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Question No 1

Part "A"

Requried :-

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

(ii) Power absorbed due to hydralic jump (in unit of Kw)

Given data :-

width $b = 8m$

Discharge $= Q = 7859$ liter/sec

$Q = 7.859 \; m^3/sec$

Mean velocity $= V_1 = 7859 - 220 = 7639$ ft/sec

$$V_1 = \frac{7639}{3.28} = 2328.9 \; m/sec$$

Solution :-

(i) Height of hydraulic jump

* Discharg per unit width (q)

$Q = q.b$

$$q = Q/b = \frac{7.859}{8}$$

$$\boxed{q = 0.9823 \ m^2/sec}$$

To Find (y_c) critical depth:

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

$$y_c = \left(\frac{(0.98)^2}{9.8}\right)^{1/3}$$

$$\boxed{y_c = 0.46 \ m}$$

To Find critical velocity (v_c) :-

$$q = y \cdot v$$

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

Putting the value

$$v_c = \frac{0.98}{0.46}$$

$$\boxed{v_c = 2.13 \ m/sec}$$

$V_1 > V_c \Rightarrow$ critical flow.

To Find depth of water on upstream side.

$Q = AV \Rightarrow Q \Rightarrow b \cdot y \cdot v$

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

$$y_1 = Q/v_c \cdot b$$

$$y_1 = \frac{7.859}{(2.13)(8)}$$

$$\boxed{y_1 = 0.461\ m}$$

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

$$y_2 = -\frac{0.461}{2} + \sqrt{\frac{(0.461)^2}{4} + \frac{2(0.461)(2.13)^2}{9.81}}$$

$$\boxed{y_2 = 0.461\ m}$$

__Depth difference (Δy):-__

$$\Delta y = y_2 - y_1$$

$$\Delta y = 0.461 - 0.461$$

$$\boxed{\Delta y = 0 m}$$

__Find V_2:-__

we know ~~state~~ that

$$\Delta E = E_1 - E_2$$

$$Q_1 = Q_2$$

$$A_1 V_1 = A_2 V_2$$

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

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

$$V_2 = \frac{(0.461)(2328.9)}{(0.461)}$$

$$\boxed{V_2 = 2328.9}$$

Difference in S. Energy:

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

$$E_1 - E_2 = \left(0.461 + \frac{(2328.9)^2}{2 \times 9.8} \right) - \left(0.461 + \frac{2328.9}{2 \times 9.8} \right)$$

$$\boxed{E_1 - E_2 = 0\,m}$$

Power Dissipated in hydralic jump:-

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

$$\Delta P = (1000)(9.8)(7.859)(277013.39)$$

$$\Delta P = 2.13 \times 10^{10} \; w$$

$$\boxed{\Delta P = 2135685.17 \; KW}$$

Question No 1

"Part "B""

Given data:-

width $b = 4m$

$Q = 7859 \; ft^3/sec$

Hight of upstream $y_1 = 2.9m$

Hight of downstream $y_2 = 1.1m$

Requried:-

Down stream velocity = ?

Flow type at upstream and down stream -

Solution :-

we assumed $E_1 = E_2$

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

$$Q_1 = Q_2$$

$$A_1 \cdot v_1 = A_2 \cdot v_2$$

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

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

$$v_2 = \frac{(2.9)(v_1)}{(1.1)}$$

$$\boxed{v_2 = 2.64\, v_1} \longrightarrow \quad X$$

Putting the value in equation (i)

$$(2.9) + \frac{v_1^2}{2g} = (1.1) + \frac{(2.64\, v_1)}{2g}$$

$$\frac{v_1^2}{2g} - \frac{6.97\, v_1^2}{2g} = 1.1 - 2.9$$

$$-5.97 \cdot \frac{v_1^2}{2g} = -1.8$$

Scanned with CamScanner

$$V_1 = \sqrt{\frac{1.8 * 2 * 9.81}{5.97}}$$

$$\boxed{V_1 = 2.432 \ m/sec}$$

Putting the value in equation (x)

$$V_2 = 2.64 \,(2.420 \ m/sec)$$

$$\boxed{V_2 = 6.420 \ m/sec}$$

Flow type :-

At upstream side :-

$$Fr_1 = \frac{V}{\sqrt{g \cdot y_1}}$$

$$Fr_1 = \frac{2.432}{\sqrt{(9.81)(2.9)}}$$

$\boxed{Fr_1 = 0.456}$ < 1 The flow is subcritical flow

At downstream side:-

$$Fr_2 = \frac{V_2}{\sqrt{g \cdot y_2}}$$

$$Fr_2 = \frac{6.420}{\sqrt{(9.81)(1.1)}}$$

$\boxed{Fr_2 = 1.95} > 1$ supercritical flow

"Question No 2"

"Part "A""

Given data:-

width = 66 ft = 20.1m

$Q = 7859$ ft/sec

$$Q = \frac{7859}{3.28} = 2396.0 \text{ m}^3/\text{sec}$$

Depth = 1.8 m

Requried:-

P = ? weir height

Solution:-

By discharge equation

$$Q = AV$$

$$V_1 = Q/A$$

$$V_1 = Q/b.y$$

$$V_1 = \frac{2396.0}{\left(\frac{66}{3.28}\right)(1.8)} = 66.152 \text{ m/sec}$$

$$\boxed{V_1 = 66.152 \text{ m/sec}}$$

Critical depth:

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

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

$$y_c = \left(\frac{2396.0}{(20.1)^2(9.81)}\right)^{1/3}$$

$$\boxed{y_c = 11.314\,m}$$

Critical velocity (v_c) :-

$$V = \sqrt{g \cdot y}$$

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

$$v_c = \sqrt{(9.81)(11.31)}$$

$$\boxed{v_c = 10.53\ m/sec}$$

To Find P :

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

$$\frac{(66.158)^2}{2(9.81)} + (1.8) = \frac{(10.53)^2}{2(9.81)} + 11.31 + P$$

$$224.84 = 16.961 + P$$

$$P = 224.84 - 16.961$$

$$\boxed{P = 207.87}\ m$$

Question No 2

Part "B"

Given data :-

width $b = 2.8 m$

Depth $= d = 1.5 m$

$H_1 = 5m$

$H_2 = 5 + 1.5 = 6.5m$

$H = 5 + 0.6 = 5.6m$

$Cd = 0.7859$

Requried :-

Discharge $Q = ?$

Solution :-

Discharg through submerged portion

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

$$Q_1 = (0.7859) \times (2.8) \times (6.5 - 5.6) \times 1 \sqrt{2 \times 9.8 \times 5.6}$$

$$\boxed{Q_1 = 20.78 \; m^3/sec}$$

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Discharg through free Portion:-

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

$$Q_2 = \frac{2}{3}(0.7859) \times 2.8\sqrt{2\times9.8}\left[(5.6)^{1/2} - (5)^{3/2}\right]$$

$$\boxed{Q_2 = 13.476 \ m^3/sec}$$

Total Discharg :-

$$Q = Q_1 + Q_2$$

$$Q = (20.78) + (13.476)$$

$$\boxed{Q = 34.256 \ m^3/sec}$$

Question No "3"

Part "A"

Given data:

$D_1 = 7859 - 200 = 7659mm = 7.659m$

$D_2 = 7859 + 300 = 8159mm = 8.167m$

$Q = 0.95 \ m^3/sec$

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Pressure in large pipe = R + 800

7859 + 800 = 8659 N/m^2

Area $= \frac{\pi}{4}(D_1)^2 = \frac{3.14}{4}(7.659)^2 = 46.04\ m^2$

Area $= \frac{\pi}{4}(D_2)^2 = \frac{3.14}{4}(8.167)^2 = 52.35\ m^2$

Solution :-

$Q = AU \Rightarrow Q/A$

$U_1 = Q/A_1$

$$U_1 = \frac{0.95}{46.04}$$

$$\boxed{U_1 = 0.020}\ m/sec$$

$$\cancel{U_2 = \frac{0.95}{52.35}} \qquad U_2 = \frac{0.95}{8.167}$$

$$\boxed{U_2 = 0.116\ m/sec}$$

Head loss due to sudden Enlargment

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

$$he = \left(1 - \frac{46.04}{52.35}\right)^2 \cdot \left(\frac{(0.020) - (0.116)}{2 \times 9.81}\right)^2$$

$$\boxed{\cancel{he = 3.478 \times 10^{-7}\ m}} \quad \boxed{he = 5.224 \times 10^{-8}}$$

Power loss due to sudden enlargment (P):-

$$P = \rho \cdot g \cdot Q \cdot he$$

$$P = (1000) \cdot (9.8) \cdot (0.95)\ \cancel{(3.478 \times 10^{-7})}\ (5.224 \times 10^{-8})$$

$$\boxed{P = 4.86 \times 10^{-4}}$$

Bernoulli's eauation

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

$$\frac{P_1}{(1000)(9.81)} + \frac{(0.020)^2}{2 \times 9.8} = \frac{8659}{(1000)(9.8)} + \frac{(0.116)^2}{2 \times 9.8} + (5.224 \times 10^{-8})$$

$$\frac{P_1}{(1000)(9.81)} + 0.00002789 = 0.8835$$

$$\frac{P_1}{9810} = 0.8835$$

$$\boxed{P_1 = 8667.135\ N/m^2}$$

Question 03

Part B

Blue curve :-

it is clear from the above diagram drawn for constant discharge for any give value of E, there whould be two possible lengths /depths say y_1, y_2 These two depths are called Alternate depths.

=> However for point c corresponding to minimum specific energy E min, there would be only one possible depth "y_c" the depth "y_c" is know as critical depth.

=> $(E - y) y^2$ = constant

In the equation the q and $2g$ are constant and the equation is three dimensional polynomial equation It can be used to prepare a plot at specific energy "E" and depth of water "y".

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How it is obtained :-

Total energy = Potential energy + Kinetic energy.

$$T.E = P.E + K.E$$

$$T.E = mgh + \frac{1}{2} mv^2$$

$$T.E = wh + \frac{1}{2} \frac{w}{g} v^2 \quad \text{(w is ignored)}$$

$$T.E = h + \frac{1}{2g} \cdot v^2$$

$$T.E = y + \frac{v^2}{2g} \qquad E = y + \frac{v^2}{2g} \quad \text{—— (a)}$$

we know that

$$Q = AV \Rightarrow V = Q/A \Rightarrow V^2 = Q^2/A^2$$

* So- equation a will be

$$E = y + \frac{Q^2}{A^2 \cdot 2g} \quad \text{—— (b)}$$

For rectangular channel

$$A = y \times b \longrightarrow x$$

$$q = Q/b \longrightarrow y$$

Putting (x) and (y) in equation (b)

$$E = y + \frac{Q^2}{A^2 \cdot 2g} \Rightarrow E = y + \frac{Q^2}{(y^2 \times b^2)\, 2g} \rightarrow x^{2}$$

$$E = y + \frac{q^2}{y^2 \cdot 2g} \longrightarrow \text{"}y\text{" is putted}$$

$$E - y = \frac{q^2}{y^2 \cdot 2g}$$

$$(E - y)\, y^2 = \frac{q^2}{2g}$$

$$(E - y)\, y^2 = \text{constant}$$

Critical Depth (y_c):

It is depth corresponding to minimum secific energy.

$y > y_c$, $E > E_{min}$ (subcritical flow)

$y = y_c$, $E = E_{min}$ (critical flow)

$y < y_c$, $E < E_{min}$ (super critical flow)