(1)

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Section :- B

Subject :- Hydrolic Engineering

Module :- 6th

QNo1 (A)

Given Data

Channel width = $b = 8m$

Discharge $= Q = 7834\ \text{lit/sec} = 7.834\ m^3/sec$

Mean velocity $= V = R - 220\ ft/sec = 7834 - 220$

$= 7614$

$= 2321.341\ m/sec$

As we know

$$Q = qb$$

$$q = \frac{Q}{b} = \frac{7.834}{8} = 0.9792\ m^2/sec$$

$$\Rightarrow y_c = \left(\frac{q^2}{g}\right)^{1/3} = \left(\frac{0.9792^2}{9.81}\right)^{1/3} = 0.4606m$$

$$y_c = 0.4606m$$

As it is rectangular section

$$Q = qb \longrightarrow (1)$$

$$Q = AV \longrightarrow (2)$$

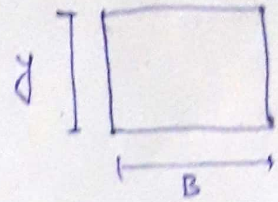
(2)

Equating (1) and (2)

$qb = AV$

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

$q = yV$



$V_c = \frac{q}{y_c} = \frac{0.9792}{0.4606} = 2.125\,m/sec$

$\therefore V > V_c$ (supercritical flow)

Weight of hydralic jump in the upstream side

As

$Q = AV$

$Q = byV$

$y_1 = \frac{Q}{v_1 b}$

$y_1 = \frac{7.834}{2321.34 \times 8} = 0.00042\,m$

$\Rightarrow y_2 = -\frac{y_1}{2} + \sqrt{\frac{y_1^2}{4} + \frac{2y_1v_1^2}{g}}$

$y_2 = -\frac{0.00042}{2} + \sqrt{\frac{(0.00042)^2}{4} + \frac{2(0.00042)(2321.34)^2}{9.81}}$

$y_2 = 21.480\,m$

$\Rightarrow \Delta y = y_2 - y_1 = 21.480 - 0.00042$

$\Delta y = 21.479$

$\therefore \Delta E = E_1 - E_2$

As we know that

$Q_1 = Q_2$

$A_1V_1 = A_2V_2$ $\quad$:- $b_1 = b_2 = b$

$\cancel{b}y_1V_1 = \cancel{b}y_2V_2$

$$V_2 = \frac{y_1V_1}{y_2}$$

$$V_2 = \frac{(0.00042)(2321.34)}{21.480} = 0.0453 \text{ m/sec}$$

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

$$= \left(0.00042 + \frac{(2321.34)^2}{2(9.81)}\right) - \left(21.479 + \frac{0.045^2}{2(9.81)}\right)$$

$$= 274627.82$$

⇒ Power Absorbed

$$\Delta P = \rho g Q \underbrace{(274627.82)}_{}^{(E_1 - E_2)}$$

$$\Delta p = 1000 \times 9.81 \times 7.834(274627.82)$$

$$\Delta p = 21105570.89 \text{ KN}$$

Part b

Given Data

$B = 4m$

$Q = 7834\ ft^3/sec = \frac{7834}{(3.28)^3} = 222.00\ m^3/sec$

$y_1 = 2.9m$

$y_2 = 1.1m$

Let specific energy at upstream and downstream side

$E_1 = E_2$

$Y_1 + \frac{v_1^2}{2g} = y_2 + \frac{v_2^2}{2g} \longrightarrow (1)$

As we know that

$Q = A_1V_1 = A_2V_2$

$\cancel{b}y_1V_1 = \cancel{b}y_2V_2 \quad b_2 = b_1 = b$

$V_2 = \frac{y_1V_1}{y_2} = \frac{(2.9)(v_1)}{1.1} = 2.634V_1 \rightarrow (2)$

Put the value of eq 2 in eq (1)

$2.9 + \frac{v_1^2}{2(9.81)} = 1.1 + \frac{(2.634v_1)^2}{2(9.81)}$

$2.9 - 1.1 = \frac{6.938v_1^2}{19.62} - \frac{v_1^2}{19.62}$

$1.8 = \frac{6.938v_1^2 - v_1^2}{19.62}$

$$1.8 \times 19.62 = 5.938 v_1^2$$

$$v_1^2 = \sqrt{\frac{1.8 \times 19.62}{5.938}}$$

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

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

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

$$2.9 + \frac{2.44^2}{2g} = 1.1 + \frac{v_2^2}{2g}$$

$$2.9 - 1.1 = \frac{v_2^2}{2g} - \frac{5.95}{2g}$$

$\cancel{1.8 \times 2 \times}$

$$1.8 = \frac{v_2^2 - 5.95}{2g}$$

$$1.8 \times 2 \times 9.81 = v_2^2 - 5.95$$

$$\sqrt{v_2^2} = \sqrt{41.266}$$

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

Using Froud No to determine type of flow

upstream side

$$Fr_1 = \frac{v_1}{\sqrt{gy_1}} = \frac{2.44}{\sqrt{9.81 \times 2.9}} = 0.457 < 1 \text{ (subcritical flow)}$$

Downstream side :-

$$Fr_2 = \frac{V_2}{\sqrt{9.81 \times 1.1}} = 1.95 > 1$$

(super critical flow)

QNo2 Part A

Given Data

$y_1 = 1.8m$

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

$Q = \frac{7834}{3.28^3} = 222.00\ m^3/sec$

Required Data

Minimum height (P) of weir

$Q = AV$

$$V = \frac{Q}{A} = \frac{Q}{by} = \frac{222.00}{(20.12) \times 1.8} = 6.12\ m/sec$$

As we know

$$y_c = \left(\frac{q^2}{g}\right)^{1/3} = \left(\frac{11.03^2}{9.81}\right)^{1/3} \quad \because q = \frac{Q}{b} = \frac{222.00}{20.12} = 11.03$$

$y_c = 2.31m$

Also $V = \sqrt{gy} = \sqrt{g y_c}$

$$V = \sqrt{9.81 \times 2.31}$$

$$V_c = 4.76 \ m/sec$$

Now According to specific energy

$$E_1 = E_2$$

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

$$1.8 + \frac{6.12^2}{2 \times 9.81} = \frac{4.76^2}{2 \times 9.81} + 2.31 + P$$

$$3.70 = 3.46 + P$$

$$P = 3.70 - 3.46$$

$$P = 0.24$$

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Q No 2 (b)

Given Data

$b = 2.8m$

$d = 1.5m$

$H_1 = 5m$

$H_2 = 5 + 1.5 = 6.5m$

$H = 5 + 0.6 = 5.6m$

$C_d = 0.7834$

Required Data

$Q = ?$

Discharge through submerged portion

$Q_1 = C_d \times b \times (H_2 - H) \times \sqrt{2gh}$

$Q_1 = 0.7834 \times 2.8 \times (6.5 - 5.6) \times \sqrt{2(9.81)(5.6)}$

$Q_1 = 20.69 \, m^3/sec$

Discharge of free portion

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

$= \frac{2}{3} (0.7834 \times 2.8 \sqrt{2(9.81)} \left[5.6^{3/2} - 5^{3/2} \right]$

$= 13.422 \, m^3/sec$

Total Discharge

$$Q = Q_1 + Q_2$$

$$Q = 20.69 + 13.422$$

$$Q = 34.11 \, m^3/sec$$

Q NO3 (A)

(A)

Given Data

$$P_1 = R + 800 = 7834 + 800 = 8634 \, N/m^2$$

$$d_1 = R - 200 = 7834 - 200 = 7634 \, mm = 7.634 \, m$$

$$A_1 = \frac{\pi}{4} d_1^2 = \frac{\pi}{4}(7.634)^2 = 45.77 \, m^2$$

$$d_2 = R + 3000 = 7834 + 3000 = 10834 \, mm$$

$$= 10.834 \, m$$

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

$$= \frac{\pi}{4}(10.834)^2 = 92.18 \, m^2$$

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

$$Q = AV$$

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

$$V_1 = \frac{Q_1}{A_1} = \frac{0.95}{45.77} = 0.020 \, m/sec$$

$$V_2 = \frac{Q_2}{A_2} = \frac{0.95}{92.18} = 0.01\,m/sec$$

(1) Head loss due to sudden Enlargement

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

$$h_e = \left(1 - \frac{45.77}{92.18}\right)^2 \left(\frac{0.020 - 0.01}{2(9.81)}\right)^2$$

~~he = 0.00000000~~

$$h_e = 1.29 \times 10^{-6}\,m$$

(2) Power lost due to sudden Enlargment

$$P = \rho g Q h_e$$

$$P = 1000 \times 9.81 \times 0.95 \times 1.29 \times 10^{-6}$$

$$P = 0.012\,W$$

(3) Pressure into smallest pipe

Apply Bernoulli eq

$$\frac{P_1}{\rho g} + \frac{V_1^2}{2g} = \frac{P_2}{\rho g} + \frac{V_2^2}{2g} + h_e$$

$$\frac{8634}{1000 \times 9.81} + \frac{0.020^2}{2(9.81)} = \frac{P_2}{1000 \times 9.81} + \frac{0.01}{2(9.81)} + 1.29 \times 10^{-6}$$

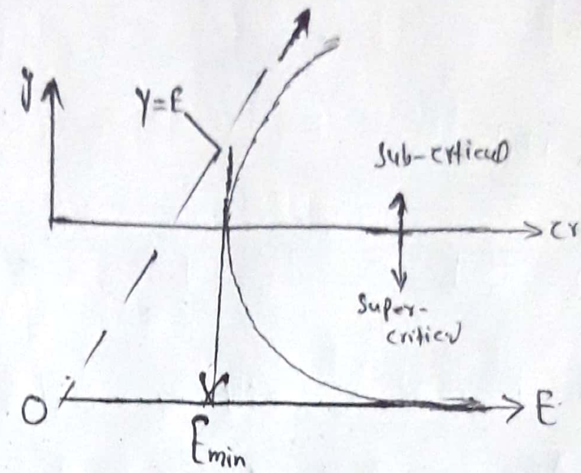
Scanned with CamScanner

$$\frac{P_2}{1000 \times 9.81} = 0.88015 - 6.4368 \times 10^{-6}$$

$$P_2 = 0.88013 \times 9810$$

$$P_2 = 8634.136$$

Q No3 (b)



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

Ans The above graph is plot between depth flow (y) and specific energy (E) Pagnomical equation which shows us the different specific energy for the depth flow which may be either

(i) sub critical

(ii) critical

(iii) Super critical

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

$$TE = mgh + \frac{1}{2}mv^2 \qquad w = mg$$

$$m = \frac{w}{g}$$

$$= wh + \frac{1}{2}\frac{w}{g}v^2$$

Ignoring "w" weight of water

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

$$T.E = \cancel{y} + \frac{v^2}{2g} \longrightarrow (i)$$

As we Know that

$$Q = VA$$

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

Squaring both sides

$$v^2 = \frac{Q^2}{A^2}$$ put v^2 in eq(i)

Let suppose the channel is Rectangular

(13)

$A = y \times b \longrightarrow x$

$Q = q\, b \longrightarrow y$

x and y in 2

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