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SECTION # B

Module # 6Th

Subject # HYDRAULIC ENG

Submitted To # ENGR FAWAD

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Q1 A Lets suppose a rectangular channel, discharge R Ltr/sec of water into 8m wide apron with zero slope. Mean velocity is R-220? 7846

Calculate

i) Height of hydraulic jump (m)

(ii) Power absorbed due to hydraulic jump (KW)?

Ans Given that

Channel width = b = 8m.

Discharge = Q = 7846 Ltr/sec

$\Rightarrow$ 7.846 m³/sec.

Mean velocity $\Rightarrow$ v = R-200

$\Rightarrow$ 7846 - 200

$\Rightarrow$ ~~78~~ 7646 ft/sec.

$\boxed{2331.09}$ m/sec.

As we know:

$$Q = q\,b.$$

$$q = Q/b \Rightarrow \frac{7.846}{8} = \cancel{0.979}$$

$$\Rightarrow 0.98075 \text{ m}^2/\text{sec.}$$

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

$$\Rightarrow \left(\frac{0.98075^2}{9.81}\right)^{1/3} = \boxed{0.4641 \text{ m}}$$

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As it is Rectangular Section.

$Q = qb \rightarrow (i)$

$Q = Av \rightarrow (ii)$.

equating (1) & (2).

$qb = Av$.

$q\cancel{b} = y\cancel{b}v$

$q = yv$

$V_c = q/y_c = \frac{0.98075}{0.4641}$

$V_c \Rightarrow \boxed{2.113 \text{ m/sec}}$

$\because V > V_c$ Supercritical flow.

Height of hydraulic jump on the upstream side:

As.

$Q = Av$

$Q = byv$

$y_1 = Q/v_1 b$

$y_1 = \frac{7.846}{2331.09 \times 8} = 0.000420\text{m}$

$$y_2 = \frac{-y_1}{2} + \sqrt{\frac{y_1^2}{4} + \frac{2qv_1}{g}}$$

$$y_2 = \frac{-0.00042}{2} + \sqrt{\frac{0.00042}{4} + \frac{2(9.81)(2331.09)^2}{9.81}}$$

$$y_2 = \boxed{21.57m}$$

$$\Delta y = y_2 - y_1$$

$$= 21.57 - 0.00042$$

$$\Delta y = \boxed{21.570}$$

ii) $\Delta E = E_1 - E_2$

As we know.

$$A_1 V_1 = A_2 V_2$$

$$\cancel{b} y_1 V_1 = \cancel{b} y_2 V_2$$

$$V_2 = y_1 V_1 / y_2$$

$$V_2 = \frac{0.00042 \times (2331.09}{21.57} = \boxed{0.045 m/sec}$$

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$$\Delta E = E_1 - E_2 = \left(y_1 - \frac{v_1^2}{2g}\right) - \left(y_2 + \frac{v_2^2}{2g}\right)$$

$$\Rightarrow 0.00042 + \left(\frac{2331.09^2}{2(9.81}\right) - \left(21.57 - \frac{0.045^2}{2g}\right)$$

$$\boxed{E_1 - E_2 = 276939.72}$$

$\Rightarrow$ Power Absorbed :

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

$$\Delta P \Rightarrow 1000 \times 9.81 \times 7.846 (276939.72)$$

$$\boxed{\Delta P \Rightarrow 2.13158 \times 10^{10}}$$

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

Sol Given Data:

$b = 4m$

$Q = 7846\ ft^3/sec = \frac{7846}{(3.28)^3} = \boxed{222.06\ m^3/sec}$

$Q \Rightarrow \boxed{222.34\ m^3/sec}$

$y_1 = 2.9m$

$y_2 = 1.1m$

let specific energy at upstream = downstream side.

$E_1 = E_2$

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

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As we know that.

$$Q = A_1 V_1 = A_2 V_2$$

$$b y_1 V_1 = b y_2 V_2$$

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

$$\boxed{V_2 = 2.634 V_1} \rightarrow (2)$$

put the value of equ(2) in equ (1).

$$2.9 + \frac{V_1^2}{2\times 9.81} = 1.1 + \frac{(2.636 V_1)^2}{2\times 9.81}$$

$$2.9 - 1.1 = \frac{6.938 V_1^2}{19.62} - \frac{V_1^2}{19.62}$$

$$1.8 = \frac{6.938 V_1^2 - V_1^2}{19.62}$$

$$1.8 \times 19.62 = 5.938 V_1^2$$

$$V_1^2 = \sqrt{\frac{1.8 \times 19.62}{5.938}}$$

$$\boxed{V_1 = 2.44 \text{ m/sec}}$$

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Now put the value of "V_1" in eq (1)

$$y_1 + \frac{V_1^2}{2g} = y_2 + \frac{V_2^2}{2g} \quad (\text{putting } V_1)$$

$$2.9 + \frac{2.44^2}{2g} = 1.1 + \frac{V_2^2}{2g}$$

$$2.9 - 1.1 = \frac{V_2^2}{2g} - \frac{5.95}{2g}$$

$$1.8 = \frac{V_2^2 - 5.95}{2g}$$

$$1.8 \times 2 \times 9.81 = V_2^2 - 5.95$$

$$\sqrt{V_2^2} = \sqrt{41.266}$$

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

Using Froud No to Determine type of flow.

Upstream Side :⇒ $F_{r1} = \frac{V_1}{\sqrt{g y_1}} = \frac{2.44}{\sqrt{9.81 \times 2.9}} = 0.457$

$0.457 < 1$

(Subcritical flow)

Downstream Side:

$$F_{r_2} = \frac{V_2}{\sqrt{g y_2}} \Rightarrow \frac{6.42}{\sqrt{9.81 \times 1.1}} =$$

$$\Rightarrow 1.95 > 1$$ Supercritical flow.

3) What is the minimum height (in unit m) of broad crested weir if it is to function critical depth on the crest. If water flows along a rectangular channel at a depth of 1.8 m with a discharge of R ft^3/sec. The channel width is 66'.

Sol Given data:

$y = 1.8$ m

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

$Q = \frac{7846}{3.28^3} = 222.34$ m^3/sec.

Required data: minimum height (P) of ~~water~~ weir.

$Q = AV$

$V = \frac{Q}{A} = \frac{Q}{by} = \frac{222.34}{20.12 \times 1.8} = 6$

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$V = 6.139 \text{ m/sec}$

As we know:

$$y_c = \left(q^2/g\right)^{1/3} = \left(\frac{11.045^2}{9.81}\right)^{1/3} \quad \because q = Q/b$$

$$\boxed{y_c = 2.316 \text{ m}}$$

Also

$$V = \sqrt{gy}$$

$$V_c = \sqrt{gy_c} = \sqrt{9.81 \times 2.316}$$

$$\boxed{V_c = 4.76 \text{ m/sec.}}$$

Now

According to specific energy.

$$E_1 = E_2$$

$$y_1 + \frac{V_1^2}{2g} = \frac{V_c^2}{2g} + y_c + P$$

$$1.8 + \frac{6.139^2}{2(9.81)} = \frac{4.76^2}{2(9.81)} + 2.316 + P$$

$$\Rightarrow 3.720 = 3.47 + P$$

$$\boxed{P = 0.25 \text{ m}}$$

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3 An orifice in one side of Large tank is rectangular in shape, 2.8 m braad and 1.5 m deep. The water level on one side of the orifice is 5m above it's top edge. The water level on the other side of the orifice is 0.6m below its top edge. Calculate the discharge through the orifice if coefficient of discharge

$Cd = 0.R.$

Sol Given data: $b = 2.8$ m

$d = 1.5$ m

$H_1 = 5$ m

$H_2 = 5 + 1.5 = 6.5$ m

$H = 5 + 0.6 = 5.6$ m.

$cd = 0.7846.$

Required ?

$Q = ?$

Discharge through submerged portion.

$Q_1 = cd \times b \times (H_2 - H) \times (2gH).$

$= 0.7846 \times 2.8 \times (6.5 - 5.6) \times \sqrt{2 \times 9.81 \times 5.6}$

$\boxed{Q_1 \Rightarrow 20.72 \text{ m}^3/\text{sec}}$

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Discharge of free portion.

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

$$Q_2 = \frac{2}{3} (0.7846) \times 2.8 \sqrt{2 \times 9.81} \times \left[5.6^{3/2} - 5^{3/2} \right]$$

$$\boxed{Q = 13.439 \ m^3/sec}$$

Total Discharge.

$$Q = Q_1 + Q_2.$$

$$Q = 20.72 + 13.439.$$

$$\boxed{Q = 34.15} \ m^3/sec.$$

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3\. A The diameter of a water pipe is a suddenly enlarged from R-200 mm to R+3000 mm. The rate of flow through is 0.95 m^3/sec and the pressure in the larger pipe is R+ 800 N/m^2

Calculate.

1) The loss of head due to sudden enlargement.

(2) The power lost due to sudden enlargement.

3) The pressure in the smallest pipe (if the pipe is horizontal).

Sol Given data.

$P_1 = R + 800 = 7846 + 800 = 8646\ N/m^2$

$d_1 = R - 200 = 7846 - 200 = 7646\ mm.$

$= 7.646\ m$

~~$A_1 = \frac{\pi}{4} d_2^2 = \frac{\pi}{4} ($~~

$d_2 = R + 3000 \Rightarrow 7846 + 3000 \Rightarrow 10846mm$

$A_1 = \frac{\pi}{4} d_1^2 = \frac{\pi}{4}(7.646)^2 \Rightarrow 45.91\ m^2$

$A_2 = \frac{\pi}{4} d_2^2 = \frac{\pi}{4}(10.846)^2 = 92.22\ m^2$

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

$\because \quad Q = AV$

$V = Q/V$

$$V_1 = \frac{Q_1}{A_1} = \frac{0.95}{45.91} = 0.020 \ m/sec.$$

$$V_2 = \frac{Q_2}{A_2} = \frac{0.95}{92.2} = 0.010 \ m/sec.$$

Head loss due to ~~do~~ sudden enlargement

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

$$= \left(1 - \frac{45.91}{92.22}\right)^2 \times \left(\frac{(0.020 - 0.010)^2}{2 \times 9.81}\right)^2$$

$$\Rightarrow \boxed{h_e = 1.28 \times 10^{-6}}$$

Power lost due to sudden enlargement.

$P = \rho g Q h_e$

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

$$\boxed{P = \cancel{0.0} \ 0.0119 \ W}$$

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3) Pressure in the smallest pipe.

Apply Bernoulli's equ.

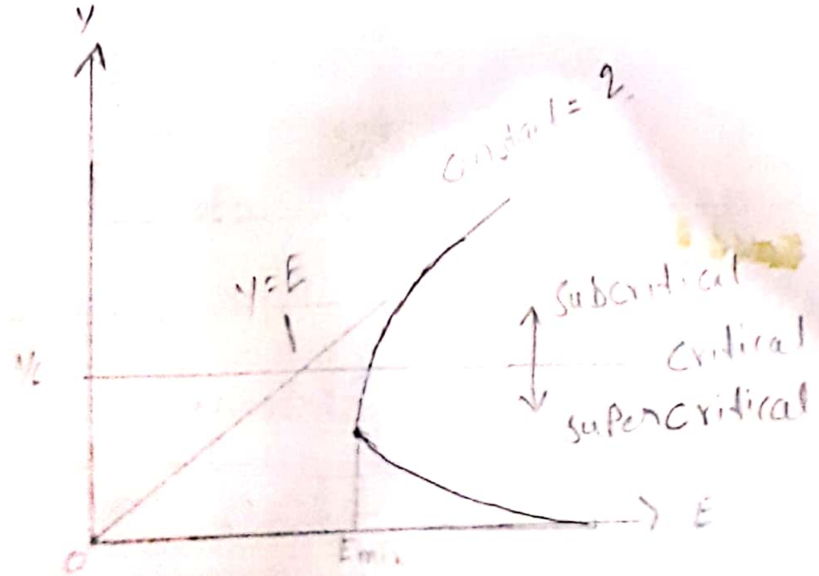
$$\frac{P_1}{\rho g} + \frac{v_1^2}{2g} = \frac{P_2}{\rho g} + \frac{v_2^2}{2g} + h_c.$$

$$\frac{8646}{1000 \times 9.81} + \frac{0.020^2}{2(9.81)} = \frac{P_2}{1000 \times 9.81} + \frac{0.010^2}{2(9.81)} + 1.28 \times 10^{-6}.$$

$$\boxed{P_2 = 8642.56 \ N/m^2}$$

3B. What does blue curve indicates How it is obtained. Explain The above figure from each and every point of view.

Ans



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Ans The above graph is plot between 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 b either

(i) Subcritical (ii) Critical (iii) Supercritical.

Specific energy is used to clarify the meaning of the above terms in an open channel.

How is this Acheived ?

Total energy = Potential energy + Kinetic energy

$$T.E = mgh + \frac{1}{2}mv^2 \qquad \because W = mg$$

$$= Wh + \frac{1}{2}\frac{W}{g}v^2 \qquad m = W/g$$

Ignoring 'W' weight of water.

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

$$T.E = y + \frac{v^2}{2g} \rightarrow ①$$

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As we know that

$Q = VA$

$V = Q/A$ squaring b/s.

$V^2 = \frac{Q^2}{A^2}$

Put V^2 in eq (1).

$$E = Y + \frac{Q^2}{A^2 2g} \rightarrow (2).$$

Lets Supose The channel is Rectangular.

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

$Q = q b \Rightarrow (Y)$

Putting value of (x) & (Y) in (2).

$E = Y + \frac{Q^2}{Y^2 b^2 . 2g}$ putting (x).

$E = Y + q + \frac{q^2}{Y^2 . 2g}$ Putting (Y).

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

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

$$\boxed{(E - Y) Y^2 = \text{Constant}}$$

As "q" and "g" are Constants.

* Critical depth is the flow depth corresponding to minimum specific energy

$y > y_c \rightarrow$ Subcritical flow

$y = y_c \rightarrow$ Critical flow

$y < y_c \rightarrow$ Supercritical flow.