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Scetion " "A"

Subject " Hydrulic Engineering

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Semester " 6th

Q No 1 Part "A"

Let suppose a rectangular channel, discharge R lit/sec of water Into In 8m wide open with zero slope Mean velocity is R - 220 ft/sec

Given:-

Discharge (G) = 7819 Lit/sec

$= 7819/1000 = 7.819\ m^3/sec$

Breadth (b) = 8 m

Mean velocity (V) = 7819 - 200

$= 7819 - 200 = 7619\ ft/sec$

$= 7619/3.28 = 2383.8\ m/sec$

Required:-

1) Height of hydraulic Jump (in meter)
2) Power absored due to hydraulic Jump (in KW).

1) **Height of hydraulic Jump :-**

Specific - energy

(2)

As we know that "q" → discharge per unit breath

$$q = Q/b = \frac{7.819}{8} = \boxed{0.977\ m^2/sec}$$

⇒ Critical depth:-

$$y_c = \left(\frac{(q)^2}{g}\right)^{1/3} = \left(\frac{(0.977)^2}{9.81}\right)^{1/3}$$

$$\boxed{y_c = 0.468\ m}$$

⇒ critical velocity:-

we know that,

$$q = vy$$

$$v = q/y \Rightarrow v_c = q/y_c$$

$$v_c = \frac{0.977}{0.468} \Rightarrow \boxed{2.087\ m/sec}$$

Depth of water on upstream side of Hydraulic Jump:-

by discharg formula,

$$Q = AV$$

$$\Rightarrow Q = (b \times y)V \Rightarrow y = Q/_{b \times V_c}$$

$$y_1 = \frac{Q}{V_c \times b} \Rightarrow \frac{7.819}{2.087 \times 8} \Rightarrow \boxed{y_1 = 0.468}$$

(3)

by formula:-

water depth on Downstream is:

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

$$y_2 = -\frac{0.468}{2} + \sqrt{\frac{(0.468)^2}{4} + \frac{2(0.468)(2.087)^2}{9.81}}$$

$$= -0.243 + \sqrt{0.537077}$$

$$\boxed{y_2 = 0.489m}$$

Differen in Depth:-

$$\Delta y = y_2 - y_1$$

$$= 0.489 - 0.468$$

$$\boxed{\Delta y = 0.02}$$

Also by formula:-

$$Q_1 = Q_2$$

$$A_1 V_1 = A_2 V_2$$

$$(b_1 \cdot y_1) V_1 = (b_2 \cdot y_2) V_2 \quad \because b_1, b_2 = b$$

$$(\cancel{b} \cdot y_1) V_1 = (\cancel{b} \cdot y_2) V_2$$

$$y_1 \cdot V_1 = y_2 \cdot V_2$$

$V_2 = \frac{y_1 v_1}{y_2} = \frac{0.468 \times 2383.8}{0.489}$

$\boxed{V_2 = 2281.46}$

Now. $\Delta E = E_1 - E_2$

$(E_1 - E_2) = \left(y_1 + \frac{v_1^2}{2g}\right) - \left(y_2 + \frac{V_2^2}{2g}\right)$

$= \left(0.468 + \frac{(2383.8)^2}{2(9.81)}\right) - \left(0.489 + \frac{(2281.46)^2}{2(9.81)}\right)$

$= 289,628.07 - 265279.63$

$\boxed{E_1 - E_2 = 24,348.44}$

Power Dissipation In Hydraulic Jump:-

by using formula:-

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

$\Delta P = (1000)(9.81)(7819)(24348.44)$

$\Delta P = 1,867,632,237.65 \; W$

$\boxed{\Delta P = 1,867,632,23765 \; kW}$

Q No#1 Part 'B'

A sluice gate controls the flow in a channel of width of 4m if the discharge is R ft³/sec and the upstream and down stream water depth is 2.9m and 1.1m respectively calculate the down stream velocity. Also state the type of flow at upstream ~~velocity~~. and down stream side using any equation.

Given data:~

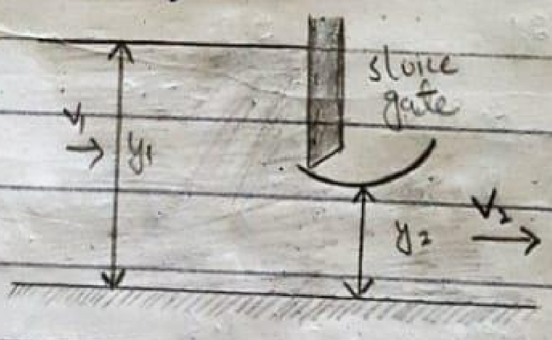
channel width $= b = 4m$

discharge $Q = 7819\ ft^3/sec$

$$Q = \frac{7819}{1000} = 7.819\ m^3/sec$$

depth of upstream $= 2.9\ m$

depth of downstream $= 1.1\ m$



Solution:-

Downstream velocity:-

As from specific energy equation

$$E_1 = E_2$$

$$y_1 + \frac{V_1^2}{2g} = y_2 + \frac{V_2^2}{2g} \longrightarrow (a)$$

Also we know that

$$Q = AV$$

$$A_1V_1 = A_2V_2 \quad \therefore b_1, b_2 = b$$

$$\cancel{b_1} \cdot y_1 \cdot V_1 = \cancel{b} \cdot y_2 \cdot V_2$$

$$V_2 = \frac{y_1 V_1}{y_2} = \frac{2.9 \, V_1}{1.1}$$

$$V_2 = 2.63 \, V_1 \longrightarrow (1)$$

put in equation (a)

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

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

$$\frac{V_1^2}{2 \times 9.81} - \frac{6.91 V_1^2}{2 \times 9.81} = 1.1 - 2.9$$

$$\frac{V_1^2 - 6.91 V_1^2}{19.62} = 1.8$$

$$+ 5.91 V_1^2 = +(1.8)(19.62)$$

$$V_1^2 = \frac{(1.8)(19.62)}{5.91}$$

$$\sqrt{V_1^2} = \sqrt{\frac{(1.8)(19.62)}{5.91}}$$

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

put the value of V_1 in eq (i)

$$V_2 = 2.63 (V_1)$$

$$V_2 = 2.63 (2.44)$$

$$\boxed{V_2 = 6.41 \text{ m/sec}}$$

Type of flow upstream side:-

by Frouad number

$$Fr_1 = \frac{V}{\sqrt{g y_1}} = \frac{2.44}{\sqrt{9.81 \times 2.91}}$$

$$Fr_1 = 0.45$$

$Fr < 1 \rightarrow$ sub critical flow

Type of flow down stream side:-

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

$$Fr_2 = 1.95$$

$Fr > 1 \Rightarrow$ super critical flow

Q No # 02 Part "A"

What is the minimum height (in unit meter) of broad crested weir if it is to function critical depth on the crest if water flows along a rectangular channel at depth of 1.8 m with discharge of R ft^2/sec The channel width is 66 ft

Given data:-

channel depth = 1.8 m

discharge $Q = \frac{7819}{(3.28)^3} = 221.5 m^3/sec$

depth of channel = 1.8 m

width of channel = 66ft = 20.1 m

Required

weir height = P = ?

Solution

As we know that

$Q = AV$

$V = Q/A \Rightarrow V = Q/b \times y$

$V = \frac{221.57}{20.1 \times 1.8} = 6.12 m/sec$

$\boxed{V = 6.12\ m/sec}$

Critical depth:-

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

$$q = Q/b = 221.57/20.1 = 11.02\ m^2/sec$$

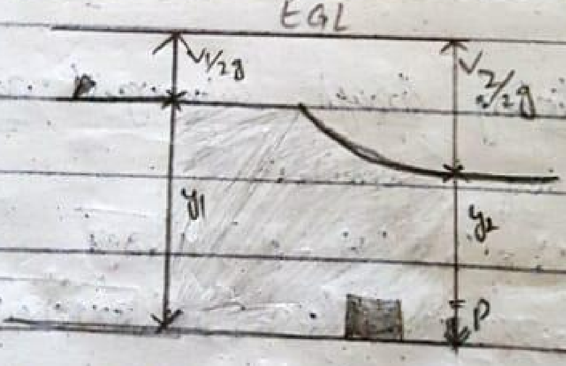
$$y_c = \left(\frac{(11.02)^2}{9.81}\right)^{1/2}$$

$$\boxed{y_c = 2.31\ m}$$

Also $V = \sqrt{gy}$

$$V_c = \sqrt{gy_c} = \sqrt{9.81 \times 2.31}$$

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



According to the given figure

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

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

$1.908 + 1.8 = 1.154 + 2.31 + P$

$\boxed{P = 0.24\ m}$

QNo # 2 Part "B"

Given data:-

breath = b = 2.8 m

depth = d = 1.5 m

$H_1 = 5m$

$H_2 = 5 + 1.5 = 6.5\ m$

$H = 5 + 0.6 = 5.6m$

$cd = 0.7819$

Required

discharg = Q = ?

Solution:

discharg through submerged portion

by using formole:-

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

$Q_1 = 0.7819 \times 2.8 \times (6.5 - 5) \times \sqrt{2 \times 9.81 \times 5.6}$

$Q_1 = 20.64\ m^3/sec$

Free portion:-

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

$Q_2 = 2/3\ (0.7819 \times 2.8 \sqrt{2 \times 9.81}\ [(5.6)^{3/2} - (5)^{3/2}]$

$Q_2 = 13.38\ m^3/sec$

Total discharge

$$Q = Q_1 + Q_2$$
$$Q = 20.64 + 13.38$$
$$\boxed{Q = 34.02 \ m^3/sec}$$

Q NO # 3 Part "A"

Calculate:-

1) The loss of head due to sudden enlargment
2) The power lost due to sudden Enlargment
3) The pressure in the smaller pipe (pipe is horizental)

Given data:

$d_1 = R - 200$ $\quad d_2 = R + 3000$

$d_1 = 7819 - 200$ $\quad d_2 = 7819 + 3000$

$d_1 = 7619 \ mm$ $\quad d_2 = 10819 \ mm$

discharge $= 0.95 \ m^3/sec$

pressure in larg pip $= R + 800$

$= 7819 + 800$

$= 8619 \ N/m^2$

Solution:

Head lost due to sudden enlargment

$d_1 = 7619 \ mm = 7.619 m$

$A_1 = \pi/4 \ d^2 = \pi/4 \ (7.619)^2 = 47.9 m^2$

$d_2 = 10819 = 10.819\,m$

$A = \pi/4\,(10.819)^2 = 91.8\,m^2$

As we know that

$Q = AV$

$V_1 = Q/A_1 \Rightarrow 0.95/47.9 = 0.019\,m/sec$

$V_2 = Q/A_2 \Rightarrow 0.95/91.8 = 0.010\,m/sec$

As sudden Enlargement :-

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

$$he = \left(1 - \frac{45.90}{91.8}\right)^2 \times \left(\frac{(0.019 - 0.010)^2}{2 \times 9.81}\right)$$

$$\boxed{he = 9.44 \times 10^{-7}\,m}$$

Power loss due to sudden enlargment

As we know that

$P = \rho g Q\, he$

$P = (1000)(9.81)(0.95)(9.44 \times 10^{-7})$

$$\boxed{P = 8.79 \times 10^{-3}\,N}$$

Pressure in smaller pipe :-

Using Bernoulli equation:

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

$$\frac{P_1}{(1000)(9.81)} + \frac{(0.019)^2}{2\times 9.81} = $$

$$= \frac{8619}{9810} + \frac{(0.016)^2}{2\times 9.81} + 9.44\times10^{-7}$$

$$\frac{P_1}{9810} + 0.000177 = \frac{8619}{9810} + 0.0004905 + 0.000000944$$

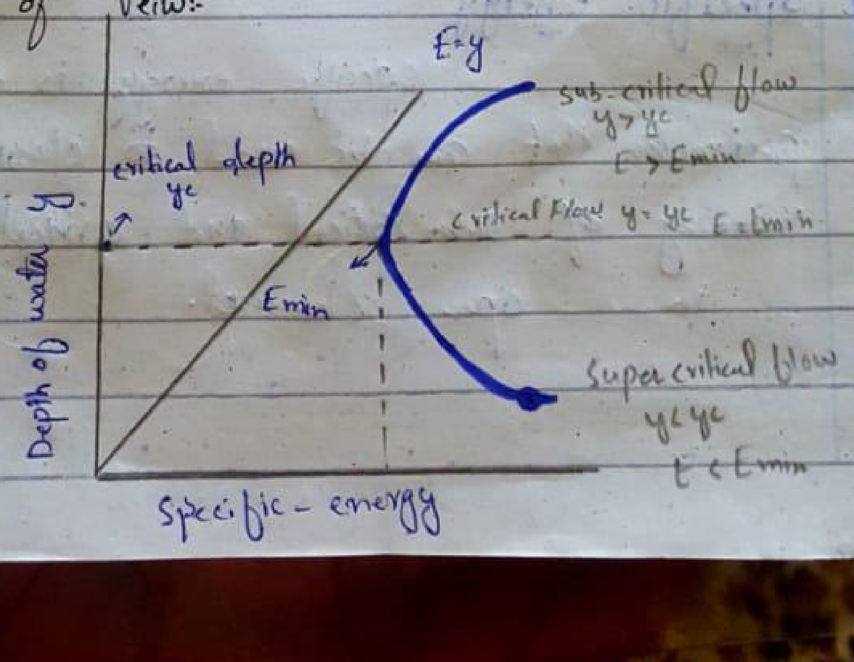
$$\frac{P_1}{9810} = \frac{8619}{9810} + 0.0004905 + 0.000000944 - 0.000177$$

$$\frac{P_1}{9810} = 0.883$$

$$\boxed{P_1 = 8665.39\,N/m^2}$$

Q No # 03 Part .B:

what does the curve Indicate How its obtain the below Figur from each and every point of veiw:-



Blue curve:-

from the above figure the blue curve is the 3 degree polynomial curve which show the flow is critical, sub critical and super critical, sub critical and super critical flow. the middle point show the depth of water is equal to the critical depth coresponding to minimum energy so the flow is critical flow.

$y = y_c$ and $E = E_{min}$

The top point show the depth of water is greater than the critical depth

$y < y_c$ and $E < E_{min}$

The lower point show the depth of water is less than the critical depth

$y > y_c$ and $E > E_{min}$

Specific Energy

specific energy is a perimeter that can be used to classify the meaning of sub critical and critical flow in open channel.