SYED JAWWAD

7386

HYDRAULIC ENGINEERING

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Q # 1

Part - A

DATA:-

Discharge = 7386 lit/Sec

$= \frac{7386}{1000}$

$= 7.386 \, m^3/Sec$

width of Apron = 8m

Mean Velocity = 7386 - 220

= 7166 ft/Sec

$= \frac{7166}{3.28}$

= **2184.75 m/Sec**

Sol:-

1) Height of Hydraulic Jump:-

As "q" is discharge Per unit width

$q = Q/b$

$q = \frac{7.386}{8}$

$q = 0.923 \, m^2/Sec$

As Critical Depth (y_c) is:-

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

$= \left(\left(\frac{0.923}{9.8} \right)^2 \right)^{1/3}$

= **0.44**

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CRITICAL VELOCITY:-

As $q = vy$

$\Rightarrow v = \frac{q}{y}$

$V_c = \frac{q}{y_c}$

$V_c = \frac{0.923}{0.44}$

$\boxed{V_c = 2.09 m/sec}$

As $V_1 > V_c$

Super Critical flow

$\Rightarrow$ Water Depth on upstream side is :- (of Hydraulic Jump)

$Q = AV$

$Q = (by) \cdot v$

$y = \frac{Q}{v \cdot b}$

$y_1 = \frac{Q}{v \cdot b}$

$y_1 = \frac{7.386}{2.09 \times 8}$

$\boxed{y_1 = 0.44 m}$

By formula:-

$$y_2 = \frac{-y_1}{2} + \sqrt{\frac{y_1^2}{4} + \frac{2 y_1 v_1^2}{g}}$$

$$= \frac{-0.44}{2} + \sqrt{\frac{(0.44)^2}{4} + \frac{2(0.44)(2.09)^2}{9.81}}$$

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$y_2 = -0.22 + 0.66$

$\boxed{y_2 = 0.44 m}$

=) Difference in Depth

$\Delta y = y_2 - y_1$

$= 0.44 - 0.44$

$\boxed{= 0}$

As

$\Delta E = E_1 - E_2$

Also $Q_1 = Q_2$

$A_1 V_1 = A_2 V_2$

$b_1 y_1 . V_1 = b_2 y_2 . V_2$ $\qquad b = b_1 = b_2$

$b . y_1 . v_1 = b . y_2 . v_2$

$v_2 = \frac{y_1 v_1}{y_2} = \frac{0.44 \times 2184.75}{0.44}$

$\boxed{v_2 = 2184.75 m/Sec}$

=) $\Delta E = E_1 - E_2$

$\left(y_1 + \frac{v_1^2}{2g}\right) - \left(y_2 + \frac{v_2^2}{2g}\right)$

$E_1 - E_2 = \left(0.44 + \frac{(2184.75)^2}{2(9.81)}\right) - \left(0.44 + \frac{(2184.75)^2}{2(9.81)}\right)$

$E_1 - E_2 = 243279.36 - 243279.36$

$\boxed{E_1 - E_2 = 0 \text{ meter}}$

-> Power Dissipation in Hydraulic Jump:-

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

$\Delta P = (1000)(9.81)(0)$

$\boxed{\Delta P = 0 W}$

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Q#1

Part - B

Data:-

Channel width (b) = 4m

Discharge = 7386 ft³/Sec

height of upstream Side = 2.9m

" " downstream Side = 1.1m

Sol:-

1) Downwardstream Velocity:-

As Specific Energy is

$$E_1 = E_2$$

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

Also from Discharge

$$Q = AV$$

$$\Rightarrow A_1V_1 = A_2V_2$$

$$(b_1 \cdot y_1) \cdot v_1 = (b_2 \cdot y_2) \cdot V_2$$

$$b_1 \cdot y_1 \cdot v_1 = b_2 \cdot y_2 \cdot v_2$$

$$y_1 \cdot v_1 = y_2 \cdot v_2$$

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

$$\Rightarrow V_2 = \frac{(2.9)}{(1.1)} v_1$$

$\Rightarrow V_2 = 2.63 V_1 \rightarrow$ Put in Equation

$$\Rightarrow 2.9 + \frac{v_1^2}{2g} = 1.1 + \frac{(2.63 V_1)^2}{2g}$$

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

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

$$\Rightarrow \cancel{-}\frac{5.91v_1^2}{2g} = \cancel{+}1.8$$

$$\Rightarrow 5.91v_1^2 = 1.8 \times 2 \times 9.81$$

$$\Rightarrow V_1 = \sqrt{\frac{1.8 \times 2(9.81)}{5.91}}$$

$v_1 = 2.44 m/Sec$

Put in an Equation

$V_2 = 2.63\ (2.44)$

$\boxed{v_2 = 6.41 m/Sec}$

TYPE OF FLOW USING FRAUD NUMBER

① ON STREAM SIDE:-

$$Fr_1 = \frac{v_1}{\sqrt{gy_1}} = \frac{2.44}{\sqrt{9.81 \times 2.9}} = 0.45$$

↓

$Fr < 1$

(Sub-Critical flow)

② ON STREAM SIDE:-

$$Fr_2 = \frac{V_2}{\sqrt{gy_2}} = \frac{6.41}{\sqrt{9.81 \times 1.1}}$$

$\boxed{= 1.95}$

$Fr > 1$

(Super-Critical flow)

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Q # 2
PART # A

DATA:-

DEPTH OF CHANNEL = 1.8m

Discharge = 7386 ft³/Sec $= \frac{7386}{(3.28m)^3} = 209.35 \, m^3/Sec$

width of Channel = 66ft

P = weir weight = ?

Sol:-

As $Q = AV$

$$V = Q/A \Rightarrow V_1 = \frac{Q_1}{A} \Rightarrow \frac{Q}{b \times y}$$

$$V_1 = \frac{209.35}{20.1 \times 1.8} = \boxed{5.78 \, m/sec}$$

Critical Depth

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

As $q = Q/b \Rightarrow \frac{209.35}{20.1} = 10.41 \, m^3/sec$

$$y_c = \left(\frac{(10.41)^2}{9.81}\right)^{1/3}$$

$$\boxed{y_c = 2.22 \, m}$$

$$v = \sqrt{gy}$$

$$v_c = \sqrt{g y_c}$$

$$v_c = \sqrt{9.81 \times 2.22}$$

$$\boxed{v_c = 4.66 \, m/Sec}$$

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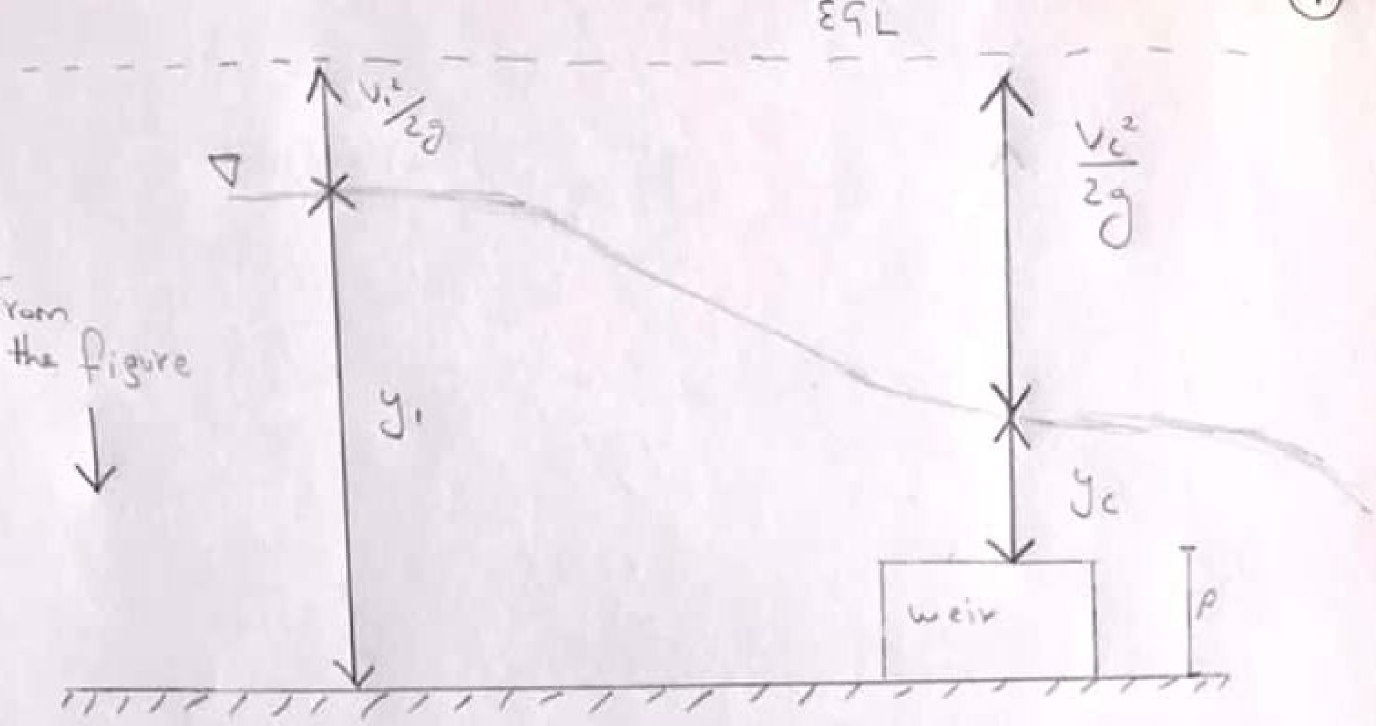
From the figure ↓



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

$$\frac{(5.78)^2}{2 \times 9.81} + 1.8 = \frac{(4.66)^2}{2.981} + 2.22 + P$$

$$\frac{33.40}{19.62} + 1.8 = \frac{(21.71)}{19.62} + 2.22 + P$$

$$1.70 + 1.8 = 1.10 + 2.22 + P$$

$$3.5 = 3.32$$

$$\boxed{P = 0.18}$$

The weir should have height of 0.18m measured from the Channel bed.

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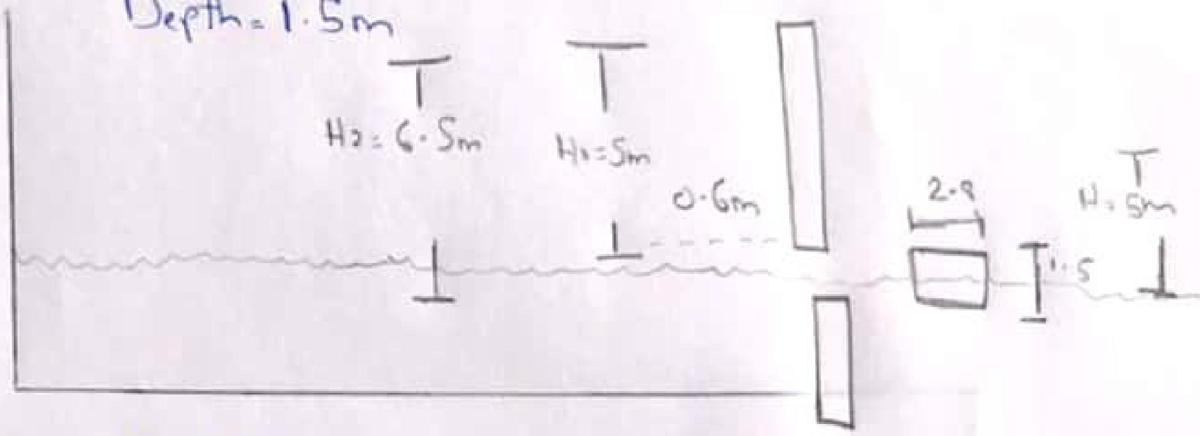
Q#2
Part-B

Given:-

width = 2.8m
Depth = 1.5m



$H_1 = 5m$
$H_2 = 6.5m$
$H = 5.6$
$Cd = 0.7789$

Solution:-

Sub-merged Portion:-

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

$Q_1 = 0.77 \times 2.8\ (6.5 - 5.6) \times \sqrt{2(9.8)(5.6)}$

$Q_1 = 20.32\ m^3/Sec$

Free Portion:-

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

$Q_2 = 2/3\ (0.77) \times (2.8)\ \sqrt{2(9.8)} \times [5.6^{3/2} - 5^{3/2}]$

$\boxed{Q = 13.18\ m^3/Sec}$

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Total = $Q + Q_2$

$Q = 20.32 + 13.18$

$\boxed{Q = 33.5\, m^3/Sec}$

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Q3
PART - A

DATA:-

$d_1 = R - 200mm$

$= 7386 - 200$

$= 7186m$

$d_2 = R + 3000$

$= 7386 + 3000$

$= 10\,386mm$

FLOWRATE (Q) = $0.95 m^3/Sec$

Pressure in large pipes = $R + 800 N/m^2$

$= 7386 + 800$

$\boxed{= 8186 N/m^2}$

Sol:-

1:- LOSS OF HEAD DUE TO SUDDEN ENLARGEMENT

$d_1 = 7186mm$

$= \frac{7186}{1000}$

$\boxed{d_1 = 7.186m}$

$A_1 = \frac{\pi}{4}(7.18)^2$

$\boxed{= 40.46m^2}$

$d_2 = 10386mm$

$= \frac{10386}{1000}$

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$d_2 = 10.386m$

$A_2 = \frac{\pi}{4}(10.386)^2$

$= 84.67 m^2$

As $Q = AV$

$V = \frac{Q}{A_1}$

$V_1 = \frac{0.95}{40.46}$

$= 0.023 m/Sec$

$V_2 = Q/A_2$

$= \frac{0.95}{84.67}$

$= 0.011 m/Sec$

By formula of Sudden Enlargement

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

$= \left(1 - \frac{40.46}{84.67}\right)^2 \times \frac{(0.023 - 0.011)^2}{2 \times 9.8}$

$= (0.27) \times \frac{(1.44 \times 10^{-4})}{19.6}$

$h_e = 1.9836 \times 10^{-6}$

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B) Power loss due to Sudden Enlargement

$P = \rho g Q h_e$

$= (1000)(9.8)(0.95)(1.98 \times 10^{-6})$

$\boxed{P = 0.0184 W}$

c) Pressure in the Smaller Pipe

By Bernoulli's Equation

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

$$\frac{P}{1000 \times 9.8} + \frac{(0.023)^2}{2 \times 9.81} = \frac{(8186)}{(1000 \times 9.81)} + \frac{(0.011)^2}{2 \times 9.81} + 1.98 \times 10^{-6}$$

$$\frac{P}{9800} + 2.69 \times 10^{-5} = 0.835 + 6.16 \times 10^{-6} + 1.98 \times 10^{-6}$$

$P_1 = 0.835 - 2.69 \times 10^{-5}$

$P_1 = 0.834 \times 9800$

$\boxed{P_1 = 8182.73 \, N/m^2}$

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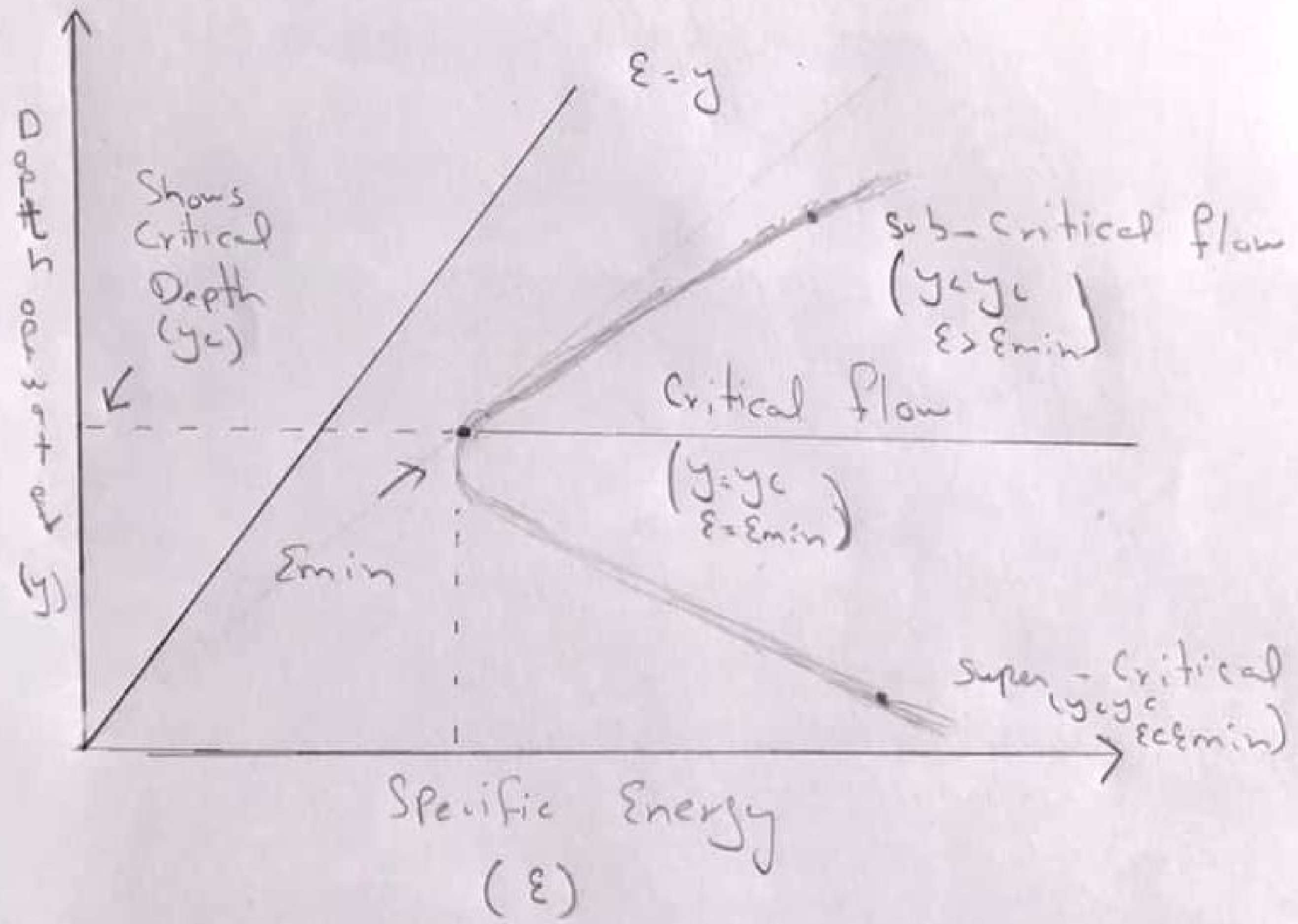
Q#3
PART-B

First we define Specific Energy as
"Specific Energy is a Parameter that can be used to Clarify the meaning of Super Critical, Sub-Critical, ~~&~~ Critical flow in an open Channel".



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