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subject # Hydraulics Engineering.

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Given data:-

Discharge = 7804 lit/sec 7.804 m^3/sec

width of opron = 8m

Mean velocity = 7804 - 220 = 7584

$\frac{7584}{3.28}$ = 2312.5 m/sec

Solution:-

As we know that

As q is discharge per unit width

$q = Q/b$

$q = \frac{7.804}{8} = 0.975$

As critical depth y_c is

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

$y_c = \left(\frac{(0.975)^2}{9.81}\right)^{1/3}$

$y_c = 0.46m$

critical velocity

As $q = vy$

$V = q/y$

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

~~$V_c = q/y$~~

$$V_c = \frac{0.975}{0.46}$$

$$\boxed{V_c = 2.119 \text{ m/sec}}$$

$$\boxed{V_c = 2.12 \text{ m/sec}}$$

As $V_1 > V_c$. Super critical flow

water depth on upstream side is Hydraulic Jump.

$$Q = AV$$

$$Q = byV$$

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

$$y_1 = \frac{7.804}{2.12 \times 8}$$

$$\boxed{y_1 = 0.46\text{m}}$$

By formula

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

$$= -\frac{0.46}{2} + \sqrt{\frac{(0.46)^2}{4} + \frac{2(0.46)(2.12)^2}{9.81}}$$

$$\boxed{y_2 = 0.50\text{m}}$$

Difference in depth.

$\Delta y = y_2 - y_1$

$= 0.50 - 0.46$

$\boxed{\Delta y = 0.04m}$

AS

Also $\Delta E = E1 - E2$

$A_1V_1 = A_2V_2$

$b_1y_1v_1 = b_2V_2V_2$; $b = b_1 = b_2$

$V_2 = \dfrac{y_1v_1}{y_2}$

$V = \dfrac{0.46 \times 2312.5}{0.50}$

$V = 2127.5$ m/sec

$\Delta E = E1 - E2.$

$E1 - E2 = \left(y_1 + \dfrac{V_1^2}{2g}\right) - \left(y_2 + \dfrac{V_2^2}{2g}\right)$

$= \left(0.46 + \dfrac{2312.5^2}{2(9.81)}\right) - \left(0.50 + \dfrac{2127.5^2}{2\,9.81}\right)$

$E1 - E2 = 272561.50 - 230696.063$

$\boxed{E1 - E2 = 41865.437\ m}$

Power Dissipation in hydraulic jump:-

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

$= 1000 (9.81) (7804) (41865.43)$

$\Delta P = 3205101772213.2$

$\boxed{\Delta P = 3205101772.2132 \text{ KW}}$

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Q1 part B.

Given data:-

channel width (b) = 4m
Discharge = 7804 ft^3/sec
height of upstream side = 2.9m
height of downstream = 1.1m

Solution:-

As we known that
As specific Energy is

$E_1 = E_2$

$$y_1 + \frac{V_1^2}{2g} = y_2 \frac{V_2^2}{2g} \quad \to (1)$$

Also from discharge

$Q = AV$

$\Rightarrow A_1V_1 = A_2V_2$

$b_1y_1V_1 = b_2y_2V_2 \quad \because b = b_1 = b_2$

$y_1V_1 = y_2V_2$

$$V_2 = \frac{y_1V_1}{y_2}$$

$$V_2 = \frac{2.9}{1.1} \times V_1$$

$\boxed{V_2 = 2.63 V_1}$ Put in eq (1)

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

$$= 2.9 + \frac{V_1^2}{2g} = 1.1 + \frac{6.91 V_1^2}{2g}$$

$$\Rightarrow \frac{V_1^2}{2g} - \frac{6.9 V_1^2}{2g} = 1.1 - 2.9$$

$$\Rightarrow + \frac{5.91 V_1^2}{2g} = +1.8$$

$$\Rightarrow 5.91 V_1^2 = 1.8 \times 2 (9.81)$$

$$V_1 = \sqrt{\frac{1.8 \times 2 (9.81)}{5.91}}$$

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

Put in V_2 equation

$$V_2 = 2.63 (2.44)$$

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

Type of flow using froud Number

(i) on upstream side.

$$Fr_1 = \frac{V_1}{\sqrt{g y_1}} = \frac{2.44}{\sqrt{9.81 \times 2.9}}$$

$Fr = 0.45$ $\quad Fr < 1$ (Sub critical flow)

(2) on Down stream side:-

$$Fr_2 = \frac{V_2}{\sqrt{gy_2}} = \frac{6.41}{\sqrt{9.81 \times 1.1}} = 1.95$$

$Fr > 1$ Super critical flow

Question # 2

Part A

Given data:-

Depth of channel = 1.8m

Discharge = 7804 Ft^3/sec = 221.20 m^3/sec

width of channel = 66 ft = 20.1 m

Required:

P = weir height = ?

Solution:-

As we know that

$$Q = AV$$

$$V = Q/A = V_1 = \frac{Q'}{A}$$

$$V_1 = \frac{Q}{b \times y}$$

$$V_1 = \frac{221.20}{20.1 \times 1.8} = 6.11 \text{ m/sec}$$

Critical Depth...

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

As $q = Q/b$

$$q = \frac{221.20}{20.1}$$

$q = 11.00\ m^2/sec$

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

$$\boxed{y_c = 2.29m}$$

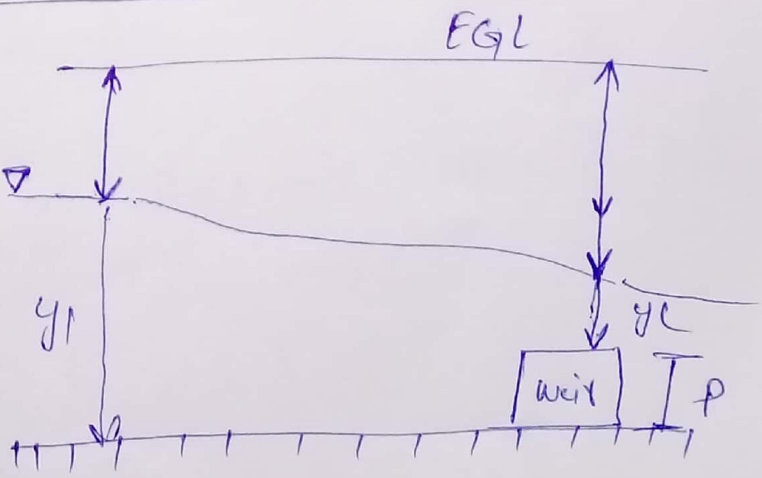
Also $v = \sqrt{gy}$

$V_c = \sqrt{g y_c}$

$V_c = \sqrt{9.81 \times 2.29}$

$V_c = 4.73\ m/sec$

From the figure



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

$$\frac{(6.11)^2}{2 \times 9.81} + 1.8 = \frac{4.73^2}{2 \times 9.81} + 2.29 + P$$

$$3.702 = 3.430 + P$$

$P = 1.07m$

The weir should have height of 1.07 measured from the channal bed.

Question NO # 2

Part # B

Given data:-

Breadth = 2.8m

Depth = 1.5m

water level on one side and above its top edge

$H_1 = 5m$

water level on other side. $H_2 = 5m + 1.5 = 6.5$

Similarly

$H = 5 + 0.6$

$= 5.6$

$C_d = 0.780$

Required:-

Discharge $Q = ?$

Solution:-

As we know that

As by formula.

Discharge through Submerged portion.

$$Q_1 = C_d \times b \times (H_2 - H_1) \times \sqrt{2gh}$$

$$= 0.78 \times 2.8 (6.5 - 5.6) \times \sqrt{2(9.81)(5.6)}$$

$$Q_1 = 20.6$$

Discharge through free portion:

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

$$Q_2 = \frac{2}{3}(0.78) \times 2.8\sqrt{2 \times 9.81} \times \left[(5.6)^{3/2} - (5)^{3/2}\right]$$

$$Q_2 = 13.36 \ m^3/sec$$

Total discharge $Q = Q_1 + Q_2$

$$Q = 20.6 + 13.36$$

$$Q = 33.96$$

Q 03
Part A

Given data.

$d_1 = R - 200$

$= 7804 - 200 = 7604mm$

$d_2 = R + 3000mm$

$= 7804 + 3000 = 10804mm$

flow rate $Q = 0.95 m^3/sec.$

Pressure in layer pipe $= R + 800 \; N/m^2$

7804 + 800

8604 N/m^2

Sol:-

① Head loss due to sudden Enlargment

$d_1 = 7604mm = 7.60 mm$

$A_1 = \frac{\pi}{4}(d_1)^2 = \pi/4 \; (7.60)^2$

$A_1 = 45.3 m^2.$

$d_2 = 10804mm$

$A_2 = \frac{\pi}{4}\left(\frac{10804}{100}\right)^2$

$A_2 = 91.6 m^2$

By Discharge formula

$$Q = AV$$

$$V = Q/A$$

$$V1 = Q/A1$$

$$V1 = \frac{0.95}{45.5} = 0.020 \, m/sec$$

Similarly

$$\Rightarrow V2 = Q/A2$$

$$V2 = \frac{0.95}{91.6} = 0.010 \, m/sec$$

By formula of sudden Enlargment

$$h_L = \left(1 - \frac{A1}{A2}\right)^2 \times \left(\frac{V1 - V2}{2g}\right)^2$$

$$= \left(1 - \frac{45.3}{91.6}\right) \times \left(\frac{0.020 - 0.010}{2(9.81)}\right)^2$$

$$= (0.225)(5.096 \times 10^{-6})$$

$$\boxed{h_L = 1.302 \times 10^{-6} m}$$

(2) power loss Due to suppen Enlargment

By formula -

$P = \rho g Q h_e$

$= (1000)(9.81)(0.95)(1.302 \times 10^{-6})$

$\boxed{P = 0.012\ W}$

(3) Pressure in smaller pipe

By using Bernoulli's equation

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

$$\frac{P_1}{(1000)(9.81)} + \left(\frac{(0.020)^2}{2(9.81)}\right) = \frac{P_2}{(1000)(9.81)} + \frac{(0.010)^2}{2 \times (9.81)} + 1.302 \times 10^{-6}$$

$$\frac{P_1}{9810} + 0.0000203 = \frac{8605}{9810} + 0.0000509 + 0.0000132$$

$$\frac{P_1}{9810} = 0.877 + 0.0000509 + 0.000001302 - 0.0000203$$

$$\frac{P_1}{9810} = 0.876$$

$P_1 = 0.876 \times 9810$

$\boxed{P_1 = 8593.56\ N/m^2}$

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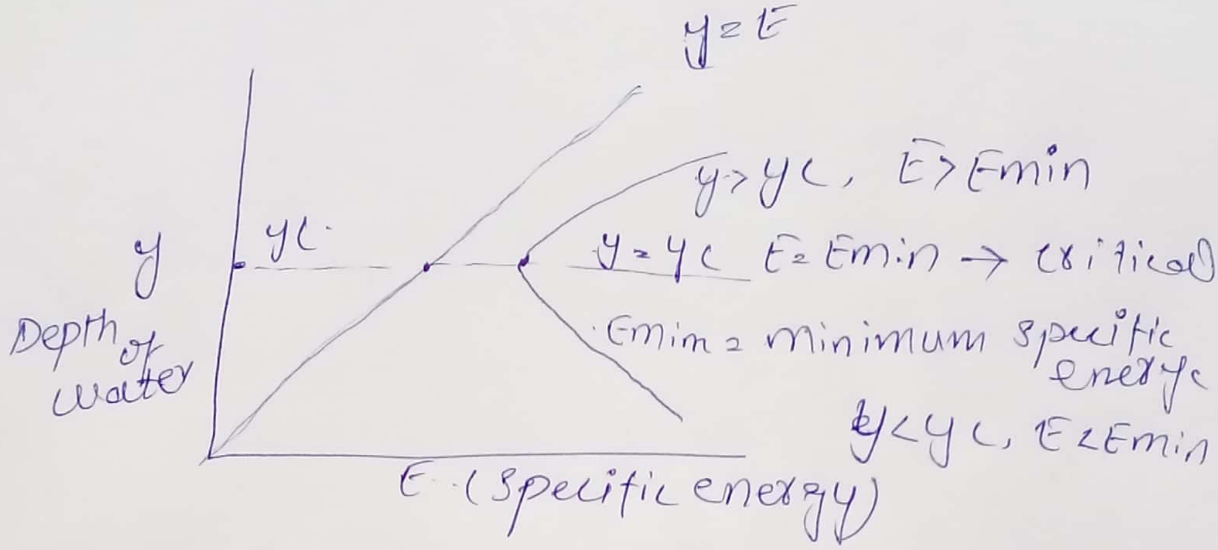
Part B:



critical depth is the depth corresponding to minimum specific energy.

↳ $y > y_c$ = $E > E_{min}$ (sub critical flow)

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

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