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ID NO : 7852 (B)

SEMESTER: 6th

SUBJECT : Hydrology

Mid Examination

QNo 1 (a)

Let suppose a rectangular channel discharge 7852 Lit/sec of water into 8m wide apron with zero slope Mean velocity is R-220 ft/sec

i) Height of hydraulic Jump
ii) Power absorbed due to hydraulic Jump.

GIVEN DATA:

Channel width $= b = 8m$
Discharge, $Q = 7.851 \, m^3/sec$
Mean velocity, $V = R-200 = 7852-200 = 7652 \, ft/sec$
$\doteq 2332.9 \, m/sec$

As we know

$$Q = qb$$

$$q = Q/b = \frac{7.851}{8} = 0.981 \, m^3/sec$$

$$y_c = \left(\frac{q^2}{g}\right)^{1/3} = \left(\frac{0.981}{9.81}\right)^{1/3} = 0.467m$$

$$y_c = 0.467m$$

As this is rectangular section

$Q = qb$

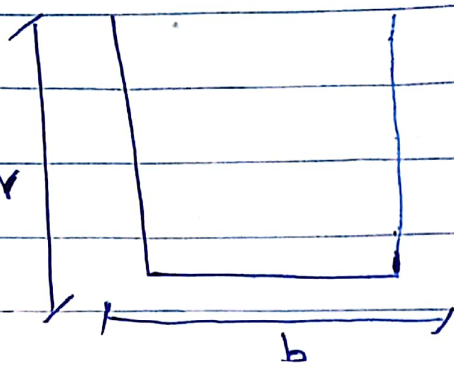
$Q = AV$

Comparing

$qb = AV$

$qb = ybv$

$q = yv$



$V_c = \frac{q}{y_c} = \frac{0.981}{0.467} = 2.10\,m/sec$

$V > V_c$ (super critical flow

Depth of water on upstream side :-

$y = \frac{Q}{V \cdot b} \Rightarrow y_1 = \frac{Q}{V \cdot b}$

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

$y_1 = \frac{7.862}{(2.13)(8)}$

$y_2 = \frac{-0.462}{2} \sqrt{\frac{0.462^2}{4} \times \frac{2(0.46)(2.13)^2}{9.81}}$

$y_1 = 0.\cancel{0}46\,m$

$y_2 = 0.462\,m$

Depth difference (Δy):-

$\Delta y = y_2 - y_1$

$\Delta y = 0.46 - 0.462$

$= 0m$

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Now finding V_2:

As

$$\Delta E = E_1 - E_2$$

$$Q_1 = Q_2$$

$$A_1 V_1 = A_2 V_2$$

$$b y_1 V_1 = b y_2 V_2$$

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

$$V_2 = \frac{(0.46)(2333.1)}{(0.462)}$$

$$V_2 = 2331.35 \text{ m/sec}$$

Difference in specific Energy:

$$\Delta E = E_1 - E_2$$

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

$$E_1 - E_2 = 0m$$

Power Dissipated in hydraulic Jump:

P-T-O

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(4)

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

$$= (1000) \times 9.81 \times 7.852 \times 277013.3$$

$$\Delta P = 2.138 \times 10^{10} \, W$$

Q1(B)

Sluice gate controls the flow in a channel of width 4m. If the discharge is 7852 ft/sec and the upstream and downstream water depth is 2.9m and 1.1m respectively. Calculate the downstream velocity. Also state the type of flow at upstream and downstream side using any equation.

GIVEN DATA:

$b = 4m$

$Q = 7852 \text{ ft}^3/\text{sec} = 7852/(3.28)^3$

$= 222.51 \text{ m}^3/\text{sec}$

$y_1 = 2.9m, \; y_2 = 1.1m$

Let specific Energy at upstream and downstream side.

$$E_1 = E_2$$

$$Y_1 + \frac{V_1^2}{2g} = y_2 + \frac{V_2^2}{2g} \quad \text{—— (i)}$$

As we know

$$Q = A_1V_1 = A_2V_2$$

$$by_1V_1 = by_2V_2 \qquad b_2 = b_1 = b$$

$$V_2 = 2.634V_1 \quad \text{— (2)}$$

Put the value of eq (ii) in (i)

$$2.9 + \frac{V_1^2}{2 \times 9.81} = \frac{(1.1 \quad 2.63 V_1)^2}{2 \times 9.81}$$

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

Now put value of V_1 in eq (1)

$$y_1 + \frac{V_1^2}{2g} = y_2 + \frac{V_2^2}{2g}$$

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

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

Using froud number to determine type of flow.

Upstream Side:

$$Fr_1 = \frac{V_1}{\sqrt{gy_1}} = \frac{2.44}{\sqrt{9.81 \times 2.9}} = 0.457 < 1$$

Sub critical flow

DOWNSTREAM SIDE:

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

Super critical flow

QNo 2 (A)

Given Data:

$y_1 = 1.8m$

$b = 66' = 20.12m$

$$Q = \frac{7852}{3.28^3} = 222.51 \ m^3/sec$$

Req:

Maximum height of weir, P

Sol:

$Q = AV$ $\quad V = Q/A = Q/by = \frac{222.51}{20.12 \times 1.8}$

$V = 6.15 \ m/sec$

As we know

$q = Q/b$

$$\frac{222.51}{20.12} = 11.07$$

$$y_c = \left(\frac{q^2}{g}\right)^{1/3} = \left(\frac{11.07^2}{9.81}\right)^{1/3}$$

$$y_c = 2.3m$$

Also

$$V = \sqrt{gy} = \sqrt{gy_c}$$

$$V_c = 4.77 \text{ m/sec}$$

Now according to specific energy

$$E_1 = E_2$$

$$y_1 + \frac{V_1^2}{2g} = \frac{V_2^2}{2g} + y_c + P$$

$$1.8 + \frac{(6.13)^2}{2 \times 9.8} = \frac{4.77^2}{2 \times 9.8} + 2.3 + P$$

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

Q No 2 (B)

Given data:

$b = 2.8m$ $d = 1.5m$, $H = 5m$

$H_2 = 6.5m$

$H = 5.6m$

Required:
Discharge through submerged portion

Sol:

$$Q_1 = cd \times b \times (H_2 - H_1) \times \sqrt{2gH}$$
$$= 0.7852 \times 2.8 \times (6.5 - 5.6) \sqrt{2 \times 9.8 \times 5.6}$$

$$Q = 20.73 \text{ m}^3/\text{sec}$$

Discharge of free portion

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

$$= 2/3\,(0.7852) \times 2.8 \sqrt{2 \times 9.81} \left[5.6^{3/2} - 5^{3/2}\right]$$

$$Q_2 = 13.51$$

Total Discharge
$$Q = Q_1 + Q_2$$

$$\boxed{Q = 34.24 \text{ m}^3/\text{s}}$$

Q No 3 (A)

GIVEN:

$P_1 = R + 800 = 7852 + 800 = 8652\ N/m^3$

$d_1 = R - 200 = 7852 - 200 = 7652\ mm$

$= 7.652\ m.$

$A_1 = \frac{\pi d_1^2}{4} = \frac{\pi}{4}(7.652)^2 = 45.96\ m^2$

$d_2 = R + 3000 = 7852 + 3000 = 10852\ mm$

$= 10.861\ m$

$A_2 = \frac{\pi d_2^2}{4} = \frac{\pi}{4}(10.861)^2 = 92.42\ m^2$

$Q = 0.95\ m^3/sec$

$\because Q = AV$

$V = Q/A = 0.95/45.96 = 0.020\ m/se$

$V_2 = \frac{0.95}{92.42} = 0.01\ m/sec$

P.T.O

Date:

1- Head Loss due to Sudden enlargement

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

$$= \left(1 - \frac{45.96}{92.59}\right)\left(\frac{0.02 - 0.01}{2 \times 9.8}\right)$$

$h_e = 1.34 \times 10^{-6} m$

$h_e = 0.0000013 m$

- Power Loss due to Sudden Enlargement:

$$P = \rho g Q h_e$$

$= 1000 \times 9.81 \times 0.95 \times 1.3 \times 10^{-6}$

$= 0.0125 W$

P.T.O

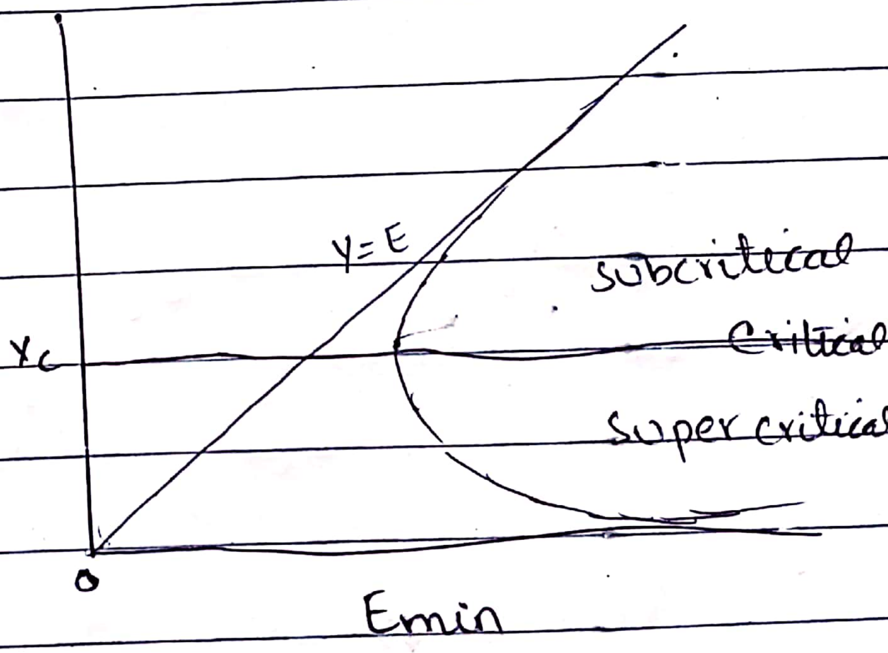
3- Pressure In the smallest pipe:

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

$$\frac{8652}{1000 \times 9.81} + \frac{(0.02)^2}{2 \times 9.81} = \frac{P_2}{1000 \times 9.81} + \frac{(0.01)^2}{2 \times 9.81} + 1.34 \times 10^{-6}$$

$$P_2 = 8653.2 \ N/m^2$$

Q No 3(b)



What does this Curve indicate How it is obtained Explain the above figure from each and every point of view

ANSWER:

The graph is plot between depth flow (y) and Specific Energy (E) It is three degree polynomial equation which show us the different specific energy for the depth flow which may be either

Critical
Subcritical
Supercritical

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

Total Energy = P.E + K.E $W = mg$

$= mgh + \frac{1}{2}mv^2$

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

Date:

$$T.E = h + \frac{V^2}{2g} \qquad h = y$$

$$= y + \frac{V^2}{2g} \quad \text{— (1)}$$

As

$$V = Q/A$$

$$V^2 = Q^2/A^2$$

If Channel is Rectangular

$$A = y \times b \quad \text{— (a)}$$
$$Q = qb \quad \text{— (b)}$$

Putting values of a & b

$$E = y + \frac{Q^2}{y^2 b^2 \times 2g} \quad \text{— (a)}$$

(15)

$$E = y + \frac{v^2}{y^2 \times 2g} \quad \text{—— (b)}$$

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

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

$y = y_c$ Critical flow

$y < y_c$ Super critical fl

$y > y_c$ Subcritical flow

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