Name: M. Shaheer Khan.

ID : 7856

Subject : Hydraulic Engineering

Module : 6th

Section : B

Date : 22/4/2020

Q(1)

A) Led suppose a reetangular channel discharges R l/s of water into 8m wide apron width zero slope Mean valocity is R-220ft/sec

Calculate:

(i) Height of hydraulic Jump (m)

(ii) Power absorbed due to hydraulic Jump (km).

Solution:-

Given data

Channel width = b = 8m.

Discharge = Q = 7856 ltr/sec = 7.856 m³/sec

Mean velocity = V = R-200 = 7856 - ~~200~~ 220 = ~~7656~~ 7636 ft/sec

$= \frac{7636}{3.28} = 2328 \text{ m/sec}$

Height of hydraulic Jump.

As "q" is discharge per unit width

$q = Q/b = \frac{7.856}{8} = 0.982 \text{ m}^2/\text{sec}$

As critical depth (y_c) is.

$$y_c = \left(\frac{q^2}{g}\right)^{1/3} = \left(\frac{(0.982)^2}{9.81}\right)^{1/3}$$

$y_c = 0.461 \text{m}$

Critical velocity

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

$$V_c = \frac{q}{y_c} = \frac{0.982}{0.461}$$

$$V_c = 2.13$$

As $V_1 > V_c$

Super Critical flow

water depth on upstream side is (hydraulic Jump)

$$Q = AV$$

$$Q = by \cdot V$$

$$y = \frac{Q}{b \cdot V} = y_1 = \frac{Q}{V_1 \cdot b}$$

$$y_1 = \frac{7.856}{2.13 \times 8} = 0.461$$

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

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

$$y_2 = 0.462$$

Difference in Depth.

$$\Delta y = y_2 - y_1$$

$$0.462 - 0.461 = 0.01\,m$$

$$\Delta E = E_1 - E_2$$

$$Q_1 = Q_2$$

$$A_1 V_1 = A_2 V_2$$

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

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

$$V_2 = \frac{0.461 \times 2328}{0.462} = 2322.96$$

Difference in Specific Energy.

$$\Delta E = E_1 - E_2$$

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

$$= \left(0.461 + \frac{2328^2}{2(9.81)} \right) - \left(0.462 + \frac{(2322.96)^2}{2(9.81)} \right)$$

$$\Delta E = 1194.74$$

Power of Dissipated in hydraulic Jump.

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

$$= 1000 \times 9.81 \times 7.856 \times 1194.74$$

$$\Delta P = 92075457.69 \text{ kw.}$$

Question No 1
Part "B"

Given Data

Channal width $(b) = 4$

Discharge $= 7856 \; ft^3/sec$

height upstream $= 2.9m.$

height downstream $= 1.1m.$

Solution:.

Down stream.

Specific energy is

$$E_1 = E_2$$

$$y_1 = \left(\frac{(V_1)^2}{2g}\right) = y_2 + \left(\frac{(V_2)^2}{2g}\right) \text{ ——— (1).}$$

$$Q_1 = Q_2$$

$$A_1 V_1 = A_2 V_2$$

$\cancel{\gamma} y_1 V_1 = \cancel{\gamma} y_2 V_2$

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

$$V_2 = \left(\frac{2.9}{1.1}\right) \cdot V_1 = V_2 = 2.63 V_1$$

Put in eq (1)

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

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

Now Put value of V_1 in eq (1)

$$2.9 + \frac{2.44^2}{2g} = 1.1 + \frac{V_1^2}{2g}$$

$$V_2 = 6.42 \text{ m/sec}$$

Using Froud number to determine type of flow.

<u>Upstream Sides:-</u>

$$Fr_1 = \frac{V_1}{\sqrt{gy_1}} = \frac{2.44}{\sqrt{9.81 \times 2.9}} = 0.457 < 1$$

Sub critical flow.

Down stream Side.

$$Fr_2 = \frac{V_2}{\sqrt{9.81 \times 1.1}} = 1.95 > 1.$$

Super critical flow.

Question No 2

Part "A"

Given Data:

$y_1 = 1.8\ m$

$b = 66' = 20.12\ m$

$Q = \frac{7856}{3.28^3} = 222.62\ m^3/sec$

Required:

Maximum Height of weir, P.

Solution:

$Q = AV \quad V = Q/A = Q/by = \frac{222.62}{20.12 \times 1.8}$

$V = 6.14\ m/sec$

As we know that.

$q = Q/b$

$$\frac{222.62}{20.12} = 11.06$$

$$y_c = \left(\frac{q^2}{g}\right)^{1/3} = \left(\frac{11.06}{9.81}\right)^{1/3}$$

$y_c = 2.32\,m.$

Also

$V = \sqrt{gy} = \sqrt{gy_c}$

$V_c = 4.77\ m/sec$

According to specific energy.

$E_1 = E_2$

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

$$1.8 + \frac{(6.14)^2}{2g} = \frac{4.77^2}{2\times 9.8} + 2.32 + P$$

$\boxed{P = 0.24\ m}$

Question No 2

Part "B"

Given Data.

$b = 2.8m$

$d = 1.5m$

$H_1 = 5m$

$H_2 = 6.5m$

$H = 5.6m$

$Cd = 0.7856$

Required

Discharge through Submerged Portion.

Solution.

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

$$= 0.7856 \times 2.8 \times (6.5 - 5.6) \times \sqrt{2 \times 9.81 \times 5.6}$$

$$Q = 20.75$$

Discharge of free Portion.

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

$$= \frac{2}{3}(0.7856) \times 2.8\sqrt{2\times 9.81}\left[5.6^{3/2} - 5^{3/2}\right]$$

$Q_2 = 13.45$

Total Discharge.

$Q = Q_1 + Q_2$

$= 20.75 + 13.45$

$$\boxed{Q = 34.2 \ m^3/s}$$

Question No 3

Part "A"

Given Data.

$P_1 = R + 800 = 7856 + 800 = 8656 \ N/m^3.$

$d_1 = R - 200 = 7856 - 200 = 7656 \ mm. = 7.656 \ m$

$A_1 = \pi/4 \, d_1^2 = \pi/4 \, (7.656)^2 = 46 \, m^2.$

$d_2 = R + 3000 = 7856 + 3000 = 10856 \ mm = 10.856 \ m.$

$A_2 = \pi/4 \, d_2^2 = \pi/4 \, (10.856)^2 = 92.56 \, m^2.$

$Q = 0.95\ m^3/sec$

$Q = AV$

$V = Q/A = 0.95/46 = 0.02\ m/sec$

$V_2 = \frac{0.95}{92.50} = 0.01\ m/sec$

1- Head loss due do Sudden enlargment.

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

$$= \left(1 - \frac{46}{92.50}\right)^2 \left(\frac{(0.02 - 0.01)^2}{2 \times 9.81}\right)$$

$h_c = 1.289 \times 10^{-6}$

Power ~~of~~ of loss due to Sudden Enlargement.

$P = \rho g Q h_c$

$= 1000 \times 9.81 \times 0.95 \times 1.289 \times 10^{-6}$

$= 0.012\ w.$

Presure In the Smallest Pipe.

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

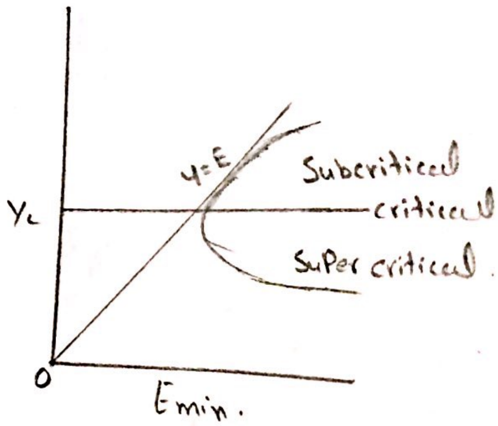
$$\frac{8656}{1000 \times 9.81} + \frac{0.02^2}{2(9.81)} = \frac{P_2}{1000 \times 9.81} + \frac{(0.01)^2}{2(9.81)} + 1.289 \times 10^{-6}$$

$P_2 = 8656.13 \ N/m^2$.

Question No 3

Part B.

What does this curve indicates How it is obtained Explain the above figure from each and every Point of view.



The above graph is Plot between depth flow(y) and specific Energy (E). It is three degree Polynomial equation which show us the different specific energy for the depth flow which are

Critical
Subcritical
Supercritical

Specific energy is used to clarify the meaning of the above terms in an open channel.

Total energy $= P.E + K.E.$ $\qquad \because w = mg$

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

$$= wh + \frac{1}{2}\frac{w}{g} v^2$$

$$T.E = h + \frac{v^2}{2g} \qquad \because h = y$$

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

As $\quad V = Q/A$

$$v^2 = Q^2/A^2$$

If channel is Rectangular

$$A = y \times b \quad \text{—} \; (a)$$

$$Q = qb \quad \text{—} \; (b)$$

Putting values of a & b

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

$$E = y + \frac{q^2}{y^2 \times 2g} \quad \text{—— (b)}$$

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

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

$y = y_c$ Critical flow

$y < y_c$ Supercritical flow.

$y > y_c$ Subcritical flow.