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Submitted to Engr Fawad

Subject Hydraulic Engineering

Semester "6th"

Section 'B'

QNO1(a) Let suppose a rectangular channel, discharge 7869 liter/sec of water into a 8m wide apron with zero slop. Mean velocity is 7869-220 ft/sec

calculate:

1) Height of hydraulic jump (in unit of meter)

2) power absorbed due to hydraulic jump (in unit of KW)

Solution:

Given data:

Channel width $= b = 8m$

Discharge $= Q = 7869$ lit/sec $= 7.869 \, m^3/sec$

mean velocity $= V = R - 220 = 7869 - 220$

$= 7649$ ft/sec

2332.01 m/sec

1) As we know

$$Q = qb$$

$$q = Q/b = \frac{7.869}{8} = 0.983 \, m^2/sec$$

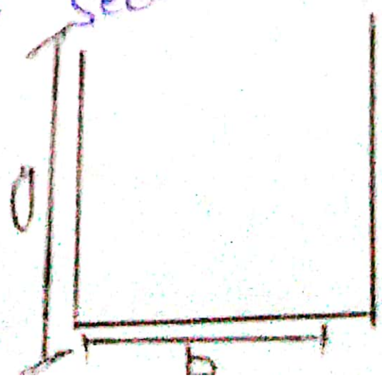
$$\Rightarrow y_c = \left(\frac{q^2}{g}\right)^{1/3}$$

$$= \left(\frac{(0.983)^2}{9.81}\right)^{1/3} \quad \boxed{= 0.461 \, m}$$

As it is a rectangular section:

$Q = qb \rightarrow ①$

$Q = AV \rightarrow ②$



As it is rectangular Section (2)

$Q = qb \rightarrow (1)$

$Q = AV \rightarrow (2)$

equating (1) and (2)

$qb = AV$

$qb = ybv$

$q = yv$

$V_c = q/y_c = 2.132 \text{ m/sec}$

$V > V_c$ (super critical flow)

Height of hydraulic Jump on the up-stream Side

As $Q = AV$

$Q = byv$

$$y_1 = \frac{Q}{V_1 b}$$

$$y_1 = \frac{7.869}{(2332.07)(8)} = 4.21 \times 10^{-4} = 0.000421 \text{m}$$

$$y_2 = \frac{-y_1}{2} + \sqrt{\frac{y_1^2}{4} + \frac{2y_1(V_1)^2}{g}}$$

$$y_2 = \frac{-0.000421}{2} + \sqrt{\frac{(0.000421)^2}{4} + \frac{2(0.00041)(2332.07)^2}{9.81}}$$

$\boxed{y_2 = 21.05}$

$$\Delta y = y_2 - y_1$$

$$\Delta y = 21.05 - 0.0004$$

$$\boxed{\Delta y = 21.0496}$$

ii) $\because \Delta E = E_1 - E_2$

As we know that

$$Q_1 = Q_2$$

$$A_1 V_1 = A_2 V_2$$

$$\cancel{b}\, y_1 V_1 = \cancel{b}\, y_2 V_2 \qquad \because b_1 = b_2 = b$$

$$y_1 V_1 = y_2 V_2$$

$$V_2 = \frac{y_1 V_1}{y_2}$$

$$V_2 = \frac{0.0004 \times (2332.01)}{21.05}$$

$$\boxed{V_2 = 0.0441}$$

$$\Delta E = E_1 - E_2 = \left(y_1 + \frac{V_1^2}{2g}\right) - \left(y_2 + \frac{V_2^2}{2g}\right)$$

$$E_1 - E_2 = \left(0.0004 + \frac{2332.01}{2(9.81)}\right) - \left(21.05 + \frac{(0.0441)^2}{2 \times 9.81}\right)$$

Power absorbed:

$$\Delta P = \rho g Q (E_1 - E_2) = 277158.90 \ (4)$$

$$\Delta P = 1000 \times 9.81 \times 7.869 (27715890)$$

$$\Delta P = 2.13 \times 10^{10} W$$

$$\boxed{\Delta P = 21398250.9 \ kW}$$

A sluice gate controls the flow in a channel of width 4m. If the discharge is 7869 ft^3/sec and the upstream and downstream water depth is 2.9m and 1.1 m respectively. calculate down stream velocity.
Also state the type of flow at upstream and down stream side using any equation.

Given data:

$b = 4m$

$Q = 7869 \ ft^3/sec = \frac{7869}{(3.28)^3} = 222.99 \ m^3/sec$

$y_1 = 2.9m$

$y_2 = 1.1m$

Specific energy at upstream and down stream side

$E_1 = E_2$

$$y_1 + \frac{v_1^2}{2g} = y_2 + \frac{v_2^2}{2g} \rightarrow (1)$$

As we know that

$Q = A_1 v_1 = A_2 v_2$

$\cancel{b} = y_1 v_1 = \cancel{b} y_2 v_2$ $(\because b_2 = b_1 = b)$

$$v_2 = \frac{y_1 v_1}{y_2}$$

$$y_2 = \frac{2.9}{1.1} v_1$$

$v_2 = 2.636\, v_1 \rightarrow (2)$

put value equ (2) in eq (1), we get

$$2.9 + \frac{v_1^2}{2 \times 9.81} = 1.1 + \left(\frac{2.636}{2 \times 9.81}\right)^2$$

$$= 2.9 - 1.1 = \frac{6.948 v_1^2}{19.62} - \frac{v_1^2}{19.62}$$

$$= 1.8 = \frac{6.948 v_1^2 - v_1^2}{19.62}$$

$$1.8 \times 19.62 = 5.948 v_1^2$$

$$v_1 = \boxed{2.436 \text{ m/sec}}$$

Now put the value of "v_1" in eq (1)

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

(6)

$$2.9 + \frac{(2.43)^2}{2g} = 1.1 + \frac{V_2^2}{2g}$$

$$2.9 - 1.1 = \frac{V_2^2}{2g} - \frac{5.904}{2g}$$

$$1.8 = \frac{V_2^2 - 5.904}{2g}$$

$$1.8 \times 2g = V_2^2 - 5.904$$

$$1.8 \times 2 \times 9.81 = V_2^2 - 5.904$$

$$\sqrt{V_2^2} = \sqrt{41.22}$$

$$V_2 = 6.42 \text{ m/sec}$$

using Froud No to determine type of flow

UP strem side

$$Fr_1 = \frac{V_1}{\sqrt{g y_1}} = \frac{2.436}{\sqrt{9.81 \times 2.9}} = 0.456 < 1$$

(sub critical flow)

Down stream

$$Fr_2 = \frac{V_2}{\sqrt{g y_2}} = \frac{6.42}{\sqrt{9.81(1.1)}}$$

$$Fr_2 = 1.95 > 1$$

(super critical flow)

~~Q(a) what is the minimum height~~ (7)

Q(A) What is the minimum height (in unit of meter) of broad created weir if it is to function critical depth on the crest. If water flows along a rectangular channel at a depth of 1.8m with a discharge of 7869 ft³/sec. the channel width is 66 ft.

Given data:

$$y = 1.8m$$

$$b = 66' = \frac{66}{3.28} = 20.12m$$

$$Q = \frac{7869}{3.28^3} = 222.99 m^3/sec$$

Required: minimum height (P) of water

$$Q = AV$$

$$V = Q/A = Q/by = \frac{222.99}{20.12 \times 1.8} = 6.15 m/sec$$

As we know

$$y_c = (q^2/g)^{1/3}$$

$$= \left(\frac{11.08^2}{9.81}\right)^{1/3}$$

$$\left[\because q = Q/b = \frac{222.99}{20.12} = 11.08 m^3/sec\right]$$

$$\boxed{y_c = 2.321m}$$

Also

$$V = \sqrt{gy}$$

$$V_c = \sqrt{gy_c} = \sqrt{9.81 \times 2.321}$$

$$= \boxed{4.771 m/sec}$$

(8) height 1m unit q. (8)

Now according to specific energy

$$E_1 = E_2$$

$$y_1 + \frac{v_1^2}{2g} = \frac{v_c^2}{2g} + y_c + P$$

$$1.8 + \frac{16.151^2}{2 \times 9.81} = \frac{(4.751)^2}{2 \times 9.81} + 2.921 + P$$

$$3.72 = 4.37 + P$$

$$P = 3.72 - 3.48$$

$$\boxed{P = 0.24\,M}$$

(B) An orifice in one side of large tank is rectangular in shape 2.8m broad and 1.5m deep. the water level on one side of the orifice is 5meter above its top edge. the water level on the other side of the orifice is 0.6m below its top edge calculate the discharge is cd = 7869

Given data:

$b = 2.8m$

$d = 1.5m$

$H_1 = 5m$

$H_2 = 5 + 1.5 = 6.5m$

$H = 5 + 0.6 = 5.6m$

$cd = 0.7869$

Required:

$Q = ?$

As we know
Discharge through submerged portion

$Q_1 = cd \times b \times (H_2 - H) \times \sqrt{2gH}$

$= 0.7869 \times 2.8 \times (6.5 - 5.6) \times \sqrt{2 \times 9.81 \times 5.6}$

$1.97 \times \sqrt{2 \times 9.81 \times 5.6}$

$\boxed{Q_1 = 20.78\ m^3/sec}$

Discharge of free portion

$$Q_2 = 2/3 \; c_d \times b \sqrt{2g} \left[H^{3/2} - H_1^{3/2} \right]$$

$$Q_2 = 2/3 (0.7869) \times 2.8 \sqrt{2 \times 9.81} \left[5.6^{3/2} - 5^{3/2} \right]$$

$$Q_2 = 13.47 \; m^3/sec$$

Total discharge

$$Q = Q_1 + Q_2$$

$$Q = 20.78 + 13.47$$

$$\boxed{Q = 34.90 \; m^3/sec}$$

(11)

QNo3(4) the diameter of a water pipe is suddenly enlarged from 7869 - 200mm to 7869 + 3000mm. the rate of flow through is 0.95 m³/sec and the pressure in the larger pipe is 7869 + 800 N/m²

calculate:-

1) the loss of Head due to sudden enlargement.

2) the power lost due to sudden enlargement.

3) the pressure in the smaller pipe

(If the pipe is in horizontal).

Sol:- Given data:-

$P_1 = R + 800 = 7869 + 800 = 8669\ N/m^2$

$d_1 = R - 200 = 7869 - 200 = 7669\ mm$

$\boxed{7.669\ m}$

$A_1 = \frac{\pi}{4} d_1^2 = \frac{\pi}{4}(7.869)^2 = 46.19\ m^2$

$d_2 = R + 3000 = 7869 + 3000 = 10869\ mm$

$\boxed{10.869\ m}$

$A_2 = \frac{\pi}{4} d_2^2 = \frac{\pi}{4}(10.869)^2$

$\boxed{A_2 = 92.78}$

$Q = 0.95\, m^3/sec$

$Q = AV$

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

$$V_1 = \frac{Q_1}{A_1} = \frac{0.95}{46.19} = 0.020\, m/sec$$

$$V_2 = \frac{Q_2}{A_2} = \frac{0.95}{92.78} = 0.010\, m/sec$$

1. Head less due to sudden enlargement

$$he = \left(1 - \frac{A_1}{A_2}\right)^2 \left(\frac{V_1 - V_2}{2g}\right)^2 =$$

$$he = \left(1 - \frac{46.19}{92.78}\right)^2 \times \left(\frac{(0.020 - 0.010)^2}{2 \times 9.81}\right)$$

$he = 1.285 \times 10^{-6}$

$\boxed{he = 0.0000012\, m}$

2// power least due to Sudden enlargment

$P = \rho g Q he$

$P = 1000 \times 9.81 \times 0.95 \times 1.28 \times 10^{-6}$

$\boxed{P = 0.011}$

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(13)

(3)

pressure in smallest pipe

Apply Bernoulles equation

$$\frac{p_1}{\rho g} + \frac{v_1^2}{2g} = \frac{p_2}{\rho g} + \frac{v_2^2}{2g} + \text{RC}$$

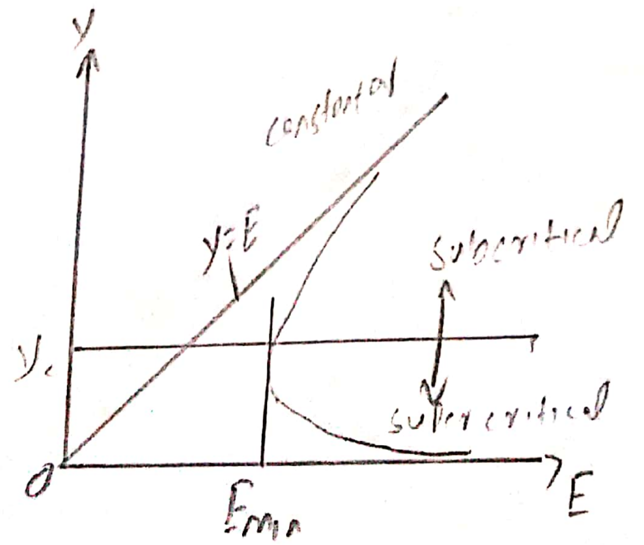
$$\frac{8683}{1000 \times 9.81} + \frac{(0.020)^2}{2 + 9.81} = \frac{p_2}{(1000 \times 9.81)} + \frac{(0.010)^2}{2 \times 9.81} +$$

1.28×10^{-6}

$$\boxed{p_2 = 8681.72 \ N/m^2}$$

Q:No 2.3

b):-



What does this blue curve indicates. How it is obtained Explain the above Figure from each and every Point of view.

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(14)

Ans:: the above graph is plast b/w depth flow (y) and specific energy (E) It is made from three degree polynomial equation which shows us the different specific energy for the depth flow which may be either

1. subcritical
2. critical
3. super critical

Specific energy is used to clarity the mening of the above terms in an open channel.

How is this ACHEIVED?

total energy = potential energy + kinetic energy

$$TE = mgh + 1/2 mv^2$$

$$w = mg$$

$$m = w/g$$

$$= wh + 1/2 \; w/g \; v^2$$

ignoring "W" weight of Water

$$\boxed{TE = y + \frac{V^2}{2g}} \rightarrow (1)$$

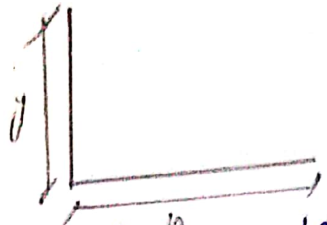
As we know that

$$Q = VA$$

$$V = Q/A$$

$$V^2 = \frac{Q^2}{A^2}$$ surving both side

put (1) in eqn (1)



$$E = y \cdot \frac{Q^2}{A^2 2g}$$

Let suppose this channel is rectangular

$$A = y \times b \rightarrow (x)$$

$$Q = qb \rightarrow (y)$$

putting value of (x) and (y) in eq (1)

$$E = y + \frac{Q^2}{y^2 b^2 2g} \quad \text{putting } (x)(y)$$

$$E - y = \frac{q^2}{y^2 2g}$$

$$(E-y)\, y^2 = \frac{q^2}{2g}$$

$$(E-y)\, y^2 = \text{constant}$$

critical depth is the flow depth corresponding to minimum specific energy

$y > y_1$ = Subcritical flow

$y = y_1 \Rightarrow$ critical flow

$y < y_1$ = supercritical.