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SEC : B

DEPT : BE (CIVIL), 6th SEMESTER.

SUBJECT : HYDRAULIC ENGINEERING.

INSTRUCTOR : ENGR: FAWAD AHMAD.

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SIGNATURE :

Qno1(A) Let Suppose a rectengle Channle.
Discharge = 7881 Lit/sec of water into a 8m wide apron with zero Slop.
Mean velocity is 7881-220 ft/Sec.

Calculate:

(i) Height of hydraulic jump (in unit of M)

(2) power absorbed due to hydraulic jum. (in unit of KW).

: Given Data:

Channle width = 8m.

Discharge = 7881 Lit/sec

$$\text{Discharge} = \frac{7881}{1000} = 7.881\ m^3/Sec.$$

Mean velocity = 7881 - 220 = 7661 ft/Sec.

or

$$\text{mean velocity} = \frac{7661}{3.28} = 2335.67$$

Solution:

(i) Hieght of hydraulic jump.

$Q = qb$.

$$q = Q/b = \frac{7.881}{8} = 0.985\ m^2/Sec.$$

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(2)

Critical Depth y_c:

$$y_c = \left(\frac{q^2}{g}\right)^{1/3} = \left(\frac{(0.985)^2}{9.01}\right)^{1/3}$$

$$y_c = 0.475$$

Critical Velocity:

$$q = yv$$

$$v_c = q/y_c = \frac{0.985}{0.475}$$

$$v_c = 2.073 \text{ m/sec}$$

So,

$$V_1 > V_c$$

This is Super Critical flow.

Depth of water of water on upstream Side.

$$Q = AV \quad [\because A = by]$$

$$Q = byv$$

$$y = \frac{Q}{vb}$$

$$y_1 = \frac{Q}{U_1 \times b} = \frac{7.881}{2335.67 \times 8} = \boxed{0.00042.}$$

Now,

$$y_2 = -\frac{y_1}{2} + \sqrt{\frac{(y_1)^2}{4} + \frac{2(y_1)(U_1)^2}{g}}$$

$$y_2 = -\frac{0.00042}{2} + \sqrt{\frac{(0.00042)^2}{4} + \frac{2(0.00042)(2335.67)^2}{9.81}}$$

$$y_2 = -0.00021 + \sqrt{0.00021 + 467.12.}$$

$$y_2 = 21.61$$

Difference in Depth.

$$\Delta y = y_2 - y_1$$

$$\Rightarrow 21.61 - 0.00042.$$

$$\Delta y = 21.6123$$

$$\Rightarrow \Delta E = E_1 - E_2.$$

As we know

$$Q_1 = Q_2$$

$$A_1 U_1 = A_2 V_2.$$

$$b_0 y_1 U_1 = b y_2 U_2.$$

$$b y_1 v_1 = b y_2 v_2$$

$$y_1 v_1 = y_2 v_2$$

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

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

$$\Rightarrow \frac{(0.00042)(2335.67)}{21.61}$$

$$v_2 = 0.0453$$

$$\Rightarrow \Delta E = E_1 - E_2.$$

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

$$= \left(0.00042 + \frac{(2335.67)^2}{2 \times 9.81}\right) - \left(21.61 + \frac{(0.0453)^2}{2 \times 9.81}\right)$$

$$\Delta E = 278029.070$$

 [redacted]

Power Dissipated in hydraulic Jumps.

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

$$(1000)(9.81)(7.881)(278029.070)$$

$$\Delta P = 21495153057.57$$

Q1:(B): A Sluice gate Control the flow in a Channel of width, $b = 4m$. If the Discharge = 7881 ft^3/Sec and the upstream and down stream water dpth 2.9m and 1.1 m, Respectively.

Calulate the downstream velocity. Also State the type of flow at upstream & downstream side using any equation.

Given Data.

Height of upstream = 2.9m

Height of down stream = 1.1m

Discharge = 7881 ft^3/Sec.

Channle width, $b = 4m$.

Solution:

① Downstream stream velocity.

$$E_1 = E_2$$

$$y_1 + \frac{V_1^2}{2g} = y_2 + \frac{V_1^2}{2g} \longrightarrow (1)$$

Also from Discharge.

$$Q = A_1 V_1 = A_2 V_2.$$

$\Rightarrow$

$$b_1 y_1 v_1 = b_2 y_2 v_2$$

$$\cancel{b} y_1 v_1 = \cancel{b} y_2 v_2$$

$$y_1 v_1 = y_2 v_2$$

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

$$V_2 = \frac{2.9}{1.1} v_1$$

$$V_2 = 2.636\, v_1 \rightarrow (2)$$

Now putting Value in eq (1).

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

$$2.9 + \frac{v_1^2}{2\times 9.81} = 1.1 + \frac{(2.631\, v_1)^2}{2\times(9.81)}$$

$$2.9 + \frac{v_1^2}{19.62} = 1.1 + \frac{6.94\, v_1^2}{19.62}$$

$$2.9 - 1.1 = \frac{6.94 v_1}{19.62} - \frac{v_1^2}{19.62}$$

$$1.8 = \frac{5.94 v_1^2}{19.62.}$$

$$(1.8)(19.62) = 5.94 v_1^2. \quad = v_1^2 = \frac{35.316}{5.94} = \sqrt{v} = \sqrt{\frac{35.316}{5.94}}.$$

$V_1 = 2.44$ m/Sec.

Putting U_1 in eq (1)

$$y_1 + \frac{U_1^2}{2g} = y_2 + \frac{U_2^2}{2g}$$

$$2.9 + \frac{(2.44)^2}{2(9.81)} = \frac{1.1 + ((U_2)^2}{2(9.81)}$$

$$3.203 - 1.1 = \frac{U^2}{19.62}$$

$$2.103 \times 19.62 = V_2^2$$

$$\sqrt{V_2^2} = \sqrt{41.260}$$

$U_2 = 6.42$ m/Sec.

Types of flow by using Fraud number.

① On upstream.

$$Fr = \frac{U_1}{\sqrt{g y_1}} = \frac{2.44}{\sqrt{(9.81)(2.9)}}$$

$Fr = 0.45 < 1.$

as fr is less then 1, So the flow is a "Subcritical flow".

(2) Down Stream:

$$fr = \frac{U_2}{\sqrt{g y_1}} = \frac{6.42}{\sqrt{9.81 \times 2.9}} = 1.95$$

As the fr is greater than 1 So the flow on Down Stream is a "Super Critical" flow.

Q no 2 : A: What is minimum height (In unit of m) of broad Crested weir if it is to function the Critical depth on the Crest.

If water flow along a rectengular Channle Channle at a depth of 1.8m ~~width~~ with a discharge of $R = 7881\ ft^3/sec$.
Channle width is 66ft.

Given data

Channle depth = 1.8m

Channle width = 66 ft or 20.1m.

Discharg, $Q = 7881\ ft^3/sec$.

$$Q = \frac{7881}{(3.28\,m)^3} = 223.33\ m^3/sec.$$

Required;

weird height.

Solution:

$$Q = AU$$

$$U = Q/A.$$

$$U_1 = Q/by.$$

$$U_1 = \frac{223.33}{(20.1)(1.8)}$$

$$v_1 = 6.17\ m/sec.$$

Critical depth:

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

$$\boxed{\begin{aligned} \therefore\ Q &= qb \\ q &= Q/b \end{aligned}}$$

$$y_c = \left(\frac{(223.33)^2}{(20.1)^2(9.81)}\right)^{1/3}.$$

$$y_c = 2.326$$

Also,

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

$$V_c = \sqrt{g y_c}.$$

$$= \sqrt{9.81 \times 2.326}$$

$$\boxed{U_c = 4.813 \text{ m/Sec.}}$$

for fig.

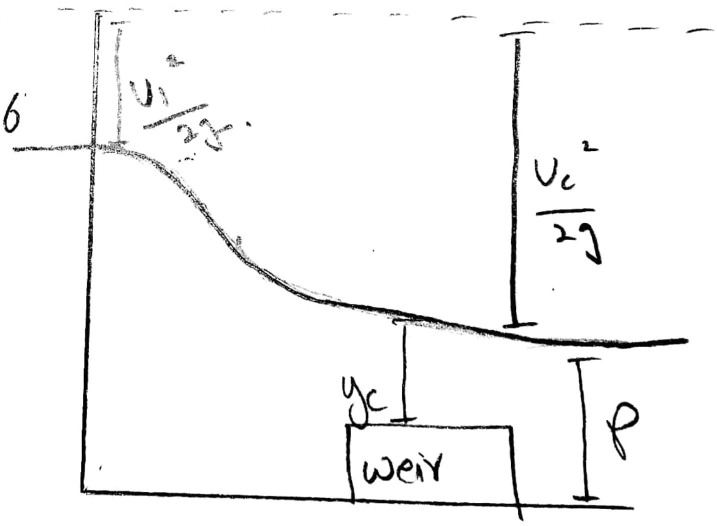
$$\frac{U_1^2}{2g} + y_1 = \frac{U_c^2}{2g} + y_c + P.$$

$$\frac{(6.17)^2}{19.62} + 1.8 = \frac{(4.813)^2}{19.62} + 2.326 + P.$$

$$3.740 = 3.506 + P$$

$$P = 3.740 - 3.506$$

$$P = 0.234 \text{ m.}$$



Q2 (B) An orifice in one side of large tank is rectengular in shape 2.8m broad and 1.5m deep.
The water level on one side of the orifice is 5 meter above its top edge. The water level on the other side of the orifice is 0.6m below it's top edge.
Calculat the discharge through the orifice, if Coeffient of discharge is $C_d = 0.7881$.

Given data

$b = 2.8m$

$d = 1.5m$

$H_1 = 5m$

$H_2 = 1.5 + 5m = 6.5m$

$H = 5 + 0.6 = 5.6\,m$

$C_d = 0.7881.$

Solution :

Discharge through Submerged Portion.

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

$Q_1 = 0.7881 \times 2.8 \times (6.5 - 5.6) \times \sqrt{2(9.81)(5.6)}$

$\boxed{Q_1 = 20.817}$

Discharge through free Portion.

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

$= 2/3 \times 0.7881 \times 2.8\sqrt{19.62}\,[(5.6)^{3/2} - (5)^{3/2}]$.

$\boxed{Q_2 = 13.49\ m^3/sec}$

Total discharge.

$Q = Q_1 + Q_2$

$\Rightarrow Q = 20.817 + 13.49 = \boxed{34.307}\ m^3/sec$.

Q no 3 (A): The diameter of a water pipe is Suddenly ~~&~~ enlarged from 7881-200 mm to 7881+3000. The rate of flow through is 0.95 m³/sec and the Pressure is ~~enlarged~~ in ~~the~~ larger Pipe is ~~7881~~ 7881+800 N/m2.

Calculate:

(1) The loss of head due to Sudden enlargment

(2) The Power lost due to Sudden enlargement

(3) The pressure in the Smaller pipe, (if pipe is horizontal.).

Given data

$D_1 = 7881 - 200 = 7681.$

$D_2 = 7881 + 3000 = 10881.$

$Q = 0.95 \, m^3/sec$

Pressure in larger Pipe = 7881 + 800 => 8681.

Solution: The loss of head due to Sudden enlargement.

$d_1 = 7681 mm$ or $\frac{7681}{1000} = 7.681 m.$

$A_1 = \frac{\pi}{4} d^2 = \frac{\pi}{4} (7.681)^2 = 46.33 m^2.$

$\boxed{A_1 = 46.33 m^2}$

$d_2 = 10881 mm$ or $10.881 m.$

$A_2 = \frac{\pi}{4} d^2 = \frac{\pi}{4} (10.881)^2$

$\boxed{A_2 = 92.98 m^2.}$

As

$Q = Av.$

$V = Q/A.$

$V_1 = Q/A_1 = \frac{0.95}{46.33} = 0.020$

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

And, by the Same Process;
we got;

$$v_2 = Q/A_2.$$

$$v_2 = \frac{0.95}{92.98} = 0.010$$

$$\boxed{v_2 = 0.010 \text{ m/Sec}}$$

Now by farmula;

$$h_L = \left(1 - \frac{A_1}{A_2}\right)^2 \cdot \left(\frac{(v_1 - v_2)^2}{2g}\right)$$

$$\Rightarrow \quad h_L = \left(1 - \frac{46.33}{92.98}\right)^2 \cdot \left(\frac{(0.020 - 0.010)^2}{2 \times 9.81}\right).$$

$$\Rightarrow \quad h_L = (0.000001283$$

$$h_L = 1.28 \times 10^{-6}.$$

Power loss due to Sudden enlargement.

$$P = \rho g Q h_L$$

$$P = 1000 \times 9.81 \times 0.95 \times 1.28 \times 10^{-6}$$

$$P = 0.0119 \text{ W}.$$

Pressure in smaller Pipe.

$$\frac{P_1}{\rho g} + \frac{v_1^2}{2g} = \frac{P_2}{\rho g} + \frac{(V_2)^2}{2g} + h_e.$$

$$\Rightarrow \frac{P_1}{1000 \times 9.81} + \frac{(0.020)^2}{19.62} = \frac{(8681)}{1000 \times 9.81} + \frac{(0.010)^2}{2 \times 9.81} + 1.28 \times 10^{-6}$$

$$\Rightarrow \frac{P_1}{9810} + 0.0000203 = 0.8849 + 0.00000509 + 1.28 \times 10^{-6}.$$

$$\frac{P_1}{9810} + 0.0000203 = 0.8884.$$

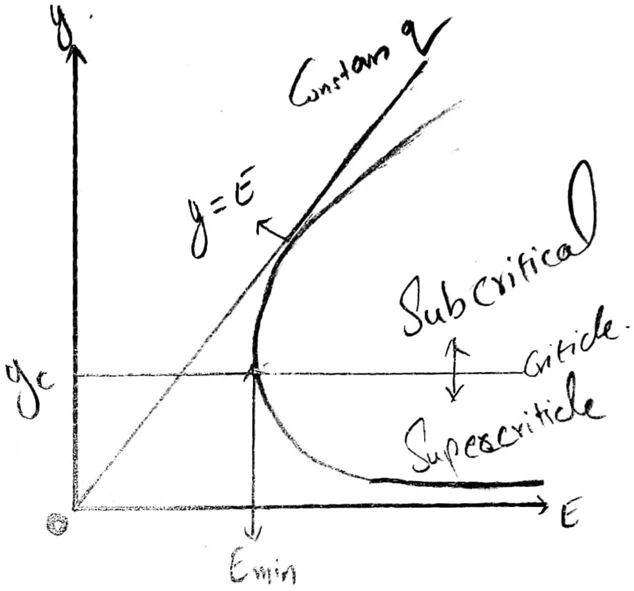
$$\frac{P_1}{9810} = 0.8884 - 0.0000203$$

$$\frac{P_1}{9810} = 0.8848.$$

$$P_1 = 0.8848 \times 9810$$

$$P_1 = 8680.732 \ N/m^2.$$

Qno 3 (B) : What does the given Curve indicate. How is it obtained. Explain that from ~~e~~ and every Point of Veiw.



Ans:

As

$$E = y + \frac{v^2}{2g} \quad (1)$$

This given graph indicates the Criticle depth. Criticle depth is that height or depth of flow, where we get minimum Specific energy.

In the given graph, x-axis represent Specific Energy, denoted by "E".

And

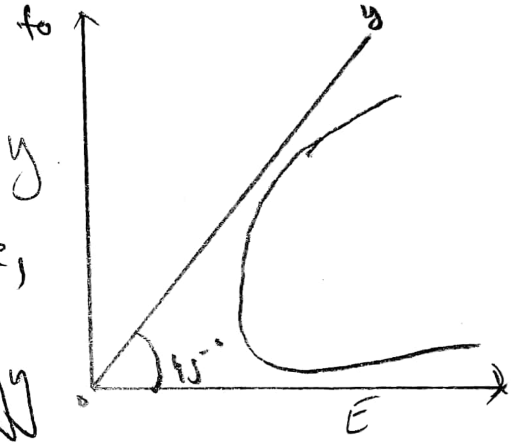
y-axis is depth of flow which is denoted by "y".

in the equation;

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

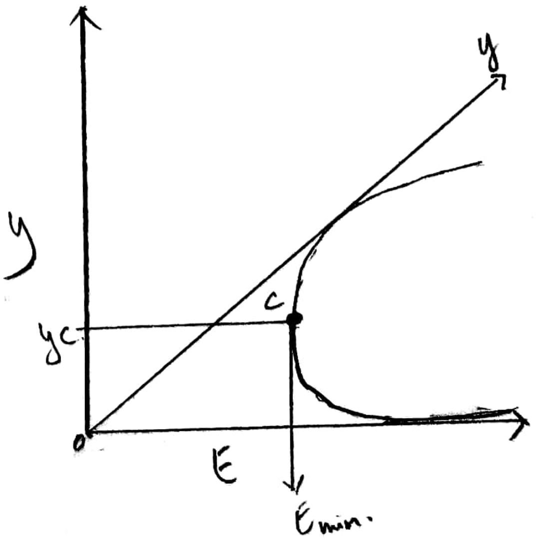
we Can See that "E" is directly porportional to "y", and when a variable $\propto$ to another, the we get a 45° Line on the graph.

And it is inversly porportional to "g" So when we Combine $y + \frac{v^2}{2g}$, we get the Curve, Which is Called Specific energy Curve.



This Curve Shows us that, How much Variation occured along the depth.

In The graph, if we move to right Side of Emin the the Specific energy increase.
So this Point "c" is give us minimum Specific energy.



Now Mathematically;

$$E = y + \frac{v^2}{2g} \rightarrow (A)$$

Putting value of $v = q/y$ in eq (A).

$$\boxed{E = y + \frac{q^2}{2y^2 g}} \longrightarrow (b)$$

Now we can show the criticle depth by differentiating eq (b) w.r.t y.

$$\Rightarrow \frac{dE}{dy} = 0$$

$$\frac{d}{dy}\left(y + \frac{q^2}{2y^2 g}\right) = 0$$

$$= 1 + \frac{q^2}{2g}\left(\frac{-2}{y^3}\right) = 0$$

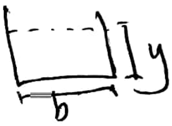
$$1 = \frac{\cancel{2}q^2}{\cancel{2}g y^3} \Rightarrow y^3 = q^2/g$$

$$= \sqrt[3]{y} = \left(\frac{q^2}{g}\right)^{1/3}$$ or $$\boxed{y_c = \left(\frac{q^2}{g}\right)^{1/3}}$$

As;

$$Q = AV$$

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



$$\therefore A = b \times y$$

$$\Rightarrow \frac{Q}{by}$$

As $$q = \frac{Q}{b} = Q = qb.$$

$$\Rightarrow V = \frac{q\cancel{b}}{\cancel{b}y}$$

$$V = q/y.$$

from the result of differentiation, it is Criticle depth expression and "y_c" is the criticle depth where we get the minimum Specific energy.

So, This graph Show that, what is the Point of Criticle depth, and from where the variation in specific energy Start.