.05 + \frac{(0.44)^2}{(2 \times 32.2)} \qquad \boxed{\text{Specific energy at depth of 0.05 ft in} = 3.16\ ft}$

$E = 0.2 + \frac{(0.44)^2}{2 \times 32.2} \qquad \boxed{\text{Specific energy at depth of 0.2 ft} = 3.32\ ft}$

$V = \frac{(0.8)}{1.5(0.05) + 2.25(0.5)^2} \qquad \boxed{\text{Average velocity at depth } 0.05\ ft = 10.0\ ft/s}$

$V = \frac{0.8}{1.5(0.2) + 2.25(0.2)^2} \qquad \boxed{\text{Average velocity at depth } 0.2\ ft = 2.05\ ft/s}$

$y_h = \frac{A}{T} = \frac{0.44}{4.5(0.05)} \qquad y_h = 1.95\ ft$

$N_F = \frac{V}{\sqrt{gy_h}} = \frac{10}{\sqrt{32.2 \times 1.95}} \qquad \boxed{N_F \text{ at } 0.05\ ft = 1.26}$

$A = 1.5(.2) + 2.25(.2)^2 = 0.39\ ft^2$

$y_h = \frac{0.39}{4.5(0.2)} = 0.43$

$N_F = \frac{2.05}{\sqrt{32.2 \times .43}} \qquad \boxed{N_F \text{ at } 0.2\ ft = 0.55}$

$WP = 6(0.2) = 1.2 \qquad R = \frac{A}{P} = \frac{0.39}{1.2} = 0.325$

$V = \frac{1}{n} R^{2/3} S^{1/2}$

$10.0 = \frac{1}{0.013}(0.325)^{2/3} S^{1/2}$

$\boxed{S = 0.076 \text{ required slope}}$

Zach Hollifield

Homework 1.5

3) After reviewing previous semester exams, I learned about the format in which the exams are to be completed. The table describes what the professor is looking for when grading. Each section must be organized and we should be explicit in own answers. If a mistake is made do not erase it. Use the opportunity to explain why the mistake was made. Do not start the test at the last minute. Late test will not be accepted.

Nathanael Yapnayon

Nathanael Yapnayon
10/3/19

1/4

1) Class

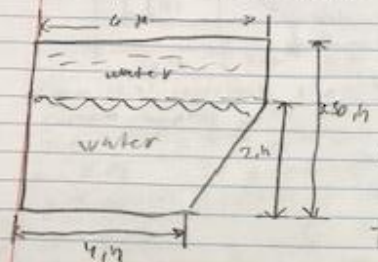
The Buoyancy force is equal gamma of fluid the surrounds the object times the volume of the Objects. Multiplying two things in different positions. Doesn't matter how deep the object is, the buoyancy will always the same. Gamma increases when temperature drops and object gets heavier. weight is mass time gravity. $\gamma = \rho g$ this is density times gravity. The condition for stability of bodies completely submerged in a fluid is that the center of gravity of the body must be below the center of buoyancy. Floating body is stable if its center of gravity is below the metacenter. Weight has to be equal buoyancy.

Nathaniel Yuparsons

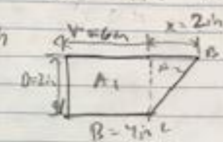
2

Problem 6

Compute the hydraulic radius for the section shown If water flows at a depth of 2.0 in



Given $D = 2$ in (Depth water)
Base $= 4$ in $W = 6$ in



Trapezoidal $A = A_1 + A_2$

$$A = A_1 + A_2$$
$$= (B \times D) + \tfrac{1}{2}(x \times D))$$
$$= (4 \times 2) + \tfrac{1}{2}(2 \times 2)$$

Area $A = 10\ in^2$

Based on triangle A2

Length

$$L = \sqrt{x^2 + D^2} = \sqrt{2^2 + 2^2} = 2.828\ in^2$$

Rain gutter section is $WP = D + B + L$

(Perimeter) $WP = 2 + 4 + 2.828\ in^2$
$= 8.828\ in$

Hydraulic radius

$$R = \frac{A}{WP} = \frac{10\ in^2}{8.828\ in^2}$$

$$\boxed{R = 1.13\ in}$$

Problem 15

Nethmanuel Yapasyon

3/11

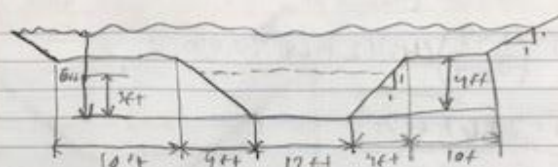
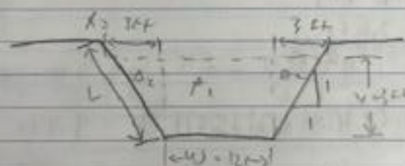


Figure 14.21 represents the approx shape of a natural stream channel with levees built on either side. The channel is earth with grass cover.

$n = 0.04$ If average slope is 0.00015, determine the normal discharge for depths of 3ft and 6ft

Given $n = 0.04$ (Manning constant) $S = 0.00015$ (Slope avg)

normal discharge $Q = \left(\frac{1.49}{n}\right) A R^{2/3} S^{1/2}$



Area

$A = A_1 + 2A_2$

Area of triangle A_2

$A_2 = \frac{1}{2} x y$

Area of square $A = wy$

$A = wy + (2 \cdot \frac{1}{2} xy)$

$A = wy + xy$

$A = (12 \cdot 3) + (3 \cdot 3) = \underline{42\ ft^2}$

Length $L = \sqrt{x^2 + y^2} = \sqrt{3^2 + 3^2} = \underline{4.242\ ft}$

wetted perimeter $WP = 2L + W = 2(4.242) + 12$

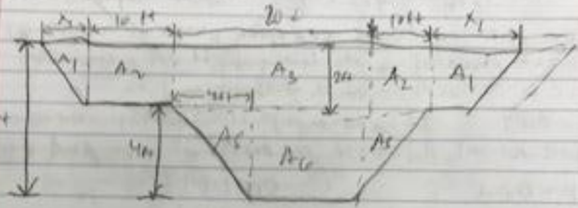
$= 20.484\ ft$

Hydraulic radius $R = \frac{A}{WP} = \frac{45}{20.484} = 2.1968 ft$

4/11

$$Q = \left(\frac{1.49}{0.104}\right)(45)(2.1968)^{\frac{2}{3}}(0.00015)^{\frac{1}{2}}$$

$$\boxed{Q = 34.67\ ft^3/s}$$



$$A = 2A_1 + 2A_2 + A_3 + A_4 + 2A_5$$
$$= 2(\tfrac{1}{2})(2)(2) + 2(10)(2) + (20)(2) + (12)(4) + 2(\tfrac{1}{2})(4)(4)$$
$$= 148\ ft^2$$

Wetted P $= 2L_2 + 2w_2 + 2L + w_1$

Length 2 $L_2 = \sqrt{(2)^2 + (2)^2} = 2.8\ ft$

Length 1 $L_1 = \sqrt{(4)^2 + (4)^2} = 5.6\ ft^2$

Wetted P $WP = (2)(2.8) + (2)(10) + (2)(5.6) + 12 = 4.9\ ft$

$$R = \frac{A}{WP} = \frac{148\ ft^2}{48.9\ ft} = 3.03\ ft$$

$$Q = \left(\frac{1.49}{n}\right) A R^{\frac{2}{3}} S^{\frac{1}{2}}$$

$$Q = \left(\frac{1.49}{0.104}\right)(148)(3.03)^{\frac{2}{3}}(0.00015)^{\frac{1}{2}}$$

$$\boxed{Q = 141.4\ ft^3/s \text{ @ } 6ft}$$

Problem 21 — 5/11

Determine the size of pipe required to carry the flow (500 gal/min) when running half full. The slope is 0.1 %

Find $AR^{\frac{2}{3}}$

Manning equation

$$Q = \left(\frac{1.49}{n}\right) A R^{\frac{2}{3}} S^{\frac{1}{2}} \qquad AR^{\frac{2}{3}} = \frac{Qn}{1.49 S^{\frac{1}{2}}}$$

R = hyd radius Q = discharge S = slope A = area

$$A = \frac{\pi D^2}{8}$$

hydraulic radius

$$R = \frac{A}{\text{wetted perimeter}} = \frac{\frac{\pi D^2}{8}}{\frac{\pi D}{2}}$$

$$R = \frac{D}{4}$$

Find $AR^{2/3}$

$$AR^{\frac{2}{3}} = \frac{\pi D^2}{8}\left(\frac{D}{4}\right)^{2/3} = \frac{\pi D^2}{8}\left(\frac{D^{2/3}}{4^{2/3}}\right) = \frac{\pi D^2}{20.158} = 0.1558 D^{8/3}$$

$n = 0.013$ (table 7.1) 500 gal/min

$1\% = S$

$$AR^{\frac{2}{3}} = \frac{Qn}{1.49 S^{\frac{1}{2}}} = \frac{(500\ \text{gal/min})\left(\frac{1\ \text{ft}^3/\text{s}}{449\ \text{gal/min}}\right)(0.013)}{1.49(0.01)^{1/2}} = 0.3056$$

Find $D^{8/3}$ 6/11

$$0.1558\,D^{8/3} = 0.3056$$

$$D^{8/3} = \frac{0.3056}{0.1558} = \left(\frac{0.3056}{0.1558}\right)^{3/8}$$

$$\boxed{D = 1.28\,ft}$$

Size of common clay drainage tile

9

Problem 6, 15, 21, 36, 42

Problem 36

7/1

Desired to carry $1.25\ ft^3/s$ of water at a velocity of $2.75\ ft/s$

Design cross-section for each of the shapes in table 14.3

Discharge $Q = 1.25\ ft^3/s$ Velocity $v = 2.75\ ft/s$

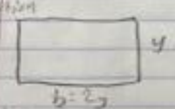
Flow equation $Q = Av$ Find $A = \frac{Q}{v}$

Cross section

$$A = \frac{1.25}{2.75} = \underline{0.4545\ ft^2}$$

Channel Section

Rectangle



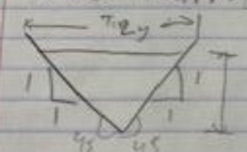
Solve for y

$$y = \frac{A}{b} = \frac{A}{2y} \qquad y = \frac{A}{2y} \quad 2y^2 = A$$

$$y = \sqrt{\frac{A}{2}} = \sqrt{\frac{0.4545}{2}} = \underline{0.476\ ft}$$

Base

$$b = 2(0.476\ ft) = \boxed{0.952\ ft}$$



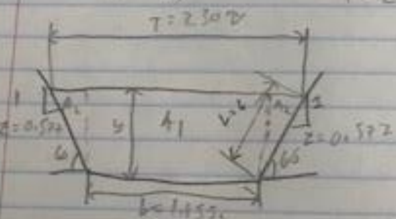
$$A = \frac{1}{2}Ty = \frac{1}{2}(2y)y$$

$$A = y^2$$

$$y = \sqrt{0.4545\ ft^2}$$

$$= 0.6741\ ft$$

$$T = 2(0.6741\ ft) = \boxed{1.348\ ft}$$



$$A = 1.73y^2$$

Find y

$$y = \sqrt{\frac{A}{1.73}} = \sqrt{\frac{0.4545\ ft}{1.73\ ft}}$$

$$y = 0.5125\ ft$$

Trapezoidal section

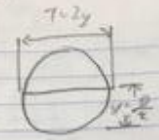
$$b = 1.155(0.5125\ ft) = \boxed{0.592\ ft}$$

$$T = 2.309(0.5125) = \boxed{1.183\ ft}$$

Semi circle

$A = 0.4545 ft^2$

8/11



$A = \frac{1}{2}\pi y^2$

Find y

$y = \sqrt{\frac{2A}{\pi}} = \sqrt{\frac{2(0.4545 ft^2)}{\pi}}$

$y = 0.537 ft$

Find D

$y = \frac{D}{2} = \quad D = 2y$

$= 2(0.537) = \boxed{1.075 ft^2}$

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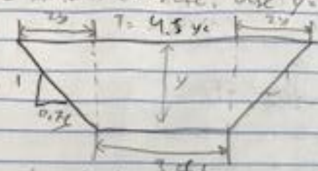
Problem 42

9/11

A trapezoidal channel with a bottom width of 3.0 ft and side slopes having a ratio of 1:0.75 carries 0.80 ft³/s of water and is made from trowel-finished concrete. Use y = 0.05 ft in (d)



Given a trapezoidal
S = 1:0.75 (slopes)
Q = flow rate = 0.80 ft³/s

(a) Critical depth

Area $= 1.73y^2$

First critical flow $\frac{A^3}{T} = \frac{Q^2}{g}$

$$\frac{(1.73y^2)^3}{(2.309y)} = \frac{0.80^2}{32.2\,ft/s} \rightarrow \frac{1.73y}{2.309y} = \sqrt[5]{\frac{0.80^2}{32.2\,ft}}$$

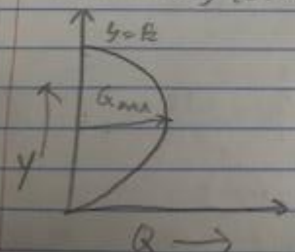
$$0.749y = 0.4567$$
$$y = 0.6097 \approx \boxed{0.61\ ft}$$

(b) Minimum specific energy $E_{min} = y + \frac{v^2}{2g}$ $v = \frac{Q}{A}$

$$\frac{0.8}{1.5(0.61) + 2.25(0.61)} = 0.44\ ft \qquad 0.62 + \frac{0.44^2}{2(32.2)}$$

$E_{min} = 3.73\,ft$

(c) Plot energy curve



$A = 1.73y^2$ 10/11

d) Determine the specific energy for given depth and the alternate depth for this energy

Specific energy

$E = y + \frac{v^2}{2g}$

Alt

$E = 0.2 + \frac{(0.44)^2}{2(32.2)} = \boxed{2.65\ ft/s}$

$E = 0.05 + \frac{(0.44)^2}{2(32.2)} = \boxed{10.0\ ft/s}$

e) Determine the velocity of flow / froude number for each depth in (d)

$V = 184.97\ ft/s$

Froud # $N_f = \frac{V}{\sqrt{g y_h}}$

Hydraulic depth $y_h = \frac{A}{T}$

$y_h = \frac{0.44}{4.5(0.05)} = 1.954$

$N_f = \frac{10}{\sqrt{32.2 \times 1.95}} = N_F$ at $0.05\ ft = \boxed{1.26}$

$A = (1.5(.2) + 2.25)(.2)^2 = 0.39\ ft^2$

$y_h = \frac{0.39}{4.5(0.2)} = 0.43$

At 0.2 ft $N_F = \frac{2.05}{\sqrt{32.2 * 0.43}} = \boxed{0.55}$

(5) $WP = 6(0.2) = 1.2$ $R = \frac{A}{P} = \frac{0.39}{1.2} = 0.325$

$V = \frac{1}{n} R^{2/3} S^{\frac{1}{2}}$ solve for S

$10.0 = \frac{1}{0.013}(0.325)^{\frac{2}{3}} S^{\frac{1}{2}}$ $S = \left(\frac{10.0(0.013)}{0.2013}\right)^2$

$\boxed{S = 0.076 \text{ required slope}}$

Nathaniel
Yeprayson

11/11

test summary

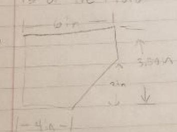
The test I revisited have some detail for each problem. These problems have a specific format compared to the homework. Purpose is used as a guide for the drawings and diagrams. I have to use equations and also describe why I use them. The test requires a lot of explaining. The idea is to solve the problems while following the rubric of the test. The amount of time given is fair enough. The test should not be turn late. It is best to take your time throughout the week of the test.

Aaron Jackson

Homework 1.5 Chapter 14: 6, 15, 21, 36, 42

1) We learned about buoyancy force and how the force equals the gamma γ of the fluid surrounding the object. The center of gravity of the body in the fluid must be below the center of buoyancy in the fluid. Weight has to be equal to buoyancy if the body is floating. The difference between the weight equation $W = \gamma V$ and buoyancy force $F_b = \gamma_f V_d$ is that the gamma is of the fluid

14.6



$A = A_1 + A_2$

$= 8 + 2 = 10 in^2$

$A_1 = 4 \cdot 2 = 8 in^2$

$A_2 = \frac{1}{2} 2 \cdot 2 = 2 in$

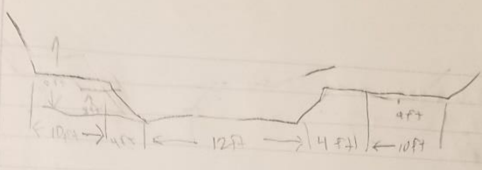
$L = \sqrt{x^2 + y^2} = \sqrt{2^2 + 2^2} = 2.8$

$Wp = D + B + L = 2 + 4 + 2.8 = 8.8$

$R = \frac{A}{Wp} = \frac{10}{8.8 in}$

$R = 1.13 in$

15



3 ft

$A_1 = 12 \cdot 3 = 36$

$A_2 = \frac{1}{2} \cdot (3)(3) = 4.5 \cdot 2 = 9 ft^2$

$A = 36 + 9 = 45 ft^2$

$L = \sqrt{x^2 + y^2}$

$= 3^2 + 3^2 = 4.24 ft$

$wp = 2L + W$

$= 2 \cdot 4.24 + 12 = 20.48 ft$

$R = \frac{A}{wp} = \frac{45 ft}{20.48} = 2.2 ft$

$Q = \frac{1.49}{n} \cdot AR^{2/3} S^{1/2}$

$Q = \frac{1.49}{0.04} \cdot 45 \cdot 2.2^{2/3} \cdot (1.5 \times 10)^{4 \frac{1}{2}}$

$Q = 34.72 ft^3/s$ @ 3 ft

6 ft

$A = 2A_1 + 2A_2 + A_3 + A_4 + 2A5$

$= 2 \cdot (\frac{1}{2} \cdot 2 \cdot 2) + 2(10)(2) + 20 \cdot 2 + 12 \cdot 4 + 2(\frac{1}{2})(4)(4) = 148 ft^2$

$wp = 2L_2 + 2w_2 + 2L_1 + W_1$

$L_2 = \sqrt{2^2 + 2} = 2.8 ft^2$

$L_1 = \sqrt{4^2 + 4^2} = 5.6 ft^2$

$Wp = 2 \cdot 2.8 + 2 \cdot 10 + 2 \cdot 5.6 + 12 = 4.8 ft$

$R = \frac{A}{Wp} = \frac{148 ft}{48.8 ft} = 3.03 ft$

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

$Q = \frac{1.49}{0.04} \cdot 148 \cdot 3.03^{2/3} \; 0.00015^{1/2}$

$Q = 141.4 \; ft^3/s$ @ 6 ft

21 $Q = \frac{1.49}{3} A R^{2/3} S^{1/2}$

$AR^{2/3} = \frac{QA}{1.495^{1/2}}$ $\quad A = \frac{\pi D^2}{8}$ $\quad R = \frac{A}{WP}$

$WP = \frac{\pi D}{2}$

$A = \frac{\frac{\pi D^2}{8}}{\frac{\pi D}{2}} = \frac{D}{4}$ $\quad AR^{2/3} = \frac{\pi D^2}{8} \frac{D}{4}^{2/3} = \frac{\pi D^2}{8}\left(\frac{D^{2/3}}{2.519}\right)$

$AR^{2/3} \cdot \frac{\pi D^{2/3}}{20.158} = 0.1558 D^{8/3}$

$AR^{2/3} = 500 \frac{gal}{min} \cdot \frac{1 \; ft^3}{449 \; gal/min} \cdot 0.013 = 0.3056$

$AR^{2/3} = \frac{\pi D^{2/3}}{20.158} = 0.1558 D^{8/3}$

$0.1558 D^{8/3} = 0.3056$ $\quad D^{8/3} = \frac{0.3056}{0.1556} = 1.961$

$D = (1.961)^{3/8}$ $\quad \boxed{D = 1.29 \; ft}$

36 $A = \frac{Q}{V}$

$= \frac{1.25}{2.75} = 0.4545\ ft^2$

$y = \frac{A}{2y}$ $y = \sqrt{\frac{A}{2}} = 0.476\ ft$ $b = 2y$ $b = 2 \cdot 0.476 = 0.953\ ft$

Rectangle = $A = 0.4545\ ft^2$ $b = 0.953\ ft$ $y = 0.476\ ft$

$A = \frac{1}{2} \cdot 2y \cdot y$ $A = y^2$ $y = \sqrt{A}$ $y = 0.4545 = 0.6741\ ft$

$T = 2y$ $T = 2 \cdot 0.6741 = 1.348\ ft$

Triangle = $A = 0.4545\ ft^2$ $T = 1.348\ ft$ $y = 0.6741\ ft$

$A = 1.73y^2 =$

$y = \sqrt{\frac{A}{1.73}} \rightarrow y\sqrt{\frac{0.4545}{1.73}} = 0.5125\ ft$

$b = 1.55y$ $b = 1.155 \cdot 0.5125 = 0.592$

$T = 2.309y = T = 2.309 \cdot 0.5125$
$= 1.183\ ft$

Trapezoid = $A = 0.4545\ ft^2$ $b = 0.592\ ft$, $T = 1.193\ ft$, $y = 0.5125\ ft$

$y = \sqrt{\frac{2A}{\pi}}$ $y = \sqrt{2 \cdot 0.4545}$ $y = 0.537$

$D = 2y = 2(0.537)$
$= 1.075$

semicircle = $A = 0.4545\ ft^2$ $y = 0.537\ ft$ $D = 1.075\ ft$

42 $A = \frac{3 + 4.5y_c}{2} y_c = 1.5y_c + 2.25y_c^2$

$$\frac{A}{T} = \frac{Q^2}{g} \rightarrow \frac{1.5y_c + 2.25y^2}{4.5y_c} = \frac{Q^2}{32.2}$$

$y_c = 0.62\text{ ft}$

$E_{min}\ y + \frac{v^2}{2g}$ $\quad v = \frac{Q}{A}$ $\quad \frac{.4}{1.5 \cdot (.62) + 2.25 \cdot 0.62^2} = 0.44\text{ ft/s}$

$$= 0.62 + \frac{0.44^2}{2 \cdot 32.2}$$

$E_{min} = 3.73\text{ ft}$

$E = 0.05 + \frac{0.44^2}{2 \cdot 32.2} = E @ 0.05\text{ ft} = 3.16\text{ ft}$

$E = 0.2 + \frac{0.44^2}{2 \cdot 32.2}$ $\quad E @ 0.2\text{ ft} = 3.32$

$V = \frac{1.6}{1.5 \cdot 0.05 + 2.25 \cdot 0.5^2}$ $\quad V @ 0.05 = 10\text{ ft/s}$

$V = \frac{0.6}{1.5 \cdot 0.2 + 2.25 \cdot 0.2^2}$ $\quad V @ 0.2\text{ ft} = 2.05\text{ ft/s}$

$$yh = \frac{A}{T} = \frac{0.44}{4.5 \cdot 0.05} \qquad yh = 1.95$$

$$N_F = \frac{V}{\sqrt{g\,y_h}} = \frac{10}{\sqrt{32.2 \cdot 1.95}}$$

$$N_F @ 0.05 = 1.26$$

$$A = 1.5 \cdot (.2) + 2.25 \cdot (.2)^2 = 0.39\ ft^2$$

$$yh = \frac{0.39}{4.5 \cdot 0.2} = 0.43$$

$$N_F = \frac{2.05}{\sqrt{32.2 \cdot 0.43}}$$

$$N_F @ 0.2 = 0.55$$

$$W_P = 6(0.2) = 1.2 \qquad R = \frac{A}{P} = 0.325$$

$$v = \frac{1}{n} R^{2/3} S^{1/2}$$

$$10.0 = \frac{1}{0.013} \cdot 0.325^{2/3} S^{1/2}$$

$$S = 0.076$$

3 The previous tests showed the way the tests should be organized. It also shows that we have a chance to understand our mistakes on tests and potentially get points back. Every answer should be detailed and have explanations of the procedure or why you chose to do it that way. It is clear that the test should be completed in a timely manner as the tests are very detailed.