Name:→ Naseer-Muhammad
I.D :→ 7885
Section:→ 'A'
Subject:→ Hydraulic Engineering
Instructor:→ Sir Fawad Ahmad
Department:→ civil engineering
Semester:→ 6th
Exam:→ mid term

Q1:→

A):→ Let suppose a rectangular channel, discharge 7885 lit/sec into a 8m wide apron with zero slop mean is "R" 220 ft/sec.

i):→ Height of hydraulic jump (in unit of meter).

ii):→ Power absorbed due to hydraulic jump (in unit kW).

Given Data

Discharge = 7885 lit/sec => 7.885 m^3/sec

width = 8m

mean velocity = 7885 − 220

$= 7665 = \frac{7665}{3.28}$

=> 2336.89 m/sec.

Scanned with CamScanner

→ Height of hydraulic Jump: →

"q" is discharge per unit width

$$q = Q/b$$

$$\cancel{q = 788/8} \quad q = 7.885/8$$

$$q = 0.985 \ m^2/sec$$

→ Critical depth (y_c)

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

$$y_c = \left(\frac{(0.985)^2}{9.81}\right)^{1/3}$$

$$y_c = 0.46 m$$

→ critical velocity

$$q = Vy$$

$$V = q/y$$

$$V_c = q/y_c$$

$$V_c = 0.985/0.46$$

$$V_c = 2.14 \ m/sec$$

Scanned with CamScanner

→ Water Depth on upstream side:→

$$Q = AV$$

$$Q = (b \cdot y)V$$

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

$$y_1 = \frac{7.885}{2.14 \times 8}$$

$$y_1 = 0.46m$$

→ water Depth on Down stream side:

$$y_2 = \frac{-y_1}{2} + \sqrt{\frac{y_1^2}{4} + \frac{2 y_1 V_1^2}{g}}$$

$$y_2 = \frac{-0.46}{2} + \sqrt{\frac{(0.46)^2}{4} + \frac{2(0.46)(2.14)^2}{9.81}}$$

$$y_2 = 0.47m$$

→ Difference in Depths:→

$$\Delta y = y_2 - y_1$$

$$\Delta y = 0.47 - 0.46m$$

$$\Delta y = 0.01m.$$

Scanned with CamScanner

$$Q_1 = Q_2$$

$$A_1 V_1 = A_2 V_2$$

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

$$y_1 V_1 = y_2 V_2$$

$$V_2 = y_1 V_1 / y_2$$

$$V_2 = \frac{0.46 \times 2336.89}{0.47}$$

$$V_2 = 2287.16$$

Now

$$\Delta E = E_1 - E_2$$

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

$$E_1 - E_2 = \left(0.46 + \frac{(2336.89)^2}{2(9.81)} \right) - \left(0.47 + \frac{(2287.16)^2}{2(9.81)} \right)$$

$$E_1 - E_2 = 11720.4 m$$

Scanned with CamScanner

⇒ Power Dissipation in hydraulic Jump:→

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

$\Delta P = (1000)(9.81)(7.885)(11720.4)$

$\Delta P = 906594622.7 \, W$

$\Delta P = 906594.6 \, KW.$

Q1:→

B):→ A sluice gate controls the flow in a channel of width 4m. If the discharge is 7885 ft^3/sec and the upstream and downstream water depth is 2.9m and 1.1m respectively, calculate the downstream velocity.

→ Also state the type of flow at upstream and downstream side using any equation.

Given Data

Discharge = 7885 ft^3/sec

$$\text{Discharge} = \frac{7885}{(3.28m)^3}$$

$$= 223.45 \, m^3/sec$$

width = 4m

Scanned with CamScanner

upstream side Depth = 2.9m

Downstream side Depth = 1.1m

Sol:→

i) Downstream velocity:→

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

$$Q = AV$$

$$Q = A_1V_1 = A_2V_2$$

$$(by_1)v_1 = (by_2)v_2$$

$$y_1v_1 = y_2v_2$$

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

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

$$v_2 = 2.63v_1$$

Scanned with CamScanner

Put "V_2" in equ ①

$$y_1 + \frac{V_1^2}{2g} = y_2 + \frac{V_2^2}{2g}$$

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

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

$$\frac{V_1^2}{2(9.81)} - \frac{6.91(V_1)^2}{2(9.81)} = 1.1 - 2.9$$

$$-\frac{5.91V_1^2}{19.62} = -1.8$$

$$5.91V_1^2 = 1.8$$

$$\sqrt{V_1^2} = \sqrt{\frac{1.8 \times 19.62}{5.91}}$$

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

Put this value in "V_2"

Scanned with CamScanner

$V_2 = 2.63(V_1)$

$V_2 = 2.63(2.44)$

$V_2 = 6.41\,m/sec$

→ Types of flow Determination

*): → Upstream side: →
using froud number,

$$Fr_1 = \frac{V_1}{\sqrt{g y_1}}$$

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

$Fr_1 = 0.45 < 1$ → sub-critical flow.

*): → Downstream side: →
using froud number

$$Fr_2 = \frac{V_2}{\sqrt{g y_1}}$$

$$Fr_2 = 6.41 / \sqrt{9.81 \times 1.1}$$

$Fr_2 = 1.95 > 1$ → super critical flow.

Scanned with CamScanner

Q2:→

A):→ What is the minimum height (In meters) of broad crested weir if is to function critical depth on the crest.

→ If water flows along a rectangular channel at a depth of 1.8m with a discharge of 7885 ft^3/sec and the channel width is 66 ft.

Given Data

$$\text{Discharge} = 7885\ ft^3 = \frac{7885}{(3.28\,m)^3}$$

$$= 223.45\ m^3/sec.$$

Depth = 1.8m

$$\text{width} = 66 = \frac{66}{3.28} = 20.1\,m$$

weir height (P) = ?

Sol:→

$$Q = AV$$

$$V = Q/A$$

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

$$V_1 = \frac{223.45}{20.1 \times 1.8}$$

$$V_1 = 6.17 \text{ m/sec}$$

Critical depth:→

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

$$q = Q/b$$

$$q = \frac{223.45}{20.1} = 11.1 \text{ m}^2\text{/sec}$$

$$y_c = \left(\frac{(11.1)^2}{9.81}\right)^{1/3}$$

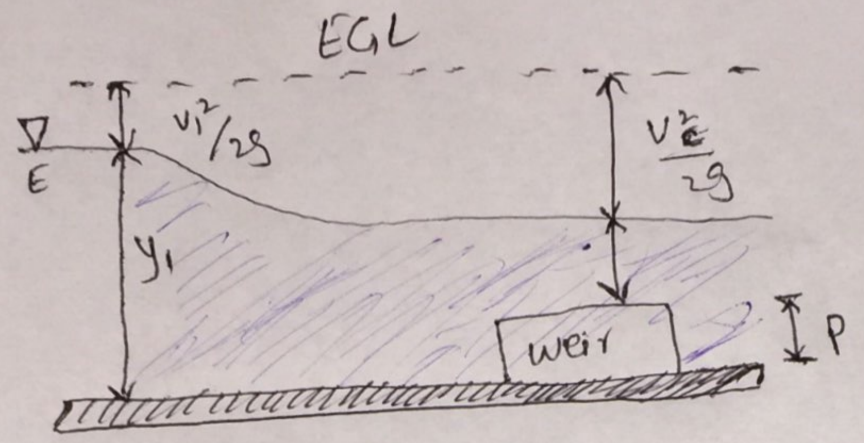
$$y_c = 2.32 \text{ m}$$

$$V = \sqrt{gy}$$

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

$$V_c = \sqrt{9.81 \times 2.32} = 4.77 \text{ m/sec}$$

Scanned with CamScanner



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

$$\frac{(6.17)^2}{2(9.81)} + 1.8 = \frac{(4.77)^2}{2(9.81)} + 2.32 + P$$

$$3.740 = 3.479 + P$$

$$P = 0.260m.$$

Q2:→

B):→ An orifice in one side of large tank is rectangular in shape 2.8m broad and 1.5m deep. The water level on one side of the orifice is 5m above its top edge. The water level on the other side of the orifice is 0.6m below its top edge. Calculate the discharge through the orifice if co-efficient of discharge is $cd = 0.7885$

Scanned with CamScanner

Given Data

Breadth = 2.8m

Depth = 1.5m

$H_1 = 5m$

$H_2 = 6.5m$

$H = 5m + 0.6 = 5.6m$

$cd = 0.7885$

Sol:→

Sub-merged portion Discharge:→

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

$Q_1 = 0.7885 \times 2.8 \, (6.5 - 5) \times \sqrt{2(9.81)(5.6)}$

$Q_1 = 34.71 \, m^3/sec.$

→ Free portion discharge:→

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

$$Q_2 = \frac{2}{3} (0.7885) \times (2.8) \sqrt{2(9.81} \times \left((5.6)^{3/2} - (5)^{3/2} \right)$$

$Q_2 = 13.51 \, m^3/sec.$

Scanned with CamScanner

Total discharge,

$Q = Q_1 + Q_2$

$Q = 34.71 + 13.51$

$Q = 48.22$

Q3

A):→ The diameter of a water pipe is suddenly enlarged from (7885−200mm) to (7885+3000mm) the rate of flow through is 0.95 m^3/sec and the pressure in the large pipe is (7885+800) N/m^2 calculate:

1):→ The loss of Head due to sudden enlargement.

2):→ The power lost due to sudden enlargement.

3):→ The pressure in the smaller pipe (if pipe is horizontal).

Given Data

$d_1 = 7885 - 200 \Rightarrow 7685m$

$d_2 = 7885 + 3000 = 10885mm$

Scanned with CamScanner

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

pressure in large pipe $= 7885 + 800 \, N/m^2$

$= 8685 \, N/m^2$

1):→ The loss of Head due to sudden enlargement:→

$d_1 = 7685 \, mm$

$\Rightarrow \; d_1 = 7.685 \, m$

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

$A_1 = 46.38 \, m^2$

$d_2 = 10885 \Rightarrow 10.885 \, m$

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

$A_2 = 93.05$

$Q = AV$

$V = Q/A$

$V_1 = Q/A_1$

$V_1 = \frac{0.95}{46.38}$

$V_1 = 0.020 \, m/sec$

Scanned with CamScanner

$V_2 = Q / A_2$

$V_2 = \frac{0.95}{93.05}$

$V_2 = 0.010 \, m/sec$

$he = \left(1 - \frac{A_1}{A_2}\right)^2 \times \left[\frac{(V_1 - V_2)^2}{2g}\right]$

$he = \left(1 - \frac{46.38}{93.05}\right) \times \left[\frac{(0.020 - 0.010)^2}{2(9.81)}\right]$

$he = 2.57 \times 10^{-6}$

2):→ The power lost due to sudden Enlargement:→

$P = \rho g Q he$

$P = (1000)(9.81)(0.95)(2.57 \times 10^{-6})$

$P = 0.023 W$

3):→ Pressure in smaller pipe:→

using Bernoulli's equation.

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

Scanned with CamScanner

$$\frac{P_1}{(1000)(9.81)} + \frac{(0.020)^2}{2(9.81)} = \frac{P_2}{(1000)(9.81)} + \frac{(0.010)^2}{2(9.81)} + 2.57\times10^{-6}$$

$$\frac{P_1}{9810} + 0.0000203 = \frac{P_2}{9810} + 0.00000509 + 2.57\times10^{-6}$$

$$\frac{P_1}{9810} = \frac{8685}{9810} + 0.00000509 + 0.00000257 - 0.0000203$$

$$\frac{P_1}{9810} = 0.8853$$

$$P_1 = 8685.32 \ N/m^2$$

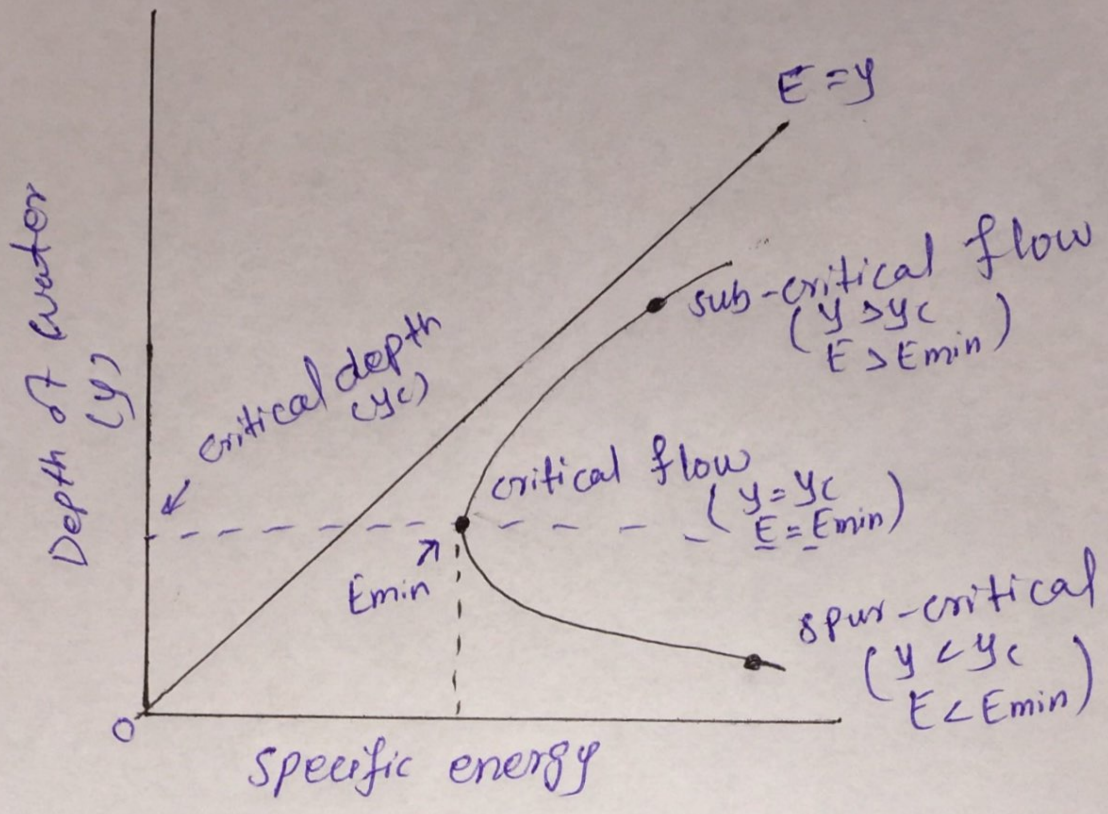
Q3

B:→

Ans:→ Specific energy:→

The parameter specific energy can be used to clarify the meaning of supercritical, subcritical and critical flow in open channel.

Scanned with CamScanner



→ From the derivation of specific energy equation a three degree polyonomial equation is obtained.

$$(E-y)y^2 = q^2/2g \rightarrow (1)$$

E = Specific energy

y = depth of water

q = Discharge of water.

→ The top most point shows that depth of water is greater than critical depth so flow is sub-critical

$y > y_c, E > E_{min}$

→ The middle Point shows that the depth of water is ~~greater~~ equal to critical depth corresponds to minimum specific energy the flow is critical flow.

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

→ The last point (located in bottom) shows that the water depth is less than critical depth the flow is super-critical flow.

$(y < y_c , E < E_{min}$.

Scanned with CamScanner