Lab Hydvulics sheet

Bashar Fandi Alomari

EX1 center of pressure

$F = \rho g \bar{y} A \sin\theta$

$y_{cp} = \bar{y} + \dfrac{I}{A\bar{y}}$

$mgL = F(\alpha + d - y + y_{cp})$

inclined gate

$F = \rho g A \bar{y} \sin\alpha$

$y_{cp} = \bar{y} + \dfrac{I}{A \cdot \bar{y}}$

EX2 orific & jet flow

$\dfrac{V}{T} = Q_{actual}$

$Q_{theo} = A * V_{theo}$

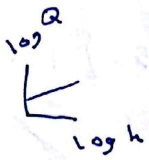
$V_{theo} = \sqrt{2gh}$ or $\sqrt{2g\Delta h}$

$\dfrac{Q_{actual}}{Q_{theo}} = C_d$

$\dfrac{V_{actual}}{V_{theo}} = C_v$

$C_v = \dfrac{X}{2\sqrt{yh}}$

$y_{intercept} = \log(C_d * \sqrt{2g} * A_{orifice})$



EX3 venturi tube

$V_1 = \sqrt{\dfrac{2g(h_1 - h_3)}{\left(\frac{A_1}{A_3}\right)^2 - 1}}$

عند الضيق ← $V_3 = \sqrt{\dfrac{2g(h_3 - h_1)}{\left(\frac{A_3}{A_1}\right)^2 - 1}}$

$V_{theo} * A = Q_{theo}$

$Q_{actual} = \dfrac{V}{T}$

$\dfrac{Q_{actual}}{Q_{theo}} = C_d$

$R_e = \dfrac{VD}{\nu}$ or $\dfrac{\rho VD}{\mu}$

$Re < 2000$ Laminar

$Re > 4000$ Turbulent

$4000 > Re > 2000$ Transition

stagnation point velocity = 0

EX:4 Impact of water jet

$\Rightarrow F_{measured} = mg$

$\Rightarrow F_{calculated} = (1-\cos\theta)\rho V Q$

$\Rightarrow$ Momentum $= \rho V Q$

$\rightarrow Q_{actual} = \dfrac{V}{T}$

$\rightarrow V_{nozel} = \dfrac{Q_{actual}}{A_{nozzel}}$

$\rightarrow V = \sqrt{(V_{nozel})^2 - 2gS}$

cone $= 120°$
f-plate $= 90°$
Hemisphere $= 180°$

EX:5 Head loss

$$\overbrace{\underbrace{\frac{P_1}{\rho g}}_{h_s} + \underbrace{\frac{V_1^2}{2g}}_{h_v} + \underbrace{Z_1}_{h_p}}^{h_t} = \frac{P_2}{\rho g} + \frac{V_2^2}{2g} + Z_2 + h_L$$

$$h_L = f\frac{L}{D}\frac{V^2}{2g}$$, $K =$ ~~[illegible]~~ loss coefficent

$f = \dfrac{64}{R_e} \rightarrow$ Laminar

$f = 0.0055\left[1 + \left(20000\dfrac{K_s}{D} + \dfrac{10^6}{R_e}\right)^{\frac{1}{3}}\right]$

experimently

$\Delta h = h_L = \dfrac{\Delta p}{\rho g}$

h_v & h_p are cons

Ex: 6 Roughness coefficients

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

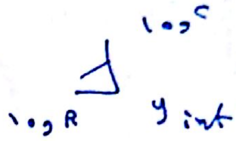
$$Q = C R^{1/2} S^{1/2} A \rightarrow \text{chezy}$$

$$Q = \sqrt{\frac{8g}{f}} R^{1/2} S^{1/2} A \rightarrow \text{Darcy}$$

super	sub
$F_r > 1$	$F_r < 1$
$h < h_c$	$h > h_c$
$v > h_c$	$V < V_c$
$S > S_c$	$S < S_c$

$$R = \frac{A}{P}$$

$$n_{avg} = \frac{\sum P \times n^2}{\sum P}$$



$y_{int} = -\log n$

$$C = \frac{R^{1/6}}{n} = \sqrt{\frac{8g}{f}}$$

$$n = \frac{1}{C} R^{1/6}$$

Ex: 7 specific energy

$$V_c = \sqrt{g\,h_c} \xrightarrow{\text{Rect.}} = \frac{Q}{A_c}$$

$$h_c = \left(\frac{q^2}{g}\right)^{1/3}$$

$$q = Q/b$$

$$R_c = \frac{A_c}{P_c}$$

$$S_c = \frac{V_c^2}{C^2 R_c}$$

$$E_c = \underbrace{\frac{3}{2} h_c}_{\text{Rectangular}} = h_c + \frac{V_c^2}{2g}$$

$$E = h + \frac{V^2}{2g}$$

$$V = \frac{q}{h}$$

$$F = \frac{h^2}{2} + \frac{q^2}{gh}$$

Ex:8 Hydralic Jump

$$F_r = \frac{v}{\sqrt{g \times h}}$$

$$h_2 = \frac{h_1}{2}\left[-1 + \sqrt{1+8F_{r_1}^2}\right]$$

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

$$\Delta E_{exp} = E_2 - E_1$$

$$\Delta E_{theo} = \frac{(h_2-h_1)^2}{4h_2 \times h_1}$$

$$h_j = h_2 - h_1$$

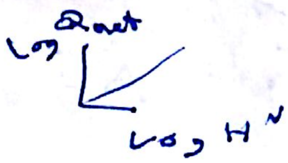
Ex:9 weirs

Rectangle

$$Q_{theo} = \frac{2}{3} b (2g)^{1/2} H^{3/2}$$

$$\frac{Q_{actual}}{Q_{theo}} = C_d$$

$$y_{int} = \log\left(\sqrt{2g} \times \frac{2}{3} \times b^{x}\right)^{C_d}$$



Triangle

$$Q_{theo} = \frac{8}{5} (2g)^{1/2} \tan\frac{\theta}{2} H^{5/2}$$

$$\frac{Q_{actual}}{Q_{theo}} = C_d$$

$$y_{int} = \log\left(C_d \times \frac{8}{15} \times \sqrt{2g} \times \tan\frac{\theta}{2}\right)$$