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Section :- "B"

Semester :- "Six"

Department :- Civil Engineering

Subject :- Hydraulic Engineering

QNo1
(A)

Given data

Discharge $(Q) = 7839$ lit/sec

$$Q = \frac{7839}{1000} = 7.839 \, m^3/sec$$

Breadth $(b) = 8m$

Mean velocity $(v) = 7839 - 220$

$v = 7619$ ft/sec

~~$v_1 = 2322.76$ m/Sec~~

1) As we know that

$$\frac{Q}{b} = \frac{q\cancel{b}}{\cancel{b}}$$

$$q = \frac{Q}{b}$$ putting value.

$$q = \frac{7.839}{8}$$

$$q = 0.9798\ m^2/Sec$$

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

Putting value.

$$y_c = \left[\frac{(0.9798)^2}{9.81}\right]^{1/3}$$

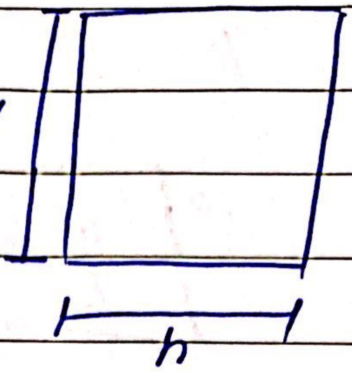
$$y_c = \left[\frac{0.96000}{9.81}\right]^{1/3}$$

$$y_c = \left[0.09785\right]^{1/3}$$

$$\boxed{y_c = 0.46084}$$

As it is Rectangular Section

$Q = qb$ — (1)
$Q = Av$ — (2)



Equation (1) And (2)

$$qb = Av$$
$$q\cancel{b} = y\cancel{b}v$$
$$q = yv$$

$$V_c = q/y_c = \frac{0.9798}{0.46084} \boxed{= 2.1261}$$

$\therefore V > V_c$ (Super Critical Flow)

Height of hydraulic jump on the upstream Side

As $Q = Av$
$$Q = byV$$
$$y_1 = \frac{Q}{v_1 b}$$

Putting value.

$$y_1 = \frac{7.839}{2322.86 \times 8} = \frac{7.839}{18582.88}$$

$$\boxed{y_1 = 0.000421 m}$$

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

$$y_2 = \frac{-0.000421}{2} + \sqrt{\frac{(0.000421)^2}{4} + \frac{2(0.000421)(2322.86)}{9.81}}$$

$$\boxed{y_2 = 0.446 m}$$

$$\Delta y = y_2 - y_1$$

$$\Delta y = 0.446 - 0.000421 =$$

$$\boxed{\Delta y = 0.441 m}$$

ii) :- $\Delta E = E_1 - E_2$

As we know that

$Q_1 = Q_2$

$A_1 V_1 = A_2 V_2$

$\cancel{b} y_1 v_1 = \cancel{b} y_2 v_2 \quad : b_1 - b_2 = b$

$V_2 = y_1 v_1 / y_2$

$V_2 = \dfrac{0.000421 \times 2322.86}{0.446} =$

$\boxed{V_2 = 2.7926 m/sec}$

$\Delta E = E_1 - E_2 = \left(y_1 + \dfrac{v_1^2}{2g}\right) - \left(y_2 + \dfrac{v_1^2}{2g}\right)$

$\Delta E = 0.000421 + \left(\dfrac{(2322.86)^2}{2g}\right) - \left(0.446 + \dfrac{(2322.86)^2}{2g}\right)$

$\Delta E = 0.000421 + 275009.0 - 0.446 + 27500.90$

$\Delta E = 0.000421 + 550017.5$

$\Delta E = 550017.5$

→ Power absorbed

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

putting value

$\Delta P = 1000 \times 9.8 \times 7839(550017.5)$

$\boxed{\Delta P = 44253.5m}$.

QNo1 (B)

Given data

$b = 4m$

$Q = 7839 \, ft^3/sec = \frac{7839}{(3.28)^2} =$

$\frac{7839}{35.2875} = 222.14 \, m^3/sec$

$y_1 = 2.9m$

$y_2 = 1.1m$

let Speific energy at upstream and down stream Side

$$E_1 = E_2$$

$$y_1 + \frac{v_1^2}{2g} = y_2 + \frac{v_2^2}{2g} \quad \text{— (1)}$$

As we know that

$$Q = A_1 v_1 = A_2 v_2$$

$$\cancel{b} y_1 v_1 = \cancel{b} y_2 v_2 \qquad \because b_2 = b_1 = b$$

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

putting value.

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

$$\boxed{v_2 = 2.634 v_1} \quad \text{— (2)}$$

Putt the value of Eq (2) in Eq (1)

$$2.9 + \frac{v_1^2}{2 \times 9.81} = \frac{1.1 + (2.634 v_1)^2}{2 \times 9.81}$$

$$2.9 - 1.1 = \frac{6.938 v_1^2}{19.62} - \frac{v_1^2}{19.62}$$

$$1.8 = \frac{6938 v_1^2 - v_1^2}{19.62}$$

$$1.8 \times 19.62 = 6.938 v_1^2$$

$$v_1^2 = \sqrt{\frac{1.8 \times 19.62}{5.938}}$$

$$v_1^2 = \sqrt{\frac{\cdot 35.316}{5.938}}$$

$$\sqrt{v_1^2} = \sqrt{5.9474}$$

$$\boxed{v_1 = 2.44 \text{ m/sec}}$$

Now the Putt the value of "v_1" in Eq (1).

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

Putting value

$$2.9 + \frac{(2.44)^2}{19.62} = 1.1 + \frac{v_2^2}{19.62}$$

$$2.9 - 1.1 = \frac{v_2^2}{2g} - \frac{5.95}{2g}$$

$$1.8 = \frac{V_2^2 - 5.95}{2g}$$

$$1.8 \times 2g = V_2^2 - 5.95$$

$$1.8 \times 2 \times 9.81 = V_2^2 - 5.95$$

$$\sqrt{V_2^2} = \sqrt{41.266}$$

$$V_2 = 6.42\ m/sec$$

Using froud No to determine type of flow

UPStream Side:-

$$F_{r_1} = \frac{V_1}{\sqrt{g y_1}} = \frac{244}{\sqrt{9.81 \times 2.9}}$$

$$= 0.457 < 1$$

(sub Critical flow)

Down Stream:-

$$F_{r_2} = \frac{V_2}{\sqrt{g y_2}} = \frac{6.42}{\sqrt{9.81 \times 1.1}}$$

$$= 1.95 > 1 \text{ (super critical flow)}$$

Q No 2 (A)

Given data:-

$y = 1.8m$

$b = 66' = \frac{66}{3.28} = 20.12m$

$Q = \frac{7839}{(3.28)^3} = 222.14 \, m^3/sec$

Required data:-

Minimum height (P) of weir

$Q = Av$

$V = \frac{Q}{A} = \frac{Q}{by} = \frac{222.14}{20.12 \times 1.8}$

$V = \frac{222.14}{36.216} = 6.14 \, m/sec$

As we know that

$y_c = (q^2/g)^{1/3} = \left(\frac{(11.04)^2}{9.81}\right)^{1/3}$

$\because q = \frac{Q}{b} = \frac{222.14}{20.12}$

$\boxed{q = 11.04}$

$$y_c = \left(\frac{(11.04)^2}{9.81}\right)^{1/3}$$

$$y_c = \left(\frac{121.88}{9.81}\right)^{1/3}$$

$$y_c = (12.424)^{1/3}$$

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

Also $v = \sqrt{gy}$

$$v_c = \sqrt{9.81 \times 2.31}$$

$$\boxed{v_c = 4.77 \ m/sec}$$

Now according to Specific energy.

$$E_1 = E_2$$

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

$$1.8 + \frac{(6.14)^2}{2g} = \frac{(4.77)^2}{2g} + (2.31) + P$$

$$P = 3.720 - 3.46$$

$$\boxed{P = 0.26m}$$

Q No 2 (B)

Given data:-

$b = 2.8m$

$d = 1.5m$

$H_1 = 5m$

$H_2 = 5 + 1.5 = 6.5m$

$H = 5 + 0.6 = 5.6m$

$Cd = 0.7839$

Required data:-

$Q = ?$

Discharge through Submerged Portion

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

Putting value.

$Q_1 = 0.7839 \times 2.8 \times (6.5 - 5.6) \times \sqrt{2 \times 9.81 \times 5.6}$

$Q_1 = 2.1949 \times (0.9) \times \sqrt{109.872}$

$Q_1 = 1.97541 \times 10.481$

$\boxed{Q_1 = 20.70 \ m^3/sec}$

$$\boxed{Q_1 = 20.70\, m^3/sec}$$

Discharge of free portion:–

$$Q_2 = \frac{2}{3} cd \times b_1\sqrt{2g}\left[H^{3/2} - H_1^{3/2}\right]$$

$$Q_2 = \frac{2}{3}(0.7839)\times 2.8\sqrt{2(9.81)}\left[(5.6)^{3/2} - 5^{3/2}\right]$$

$$Q_2 = 0.666(2.1949)\sqrt{19.62}\left[5.6^{3/2} - 5^{3/2}\right].$$

$$Q_2 = 1.4618\sqrt{19.62}\left[5.6^{3/2} - 5^{3/2}\right].$$

$$Q_2 = 1.4618 \times 4.4294\left[5.6^{3/2} - 5^{3/2}\right].$$

$$Q_2 = 6.4748\left[5.6^{3/2} - 5^{3/2}\right].$$

$$Q_2 = 6.4748\left[5.6^{1.5} - 5^{1.5}\right]$$

$$Q_2 = 6.4748[13.25 - 11.18]$$

$$Q_2 = (6.4748)(2.07)$$

$$Q_2 = \boxed{Q_2 = 13.402}$$

Total Discharge

$$Q = Q_1 + Q_2$$

Putting value.

$$Q = 20.70 + 13.402$$

$$\boxed{Q = 34.102}$$

QNo3 (A)

Given data:-

$P_1 = R + 800 = 7839 + 800 = 8639\ N/m^2$

$d_1 = R - 200 = 7839 - 200 = 7639\ mm = 7.639\ m$

$A_1 = \frac{\pi}{4} d_1^2 = \frac{\pi}{4}(7.639)^2 = 45.80\ m^2$

$d_2 = R + 3000 = 7839 + 3000 = 10839\ mm$

$d_2 = 10.839\ m$

$A_2 = \frac{\pi}{4} d_2^2 = \frac{\pi}{4}(10.839)^2 = 92.221$

$A_2 = 92.221$

$Q = 0.95\ m^3/sec$

$Q = AV$

$V = \frac{Q}{A_1}$

$V_1 = \frac{Q_1}{A_1} = \frac{0.95}{45.80} = \boxed{0.020\ m/sec}$

$V_2 = \frac{Q_2}{A_2} = \frac{0.95}{92.221} = \boxed{0.010\ m/sec}$

1. Head loss due to Sudden enlargement.

$$h_e = \left(1 - \frac{A_1}{A_2}\right)^2 \frac{[v_1 - v_2]^2}{2g} = \left[1 - \frac{45.80}{92.221}\right]^2 \times$$

$$\frac{[0.020 - 0.010]^2}{2 \times 9.81}$$

$$h_e = \left(\frac{92.221 - 45.80}{92.221}\right)^2 \times \frac{(0.01)^2}{19.62}$$

$$h_e = (0.5033)^2 \times \frac{0.0001}{19.62}$$

$$h_e = 0.2533 \times 5 \times 10^{-6}$$

$$h_e = 1.26 \times 10^{-6}$$

$$\boxed{h_e = 0.00000126 m}$$

2) Power lost due to Sudden enlargement.

$P = \rho g Q h_e$

$P = 1.00 \times 9.81 \times 0.95 \times 1.26 \times 10^{-6}$

$P = 9.319 \times 1.26 \times 10^{-6}$

$$\boxed{P = 0.0011\ W}$$

(3) Pressure is the Smallest Pipe.

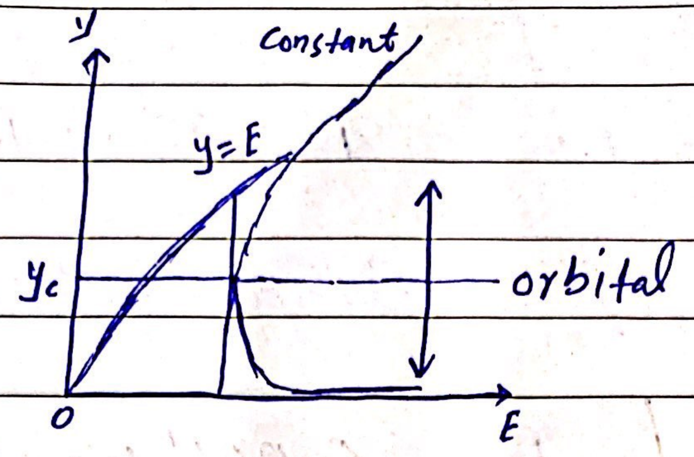
Apply Bernoullis equation

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

$$\frac{8639}{1000 \times 9.81} + \frac{(0.020)^2}{2(9.81)} = \frac{P_2}{(1000 \times 9.81)} + \frac{(0.010)^2}{2(9.81)} + 1.26 \times 10^{-6}$$

$$\boxed{P_2 = 8580.78}\ N/m^2$$

QNO3
(B)
Ans:-



The above graph is plot between depth flow (y) and specific energy (E) It is made from three degree Polynomial equation which shown us the different specific energy for the depth flow which may be either.

i) Sub Critical
ii) Critical
iii) Super Critical

Specific energy is used to Clarify the meaning the above terms in an open channel. How is this Acheivied?

Total energy = Potential energy + Kinetic energy

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

$\therefore w = mg$

$m = w/g$

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

ignoring "1N" weight of water

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

As we know that

$$Q = VA$$

$$V = \frac{Q}{A}$$ Squaring on both sides

$$v^2 = \frac{Q^2}{A^2}$$

putt v^2 in Eq (1)

$$E = y + \frac{Q^2}{A^2 2g}$$

Let suppose the Channel is Rectangular

$$A = y \times b \quad \text{— (x)}$$

$$Q = qb \quad \text{— (y)}$$

Putting value of "x" and "y" in Eq (2)

$$E = y + \frac{Q^2}{y^2 b^2 2g} \rightarrow \text{Putting } (x)$$

$$E = y + \frac{q^2}{y^2 2g} \rightarrow \text{putting } (y)$$

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

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

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

As "q" and "g" are Constants

* Critical depth is the flow depth Corresponding to maximum Specific energy

$y > y_c \Rightarrow$ Sub critical flow.

$y = y_c \Rightarrow$ Critical flow.

$y < y_c \Rightarrow$ Super Critical flow.