Mid Term online Exame

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Section "A"

Semester 6th

Subject Hydrulic Engineering

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QNO 1 part (A)

let suppose a rectangular Channel Discharge R liter/sec of water into a 8m wide apron with zero slope mean velocity is R-220 ft/sec

Calculate:-

1) Height of Hydraulic jump (in m)
2) power absorbed due to hydraulic Jump (KW)

Given Data:-

Discharge $Q = 7810$ lit/sec

$\frac{7810}{1000} = 7.810\ m^3/sec$

wide $= b = 8\ m$

Mean velocity $= v = 7810 - 220$

$= \frac{7590}{3.28} = 2314.02\ m^3/sec$

Height of Hydraulic Jump:-

As we know that

$q = Q/b$

$q = 7.810/8$

$q = 0.97625\ m^2/sec$

=> **Critical Depth :-**

$$y_c = \left(\frac{q^2}{g}\right)^{1/3} = \left(\frac{(0.97625)^2}{9.81}\right)^{1/3}$$

$$\boxed{y_c = 0.4597\,m}$$

=> **Critical velocity :-**

We know that

$q = vy \Rightarrow v = q/y$

$\Rightarrow v_c = q/y_c$

$$= \frac{0.97625}{0.4597}$$

$$\boxed{v_c = 2.123\ m/sec}$$

Depth of water on upstream side of Hydraulic Jump :-

We know that

$Q = AV \Rightarrow Q = (b \times y)v$

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

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

$$y = \frac{7.81}{2.123 \times 8}$$

$$y_1 = 0.4598$$

To find water depth on down stream side By using that formula

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

$$y_2 = \frac{0.4598}{2} + \sqrt{\frac{(0.4598)^2}{4} + \frac{2(0.4598)(2.123)^2}{9.81}}$$

$$y_2 = 0.46m$$

Difference in depth :-

$$\Delta y = y_2 - y_1$$
$$\Delta y = 0.46 - 0.4598$$
$$\Delta y = 0.0032\ m$$

By Discharge formula :-

$$Q_1 = Q_2$$
$$A_1 V_1 = A_2 V_2$$
$$\cancel{b} y_1 V_1 = \cancel{b} y_2 V_2 \qquad \because b = b_1 = b_2$$

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

$$V_2 = \frac{0.4598 \times 2314.02}{0.46}$$

$V_2 = 2313.01\ m/sec$

Since

$$\Delta E = E_1 - E_2$$

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

$$= \left(0.4598 + \frac{(2314.02)^2}{2\times9.81}\right) - \left(0.46 + \frac{(2313.01)^2}{2\times9.81}\right)$$

$$= 272920.36 - 272682.17$$

$$\Delta E = 238.19$$

Power Dissipation in Hydraulic Jump

we know that

$$\Delta p = \rho g Q [E_1 - E_2]$$

$$\Delta P = (1000)(9.81)(7.81)(238.19)$$

$$\boxed{\Delta p = 18249188.86\ watts}$$

$$\boxed{\Delta P = 18249.88\ KW}$$

QNO 1 part(B) A sluice gate controls the flow in a channel of width of 4m if the discharge is R ft^3/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 :-

Channel width = b = 4m

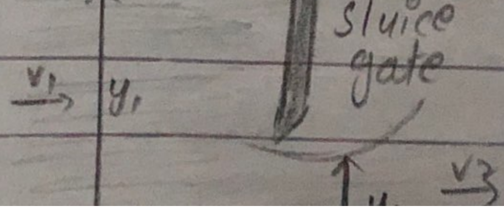
Discharge $Q = 7810\,ft^3/sec$

$$Q = \frac{7810}{1000}$$

$$Q = 7.81\,m^3/sec$$

Depth of upstrem side = 2.9m

Depth of dowstrem side = 1.1m



Solution

Downstream velocity:-

As from specific energy equation specific energy remain same on both stream

$$E_1 = E_2$$

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

Also we know that

$$Q = AV$$

$$A_1V_1 = A_2V_2$$

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

$$y_1V_1 = y_2V_2$$

$$V_2 = \frac{y_1V_1}{y_2} = \frac{2.9}{1.1}V_1$$

$$V_2 = 2.63V_1$$

put the value in eq *

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

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

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

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

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

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

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

put the value of V_1 in eq - 1

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

$$V_2 = 2.63(2.44)$$

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

⇒ Type of flow on upstream side :-

By Froud Number

$$Fr_1 = \frac{V}{\sqrt{gy_1}} = \frac{2.44}{\sqrt{9.81 \times 2.91}}$$

$$Fr_1 = 0.45$$

$Fr < 1 \rightarrow$ sub critical flow

⇒ Type of flow on down stream side :-

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

$$Fr_2 = 1.95$$

$Fr > 1 \longrightarrow$ super critical flow.

QNO 2 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^3/sec the channel width is 66 ft.

Given Data:-

Channel depth = 1.8 m

Discharge Q = 7810 ft^3/se

Discharge = 221.39 m^3/sec = ~~238109 m^3/sec~~

Width of channel = 66 ft

$$= \frac{66}{3.28} = 20.12\,m$$

Required:-

Weir Height = P = ?

Solution:-

As we know that

$$Q = AV$$

$$V = Q/A$$

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

$$V_1 = \frac{\cancel{238109}}{\cancel{20.12 \times 1.8}} = \frac{221.39}{20.12 \times 1.8}$$

$$\boxed{V_1 = 6.11\,m/sec}$$

Critical Depth :-

As we know That

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

$$q = \frac{221.32}{20.12}$$

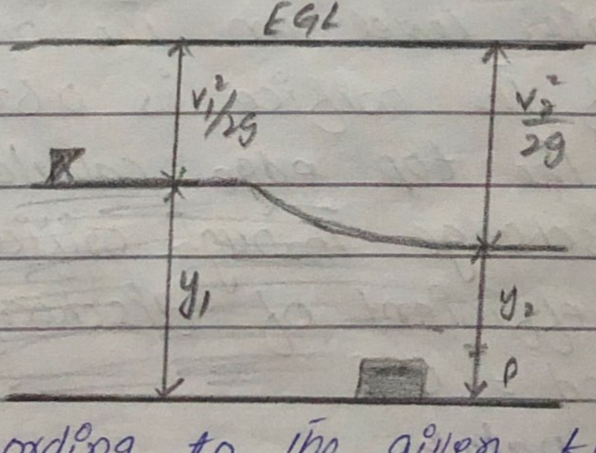
$$y_c = \left(\frac{(11)^2}{9.81}\right)^{1/3} \qquad q = 11\ m^2/sec$$

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

Also $v = \sqrt{gy}$

$$V_c = \sqrt{g y_c} = \sqrt{9.81 \times 2.31}$$

$$V_c = 4.76\ m/sec$$



According to the given figure

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

$$\frac{6.11}{2 \times 9.81} + 1.8 = \frac{4.76}{2 \times 9.81} + 2.31 + P$$

$1.902 + 1.8 = 1.1548 + 2.31 + P$

$\boxed{P = 0.237m}$

So the ~~wide~~ weir should have height of 0.237m measured from the channel bed.

QNO 2 Part (B) An orifice is one side of large tank is rectangular in slope 2.8m broad and 1.5m deep The water level on one side of the orifice is 5m above its top edge The water level on the other side of the orifice is 0.6m below the top edge. calculate the discharge through orifice if co-efficient of discharge is cd = 0.R

Given Data:-

Breath $= b = 2.8m$

Depth $= d = 1.5m$

$H_1 = 5m$

$H_2 = 5 + 1.5 = 6.5m$

$H = 5 + 0.6 = 5.6m$

$Cd = 0.781$

Solution

Discharge through submerged portion

By Using Formula

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

$$Q_1 = 0.781 \times 2.8 \times (6.5 - 5.6) \times \sqrt{2(9.81)(5.6)}$$

$$\boxed{\cancel{Q_1 = \text{[illegible]}\ m^3/sec}}$$

$$Q_1 = 20.62$$

Discharge through free portion:-

As we know that

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

$$= \frac{2}{3}(0.781) \times 2.8 \sqrt{2 \times 9.81} \times \left[5.6^{3/2} - 5^{3/2} \right]$$

$$\boxed{Q_2 = 13.37\ m^3/sec}$$

Now Total Discharge will be.

$$Q = Q_1 + Q_2$$

$$Q = 20.62 + 13.37$$

$$\boxed{Q = \cancel{47.75\ m^3/}sec}$$

$$Q = 33.99\ m^3/sec$$

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QNO 3
Part (A)

The diameter of a water pipe is suddenly enlarged from R-200mm to R+3000mm The Rate of flow through is 0.95 m^3/sec and the pressure in the pipe is R+800

Calculate:

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

Given Data :.

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

$d_1 = 7810 - 200$ $\quad d_2 = 7810 + 3000$

$d_1 = 7610\,mm$ $\quad d_2 = 10810\,mm$

Discharge 0.95 m^3/sec

pressure in large pipe $= R + 800$

$= 7810 + 800$

$= 8610\,N/m^2$

Solution

Head Loss Due to sudden Enlargment

$d_1 = 7610mm = 7.61m$

$A_1 = \frac{\pi}{4} d^2 = \pi/4 (7.61)^2$

$A_1 = 45.48 m^2$

$d_2 = 10810mm = 10.81 m$

$A_2 = \pi/4 \, d_2^2 = \pi/4 (10.8)^2$

$\boxed{A_2 = 91.60 m^2}$

As we know that

$Q = AV$

$V = Q/A$

$V_1 = Q/A_1$

$V_1 = 0.95/45.48$

$\boxed{V_1 = 0.020 m/se}$

As

$V_2 = Q/A_2$

$V_2 = 095/91.60$

$\boxed{V_2 = 0.0103 m/sec}$

As Sudden Enlargement:-

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

$$h_e = \left(1 - \frac{45.48}{91.60}\right)^2 \times \left(\frac{(0.020 - 0.0103)^2}{2 \times 9.81}\right)$$

$$\boxed{h_e = 1.2157 \times 10^{-6}\, m}$$

* Power Loss Due to Sudden Enlargment

As we know That

$$P = \rho g Q h_e$$

$$P = (1000)(9.81)(0.95)(1.2157 \times 10^{-6})$$

$$\boxed{P = 0.01132\, W}$$

* Pressure in Smaller Pipe:-

Using Bernoulli Equation

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

$$\frac{P_1}{1000 \times 9.81} + \frac{(0.020)^2}{2 \times 9.81} = \frac{P_2}{1000 \times 9.81} + \frac{(0.0103)^2}{2 \times 9.81} + 1.21 \times 10^{-6}$$

$$\frac{P_1}{9810} + 0.0000203 = \frac{8610}{9810} + 0.000005407 + 1.21 \times 10^{-6}$$

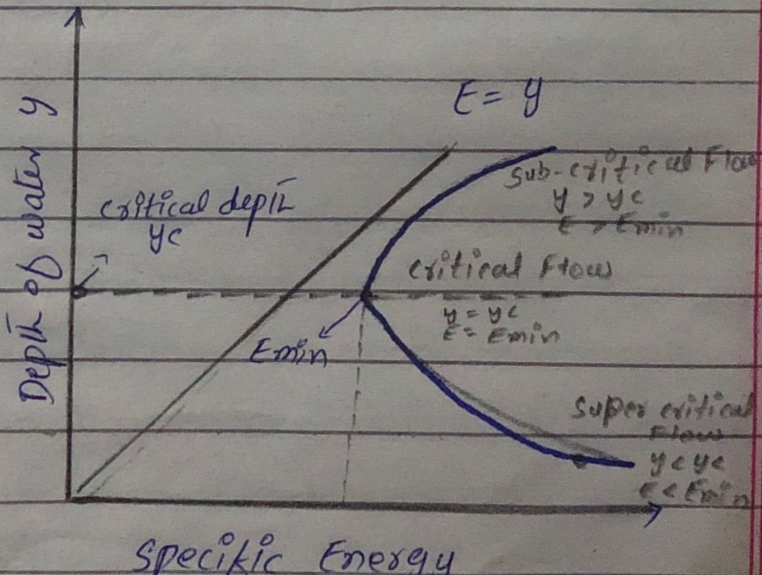
$P_1 =$

$$\frac{P_1}{9810} = 0.877682458 - 0.0000203$$

$$\frac{P_1}{9810} = 0.877662158$$

$$\boxed{P_2 = 8609.86\, N/m^2}$$

QNO #03 Part(B) What Does the curve indicate How its obtain the below Figure from each and every point of view



Blue curve:-

from the given figure

The blue curve is the 3-degree polynomial curve which show the flow is critical, sub critical and super critical flow
=) The middle point show the depth of water is equal to the critical depth corresponding 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 then the critical depth.

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

=) The lower point show the depth of water is less then the critical depth

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

Specific energy:-

Specific energy is the parameter that can be used to clarify the meaning of subcritical, critical and super critical flow is an open channel

=> The given graph is indicat the relation between depth of water (y) and critical depth (y_c)

Critical depth:-

critical depth is depth of water at which minimum specific energy is obtained.

Equation of specific Energy:-

From the derivation of specific energy equation there is three degree polynomial Equation is obtained

$$(E - y) y^2 = q^2/2g \rightarrow (A)$$

E = specific energy
y = depth of water
q = discharge per unit width it unit is m^2/sec