Group # 3

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#4.2 The flat end of the tank shown is secured with a bolted flange. If the inside ϕ of the tank is 30" and the internal pressure is raised to +14.4 psig, calculate the total force that must be resisted by the bolts in the flange.

$$\text{Area} = \frac{\pi d^2}{4} = \frac{\pi (30\,\text{in})^2}{4} = 706.858\ \text{in}^2$$

$$P = 14.4\ \text{psig}$$

$$F = P \cdot A = (14.4\ \text{psig})(706.858\ \text{in}^2)$$

$$F = 10{,}178.8\ \text{lb}$$

 # 4.10 How much force is required to open the flapper in the bottom of the tank?

→ The flapper has to be pushed up, therefore it must exceed the force of the water pushing down over JUST the flapper valve.

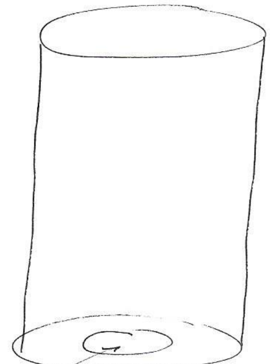
→ $F = P \cdot A$

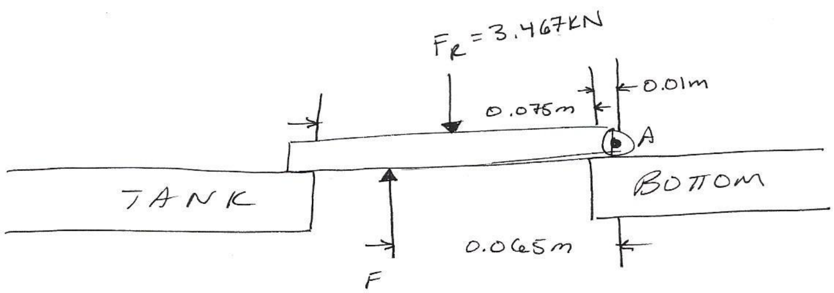
→ $P = \gamma_{H_2O @ 4°C} \times h$

→ $A = \dfrac{\pi d^2}{4}$ = Area of the flapper

$$F_R = \left(9.81\ kN/m^3\right)\left(1.8m\right)\left(\frac{\pi (0.5m)^2}{4}\right)$$

$F_R =$ 3.467 kN





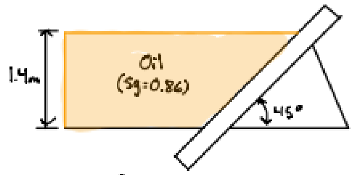
STATICS

$$\Sigma M_A = (3.467 KN)\left(\frac{.075m}{2} + 0.01m\right) - F(0.065m) = 0$$

$$\Sigma M_A = 2.53 KN$$

ANY FORCE GREATER THAN 2.53KN WILL LIFT THE FLAPPER

4-17) If the wall in the figure is 4 m long, calculate the total force on the all due to the oil pressure. Also determine the location of the center of pressure and show the resultant force on the all.



- $P_{avg} = \gamma (h/2)$

  $= (0.86 \times 9.81\ kN/m^3)(1.4\ m/2)$

  $P_{avg} = 5.9\ kPa$

- $F_R = P_{avg} \times A$, $A = 4m \times 1m = 4m^2$

  $F_R = 5.9\ kPa \times 4m^2$

  $F_R = 23.6\ N$

- $F_R = \gamma h_c A \Rightarrow h_c = \frac{F_R}{\gamma A}$

  $h_c = \frac{23.6N}{(0.86 \times 9.81\ N/s^2)(4m^2)}$ $\quad \frac{kg\cdot m/s^2}{m^3/s^2} > \cancel{\frac{kg\cdot m\cdot s^2}{m^3 s^2}} > \frac{kg}{m^2}$

  $h_c = 0.7m$

- $I_c = \frac{1}{12} h b^3$

  $= \frac{1}{12}(4m)(1m)^3$

  $I_c = 0.33\ m^4$

- $h_p = h_c + \frac{I_c \sin^2\theta}{h_c A}$

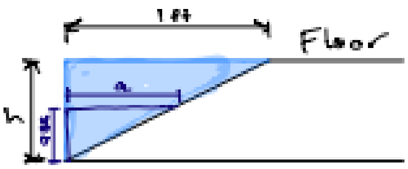
  $= 0.7m + \frac{(0.33m^4)\sin^2(45°)}{0.7m(4m^2)}$

  $= 0.7m + 0.06m$

  $h_p = 0.76m$

Resultant force on wall	Center of Pressure
$F_R = 23.4N$	$h_p = 0.76m$

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



- $1^2 + 1.64^2 = \sqrt{3.6896}$

  $c = 1.92$
- $\theta = \sin^{-1}\left(\frac{1.64}{1.92}\right)$

  $\theta = 58.67°$
- $\tan(58.67°) = \frac{0.82}{a}$

  $a = \frac{0.82}{\tan(58.67°)}$

  $a = 0.499 \approx 0.5$ ft

- For Area

  $A = \frac{1}{2}bh = \frac{1}{2}(0.5\text{ ft})(0.82\text{ ft})$

  $A = 0.205\text{ ft}^2$

- new hypotenuse

  $WP = 0.82\text{ ft} + 0.96$

  $WP = 1.78$ ft

- Hydraulic Radius

  $R = \frac{A}{WP} = \frac{0.205\text{ ft}^2}{1.78\text{ ft}}$

  $R = 0.115$ ft

Minimum Diameter for clay tile

$\boxed{D = 1.29\text{ ft}}$

- $h = 0.82$ ft
- $Q = 500$ gal/min $= 1.114\ \frac{ft^3}{s}$
- $n = 0.013$
- $S = 0.001$ • $R = 0.115$ ft

- $AR^{\frac{2}{3}} = \frac{nQ}{1.49 S^{1/2}} = \frac{(0.013)(1.114\ \frac{ft^3}{s})}{1.49(0.001)^{\frac{1}{2}}}$

  $AR^{\frac{2}{3}} = 0.307$

- From height guessing game in excel,

  $h \approx 0$ % diff $= 1.64$ ft (% diff h=1.64ft = 0.00999)

- running half full, $h = 1.64\text{ ft}/2$

  $h = 0.82$ ft

- POST REVISION
  - use geometric equations for circular objects in place of A and WP

  $A = \frac{1}{2}\pi y^2 = \frac{\pi D^2}{8}$, $WP = \pi y = \frac{\pi D}{2}$

  - $R = \frac{A}{WP} = \frac{\frac{\pi D^2}{8}}{\frac{\pi D}{2}} = \frac{2\pi D^2}{8\pi D} = \frac{D}{4}$

  - $AR^{\frac{2}{3}} = \left(\frac{\pi D^2}{8}\right)\left(\frac{D}{4}\right)^{2/3} = \frac{\pi D^2 (D^{2/3})}{8(4^{2/3})}$ $\quad \frac{2}{1} + \frac{2}{3} = \frac{6}{3} + \frac{2}{3} = \frac{8}{3}$

    $= \frac{\pi D^{\frac{8}{3}}}{(8 \cdot 2.52)} = \frac{\pi D^{\frac{8}{3}}}{20.158}$

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

  - From earlier, $AR^{\frac{2}{3}} = 0.307$

  $0.307 = 0.1558\, D^{8/3} \rightarrow \frac{0.307}{0.1558} = D^{8/3} \rightarrow 1.97 = D^{8/3}$

  $D^{\frac{8}{3}} = 1.97^{3}$

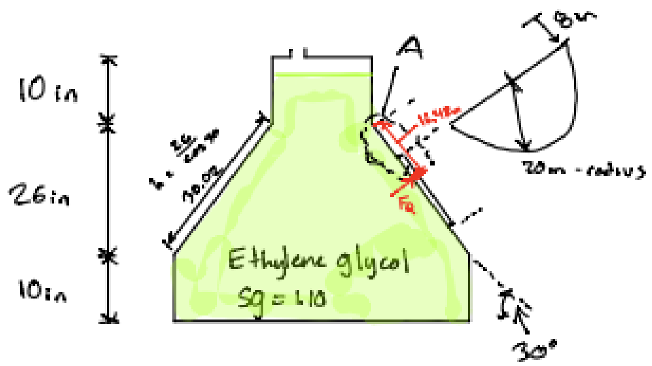
  $D^{8} = 7.645$

  $\sqrt[8]{D^8} = \sqrt[8]{7.645}$

  $D = 1.289$ ft

  $\underline{D = 1.29\text{ ft}}$

4-28) Compute the magnitude of the resultant force on the indicated area and the location of the center of pressure. Show the resultant force on the area and clearly dimension its location.



- $A = \frac{1}{2}(\pi r^2) = \frac{1}{2} \cdot \pi \cdot (20\,in)^2$
  $A = 628.319\,in^2$

- $\gamma = 1.10 \cdot 62.43\ \frac{lb}{ft^3}$
  $\gamma = 68.673\ lb/ft^3$
  $\gamma = 68.673\ \frac{lb}{ft^3} \cdot \frac{1\ ft^3}{1728\ in^3}$
  $\gamma = 0.0397\ lb/in^3$

- h_c = top of fluid to c.o.g. of area
  $cog = (0.212)(2 \cdot 20\,in) + 8\,in$
  $cog = 16.48\,in$

- $I_c = (6.86 \times 10^{-3})\,D^4$
  $= (6.86 \times 10^{-3})(2 \cdot 20\,in)^4$
  $I = 17561\ in^4$

- $h_p = h_c + \frac{I_c \sin^2\theta}{h_c A}$
  $= 24.27\,in + \frac{17561\,in^4 (0.25)}{24.27\,in\,(628.319\,in^2)}$

- $h_p = 24.56\,in$

A)

- now 14.27 in + 10 in (from figure) gives us height from top of fluid to hatch cog, $h_c = 24.27\,in$

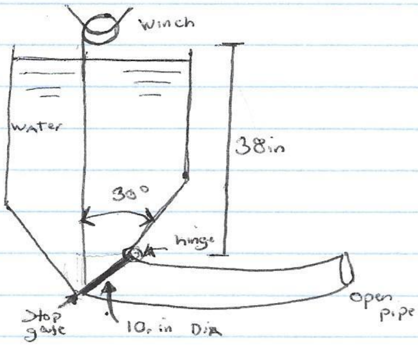
- $F_R = \gamma h_c A$
  $= (0.0397\ lb/in^3)(24.27\,in)(628.319\,in^2)$
  $F_R = 605.4\ lb$

and the location that the resultant force is acting upon is equal to the location of the center of pressure.

$h_p = 24.56\,in$

$F_R = 605.4\ lb$

4.42) 4.46



Specific weight of water, $w = 62.4 \text{ lbs/ft}^3$

$$\frac{62.4}{(12)^3} \text{ lbs/in}^3 \left[1/12\right]$$

Dia of gate = 10in

Area formula of the gate $A = \frac{\pi D^2}{4}$

$$= \frac{\pi}{4} \times (10)^2 = 78.54$$

total vetical height

$$h_c = 38 + y$$
$$= 38 + 10(\cos(30))$$
$$h_c = 46.66\text{in}$$

total length of gate

$$L_c = \frac{h_c}{(\cos(30))}$$
$$L_c = \frac{42.33}{(\cos(30))} = 48.88 \text{ in}$$

Moment of inertia circular gate

$$I_c = \frac{\pi}{4} d^4$$
$$= \pi/4 \times (10)^4 = 490.92 \text{ in}^4$$

Amount of force acting on gate

$$F_R = \gamma \, h_c \, A$$
$$= \frac{62.4}{} \times 46.66 \times 78.54$$
$$= 62.4 \left(\frac{46.66}{12}\right) \times \left(\frac{78.54}{144}\right)$$
$$F_R = 132.4 \text{lb}$$

$$L_p - L_c = \frac{I_c}{L_c A} = \frac{490.91}{48.88 \times 78.54} = .128 \text{ in}$$

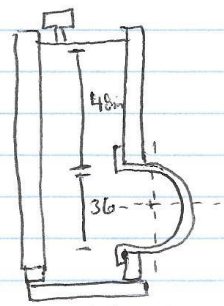
Amount of force winch exerts

$\sum M_H = 0$ (sum of moments about hinge At top is = 0)

$$F_R\left[5 + (L_p - L_c)\right] - (F_c \times 5) = 0 \quad = 5F_c = 132.40(5 + .128\text{in})$$

$$F_c = \frac{132.40 \cdot 5.128}{5} = \boxed{} \quad \boxed{135.79 \text{ Lb}}$$

4.54)



Surface is 60in Long

sg = .79

D_{semi} = 36in

$width_{curve}$ = 60in

h = 48in

Horizontal force

$F_H = \rho g h A$

$\rho = (sg) = (.79)(1000)\ K/m^3$

$= 790\ kg\ m^3$

$A = w \times D = 60 \times 36\ in^2$

$= 2160\ in^2 = 1.4\ m^2$

$\bar{h} = \frac{48+36}{2} = 66in = 1.68\ m$

$F_H = (790\ kg/m^3)(1.68m)(1.4m^2)$

$\boxed{F_H = 1858.08\ N}$

vertical force

$F_V = \rho g \cancel{\forall}$

36in = .914 m

60in = 1.52m

$= \rho g \times \left(\frac{\pi}{2}\left(\frac{d}{2}\right)^2 \times \omega\right)$

$= (790)(9.81)\left(\frac{3.14}{2}\right)\left(\frac{.916}{2}\right)^2 (1.52)$

$\boxed{F_V = 3883.82N}$

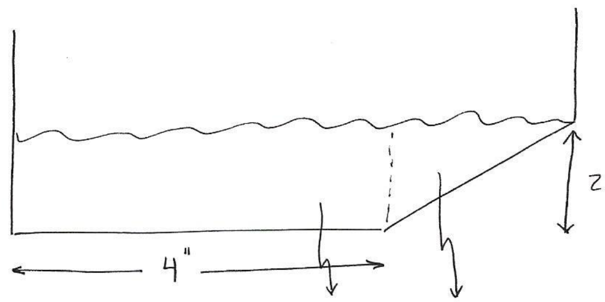
$F_R = \sqrt{F_H^2 + F_V^2} = \sqrt{(1858.08)^2 + (3883.82)^2}$

$\boxed{F_R = 4305.41N}$

$\tan\theta^{-1} = \frac{F_V}{F_H} = \frac{3883.82}{1858.08}$

$\theta = \boxed{12.67°}$

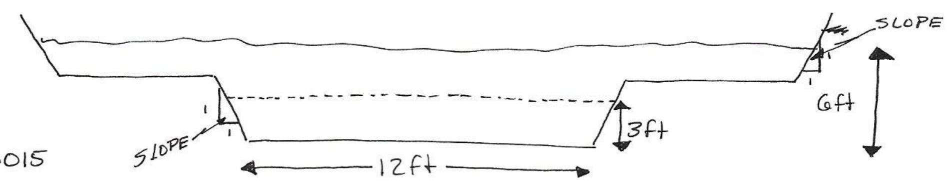
#14.6 Compute the hydraulic radius



$$R = \frac{A}{W.P.} = \frac{\text{Area}}{\text{Wetted Perimeter}} = \frac{(4"\times 2") + (2"\times 2"/2)}{2" + 4" + \sqrt{2^2+2^2}} = \frac{10\,in^2}{8.82\,in}$$

$1.13\,in = R$

#14.15



(a) $n = 0.04$

$S = 0.00015$

$y_1 = 3ft$

$$Q_1 = A_1 \cdot V_1 = A_1 \cdot \underbrace{\frac{1.49}{n} \cdot S^{1/2} \cdot R^{2/3}}_{V}$$

→ $A_1 = (b + zy)y$

b = width of trough bottom

$b = 12$ ft

z = horizontal component of slope (∠1)

$z = 1$

y_1 = depth of trough = 3ft

$A_1 = (12ft + (1)(3ft))(3ft)$

$\boxed{A_1 = 45ft^2}$

→ R_1 = Hydraulic radius

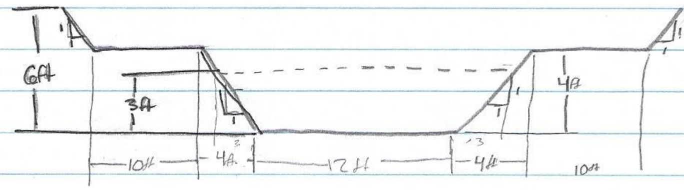
$$= \frac{(b+zy)y}{b + 2y\sqrt{1+z^2}} = \frac{45ft^2}{12ft + 2(3ft)\sqrt{1+(1)^2}}$$

$\boxed{R_1 = 2.1967ft}$

$$Q_1 = (45ft^2)\left(\frac{1.49}{0.04}\right)(0.00015)^{1/2} \times (2.1967ft)^{2/3}$$

$Q = 34.7\,ft^3/s$

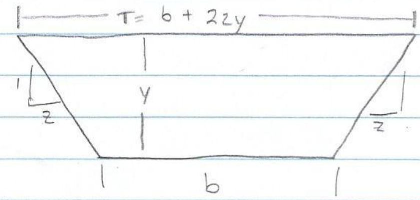
14.15 (b)



Avg. Slope = .00015°

$n = .04$

3ft depth =



T = 18

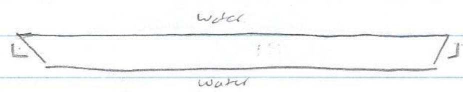
b = 12

y = 3

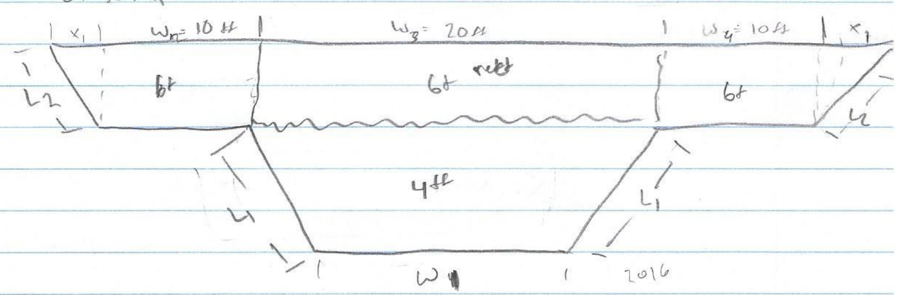
Area = $(b + zy)(y)$

$((12 + 1(3))(3)$

$\boxed{Q = 34.6922\ ft^3/s}$



A = 148 ft² total



9th 2013 2014

$W_p = W_1 + 2(W_2) + W_3 + 2L_2 + 2L_1$

$12 + 20 + 20 + 2(2.83) + (2(5.656))$

ANSWER

~~Q = A·V = A S^1/2 ...~~ $Q = 141.13\ ft^3/s$

14.15

A= (b+z*y)*(y)			3ft.	4ft.	6ft. Trap	6 ft rect	total
		T	18	20	24	20	
r=(A)/(b+2ySQRT(1+z^2))		B=	12	12	20	20	
		Y=	3	4	2	2	
R=A/WP		Z=	1	1	1	1	
		n=	0.04	0.04	0.04	0.04	0.04
q=(1.49/.04)*A*(Slope^1/2)*(r^2/3)		S=	0.00015	0.00015	0.00015	0.00015	0.00015
n=.04							
	unit	A=	45	64	44	40	148
	unit	R=	2.196699				3.022135
	unit	WP					48.972
	unit	Q=	34.69217				141.1376

14.36 $Q = 1.25\ ft^3/s$ of water

$V = 2.75\ ft/s$

$A = \boxed{.454545}$

$\boxed{Q = V \cdot A}$

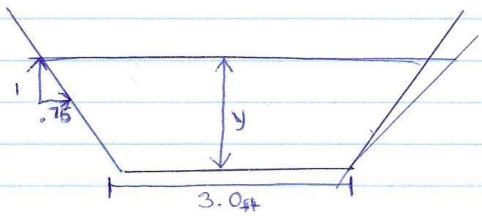
$A = 2.0 y^2$ $\qquad$ $A = \frac{1}{2}(\pi) y^2$

$y = \sqrt{A/20}$ $\qquad$ $\sqrt{\frac{2(A)}{\pi}}$

	Y y	Area A	Wetted perimeter WP	Hydraulic Radius HR
Rectangle	.476 ft	.454 ft	1.907 ft	.238 ft
Triangle	.6742 ft	.454 ft	1.908 ft	.239 ft
Trapezoidal	.512 ft	.454 ft	1.773 ft	.256 ft
Semi-circle	.538 ft	.454 ft	1.689 ft	.269 ft

Math done using Excel

14.42)



A) Critical depth

A = Area of trapezoidal section

(Substitute 3.0 for .91m)

$$= \left[\left[3.0 + \left(2 \times \frac{1}{.75} \times y\right)\right] + 3.0\right] \times \frac{y}{2} = 3.0y + \frac{4}{3}y^2$$

Critical flow at critical depth

$$\frac{Q^2}{g} = \frac{A^3}{T} = \frac{Q}{9.81} = \frac{\left[3.0y_c + \frac{4}{3}y_c^2\right]^3}{3.0 + \frac{8}{3}y_c}$$

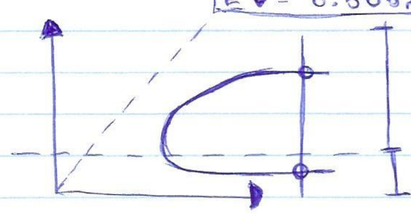
$\boxed{y_c = 5.67_m}$ → critical depth

b) min specific energy curve

$$E = y_c + \frac{v^2}{2g} \qquad v = \frac{Q}{A} = \frac{Q}{3.0y_c + \frac{4}{3}y_c^2} \quad \text{or} \quad 3/2 \times 5.67$$

$\boxed{E = 8.505_m}$

c)



d) $E_c = y + \frac{v^2}{2g} \qquad v = \frac{Q}{A} 2g =$

$$= \frac{.05 + (850)^2}{2 \times 9.81} = \boxed{36.824.67}$$

e) $y_2 = ? = v_2 = \frac{Q}{A^2} \qquad A_2 = .91y_2 + \frac{4}{3}y_2^2$

$$y_1 + \frac{v_1^2}{2g} = y_2 + \frac{v_2^2}{2g}$$

$$.5 + \frac{(5.67)^2}{2 \times 9.81} = y_2 + \frac{5/(.91y_2 + \frac{4}{3}y^2)}{2 \times 9.81} =$$

$\boxed{y_2 = 43.91_m}$

f) = At critical depth the flow is critical At y = .5m the flow is subcritical flow.