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SECTION	A
SEMESTER	6th
PROGRAM	CIVIL ENGG

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Q. No 1
(Part-A)

Given data:-

Discharge (Q) = 7884 lit/sec

$= \frac{7884}{1000} = 7.884\ m^3/sec$

Breadth (b) = 8m

Mean velocity (V) = 7884 − 220

= 7664 ft/sec

= 2336.58 m/sec

1- Height of Hydraulic Jump:-

We know that 'q' discharge per unit breadth

$q = \frac{Q}{b}$

$= \frac{7.884}{8}$

$q = 0.9855\ m^2/sec$

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Critical depth:-

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

$= \left(\frac{(0.9855)^2}{9.81}\right)^{1/3}$

$y_c = 0.462\,m$

Critical velocity:-

We know

$q = vy$

$v = q/y$

$v_c = q/y_c$

$v_c = \frac{0.9855}{0.462}$

$v_c = 2.133\, m/sec$

Depth of water on upstream side:-

Discharge formula

$Q = Av$

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$$Q = (b \times y) \cdot V$$

$$y = \frac{Q}{V_c \cdot b} \; : \; y_1 = \frac{Q}{V_c \cdot b}$$

$$y_1 = \frac{7.884}{2.133 \times 8} \Rightarrow y_1 = 0.462m$$

By formula
water depth on downstream side

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

$$y_2 = -\frac{0.462}{2} + \sqrt{\frac{(0.462)^2}{4} + \frac{2(0.462)(2.133)^2}{9.81}}$$

$$y_2 = 0.463m$$

Difference in depths:-

$$\Delta y = y_2 - y_1$$

$$= 0.463 - 0.462$$

$$\Delta y = 0.001m$$

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By Formula

$$Q_1 = Q_2$$

$$A_1 V_1 = A_2 V_2$$

$$(b_1 \cdot y_1) \cdot V_1 = (b_2 \cdot y_2) \cdot V_2$$

$$\not{b} \cdot y_1 \cdot V_1 = \not{b} \cdot y_2 \cdot V_2$$

$$y_1 V_1 = y_2 V_2$$

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

$$= \frac{0.462 \times 2336.58}{0.463}$$

$$V_2 = 2331.53 \, m/sec$$

Now $\Delta E = E_1 - E_2$

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

$$= \left(0.462 + \frac{(2336.58)^2}{2 \times 9.81}\right) - \left(0.463 + \frac{(2331.53)^2}{2 \times 9.81}\right)$$

$$= 278267.40 - 277065.88$$

$$E_1 - E_2 = 1201.52 \, m$$

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Power Dissipation in hydraulic Jump:-

Using formula

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

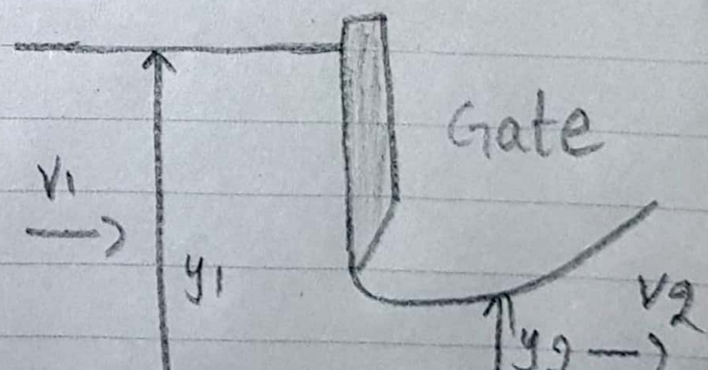
$$= (1000)(9.81)(7.884)(1201.52)$$

$$\Delta P = 92928007.9 \ W$$

$$\Delta P = 92928.0079 \ KW$$

Q.No 1
(Part b)

Given data:-



channel width (b) = 4m

Discharge = 7884 ft³/sec

$$= \frac{7884}{(3.28m)^3}$$

$$= 223.42 \ m^3/sec$$

Depth on upstream side = 2.9m

Depth on Downstream side = 1.1m

Sol:-

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Downstream velocity:-

From specific Energy equation

Specific energy remains same on bothstreams.

$$E_1 = E_2$$

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

From discharge Equation

$$Q = AV$$

$$Q = A_1V_1 = A_2V_2$$

$$(b_1y_1).v_1 = (b_2y_2)v_2$$

$$b = b_1 = b_2$$

$$\cancel{b}\, y_1v_1 = \cancel{b}\, y_2v_2$$

$$y_1v_1 = y_2v_2$$

$$v_2 = \frac{y_1v_1}{y_2}$$

$$v_2 = \frac{2.9}{1.1}v_1 \Rightarrow v_2 = 2.63v_1$$

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now put 'v_2' equation in Eq ①

$$y_1 + \frac{v_1^2}{2g} = y_2 + \frac{v_2^2}{2g}$$

$$2.9 + \frac{v_1^2}{2g} = 1.1 + \frac{(2.63v_1)^2}{2g}$$

$$2.9 + \frac{v_1^2}{2g} = 1.1 + \frac{6.91v_1^2}{2g}$$

$$\frac{v_1^2}{2(9.81)} - \frac{6.91v_1^2}{2(9.81)} = 1.1 - 2.9$$

$$-\frac{5.91v_1^2}{19.62} = -1.8$$

$$\frac{5.91v_1^2}{19.62} = 1.8$$

$$v_1 = \sqrt{\frac{1.8 \times 19.62}{5.91}}$$

$$v_1 = 2.44 \text{ m/sec}$$

Put values in Eq (2)

$$v_2 = 2.44(2.63)$$

$$v_2 = 6.41 \text{ m/sec}$$

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Type of Flow determination

On upstream side

Using Froud number

$$Fr_1 = \frac{V_1}{\sqrt{g y_1}} = \frac{2.44}{\sqrt{9.81 \times 2.9}}$$

$$= 0.45$$

$0.45 < 1$

Sub-critical Flow

$(Fr < 1)$

On Downstream side:-

$$Fr_2 = \frac{V_2}{\sqrt{g y_2}} = \frac{6.41}{\sqrt{9.81 \times 1.1}} = 1.95$$

$1.95 > 1$

Super-critical Flow

$(Fr > 1)$

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Q.No 2
(Part.A)

Given data:-

Channel depth (d) = 1.8m

Discharge = 7884 ft³/sec

$$= \frac{7884}{(3.28m)^3}$$

$$= 223.42\ m^3/sec$$

Width of channel (b) = 66ft

$$= 66/3.28$$

$$= 20.1m$$

Weir height (P) = ?

Sol:-

Using Discharge Formula

$Q = AV$

$V = Q/A \Rightarrow V_1 = Q/A_1$

$V_1 = Q/b \times y$

$$V_1 = \frac{223.42}{20.1 \times 1.8}$$

$V_1 = 6.17\ m/sec$

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Critical depth :-

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

where $q = Q/b$

$$= \frac{223.42}{20.1} = 11.11\ m^2/sec$$

$$y_c = \left(\frac{(11.11)^2}{9.81}\right)^{1/3}$$

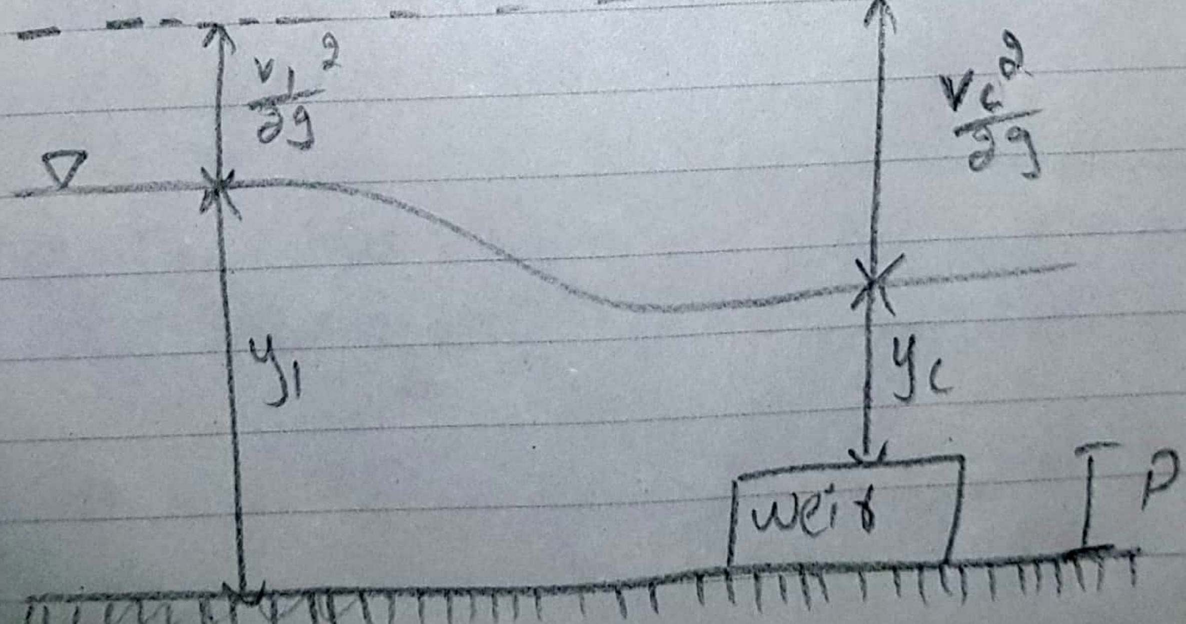
$$y_c = 2.32m$$

$$V = \sqrt{gy}$$

$$V_c = \sqrt{gy_c}$$

$$V_c = \sqrt{9.81 \times 2.32}$$

$$V_c = 4.77\ m/sec$$



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

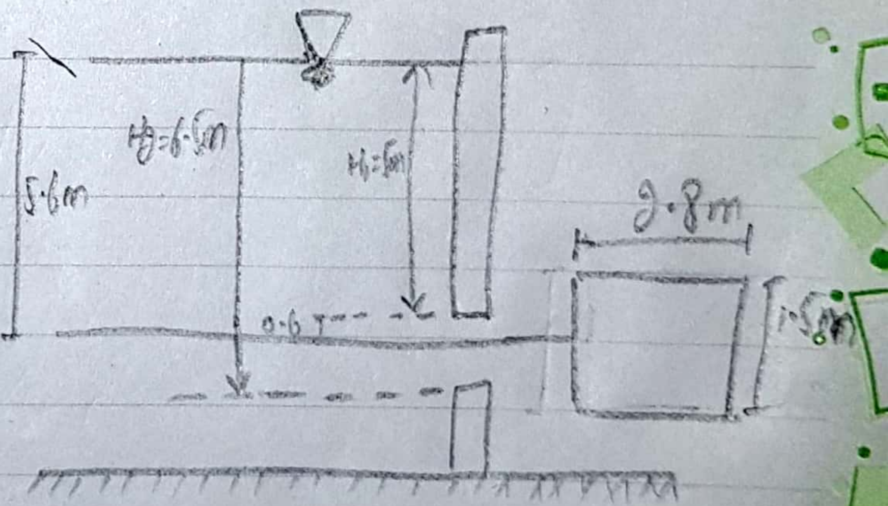
$$\frac{(6.17)^2}{2\times 9.81} + 1.8 = \frac{(4.77)^2}{2\times 9.81} + 2.32 + P$$

$$3.74 = 3.47 + P$$

$$P = 0.27m$$

Q. No 2 (Part b)

Given data:-



Breadth (b) = 2.8m
Depth (d) = 1.5m
H_1 = 5m
H_2 = 5m + 1.5m = 6.5m
H = 5m + 0.6m
= 5.6m
Cd = 0.78

Sol:-

Discharge through sub-merged portion:-

$$Q_1 = c_d \times b\,(H_2 - H_1) \times \sqrt{2gH}$$

$$= 0.78 \times 2.8\,(6.5 - 5.6) \times \sqrt{2 \times 9.81 \times 5.6}$$

$$Q_1 = 20.60\ m^3/sec$$

Discharge through free portion:-

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

$$= \frac{2}{3}(0.78) \times 2.8\sqrt{2 \times 9.81} \times \left[5.6^{3/2} - 5^{3/2}\right]$$

$$Q_2 = 13.36\ m^3/sec$$

Total discharge

$$Q = Q_1 + Q_2$$

$$= 20.60 + 13.36$$

$$Q = 33.96\ m^3/sec$$

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Q.No 3
(Part - A)

Given data:-

$d_1 = R - 220\,mm$

$= 7884 - 220$

$d_1 = 7664\,mm$

$d_2 = R + 3000\,mm$

$= 7884 + 3000$

$d_2 = 10884\,mm$

$d_1 = 7884\,mm = 7.884$

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

$= \frac{3.14}{4}(7.884)^2$

$= 48.79\,m^2$

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

$= \frac{3.14}{4}\left(\frac{10884}{1000}\right)^2$

$= 92.99\,m^2$

$Q = AV$

$V = Q/A$

$V_1 = Q/A_1$

$= \frac{0.95}{48.79}$

$V_1 = 0.019\,m/sec$

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$V_2 = Q/A_2$

$= \frac{0.95}{92.99} = 0.010 \, m/sec$

Formula of sudden enlargement

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

$= \left(1 - \frac{48.79}{92.99}\right)^2 \times \left(\frac{(0.019 - 0.010)^2}{2 \times 9.81}\right)$

$h_c = 9.32 \times 10^{-7}$

Power loss due to sudden Enlargement

$P = \rho g Q h_c$

$= 1000 \times 9.81 \times 0.95 \times 9.32 \times 10^{-7}$

$= 0.0086 \, W$

Pressure in smaller pipe :-

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

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TE :-

$$\frac{P_1}{1000\times 9.81} + \frac{(0.019)^2}{2\times 9.81} = \frac{P_2}{1000\times 9.81} + \frac{(0.010)^2}{2\times 9.81} + 9.32\times10^{-7}$$

$$\frac{P_1}{9810} + 1.83\times10^{-5} = \frac{8684}{9810} + 5.09\times10^{-6} + 9.32\times10^{-7}$$

$$\frac{P_1}{9810} = 0.885 + 0.00000509 + 0.000000932 - 0.0000183$$

$$\frac{P_1}{9810} = 0.8849$$

$$P_1 = 0.8849 \times 9810$$

$$P_1 = 8680.86 \ N/m^2$$

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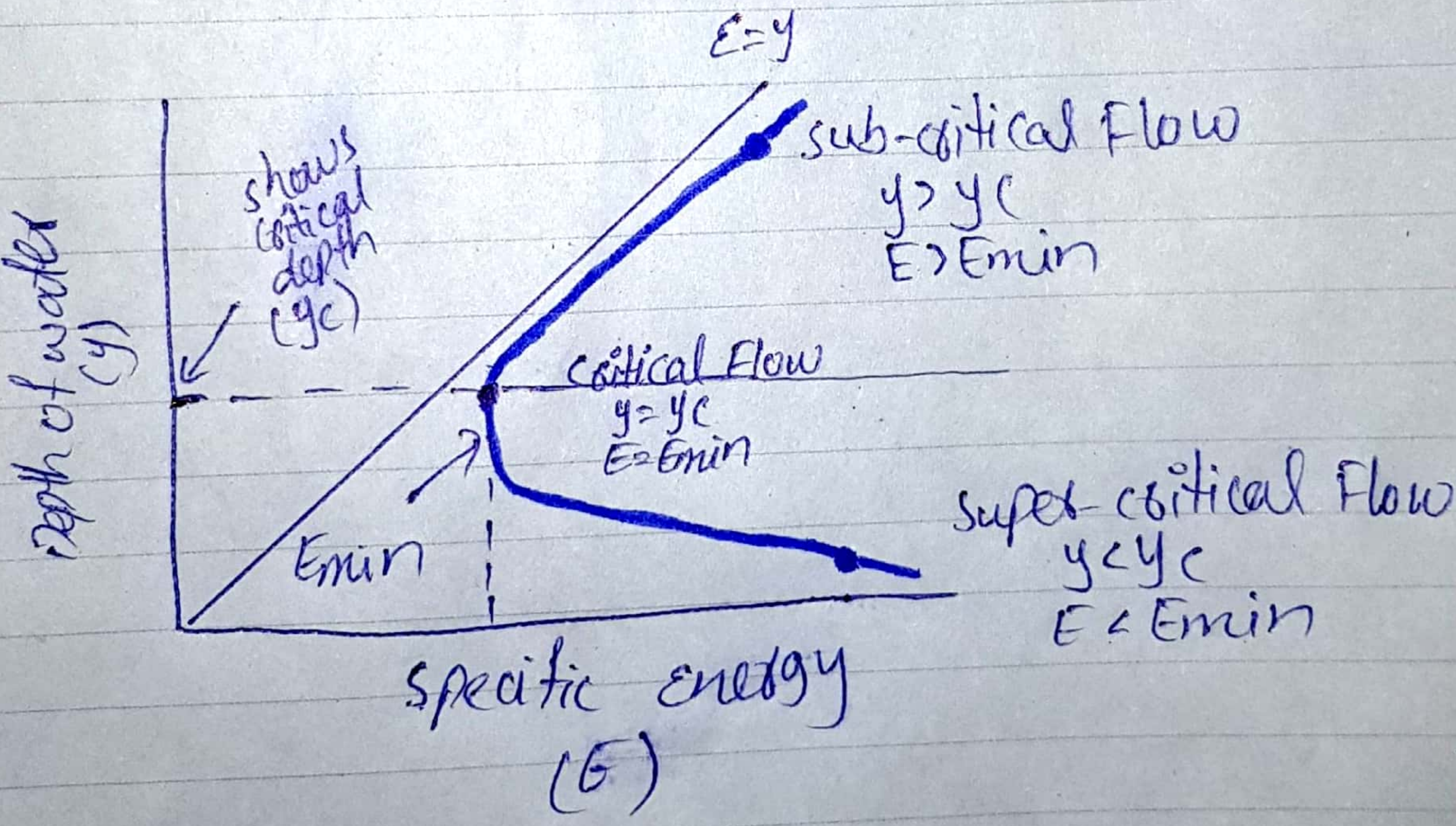
Q.No3 (Part B)

we describe first specific Energy

"Specific energy is a factor which can be used in open channel to explain the definition of super-critical, sub-critical & critical flow.



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