NAME	Hamza Ejaz
SUBMITTED BY	7835
SUBMITTED TO	Sir FAWAD
MODULE	6th
TECHNOLOGY	CIVIL ENGG
SUBJECT	HYDRAULIC ENGG
SECTION	B

Q No 1

(A) Given DATA:-

Channel width = $b = 8m$

Discharge = $Q = 7835$ ltr/sec $= 7.835\ m^3/sec$

Mean velocity = $V = R - 200$ $= 7835 - 200$

$= 7635$

$= 2388.71\ m/sec$

As we know

$Q = qb$

$q = Q/b = \frac{7.835}{8} =$

$= 0.9793\ m^2/sec$

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

$= \left(\frac{0.97935^2}{9.81}\right)^{1/3} = 0.460\ m$

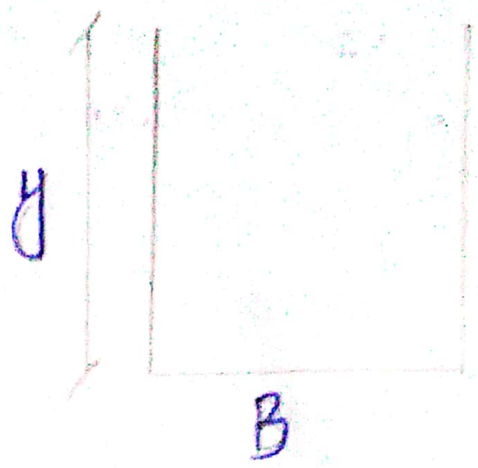
$y_c = 0.460m$

As it is rectangular section

$Q = qb$ — (1)

$Q = AV$ — (2)

Equating (1) and (2)



$qb = AV$

$q\cancel{b} = y\cancel{b}v$

$q = yv$

$v_c = q/y_c = \frac{0.9793}{0.460}$

$= 2.12$ m/sec

$\therefore v > v_c$ (supercritical flow)

Height of hydraulic jump on the upstream side

As

$Q = AV$

$Q = byv$

$y_1 = \frac{Q}{V_1 b}$

$y_1 = \frac{7.835}{2388.71 \times 8} = 0.00041$ m

$y_2 = -\frac{y_1}{2} + \sqrt{\frac{y_1^2}{4} + \frac{2y_1v_1}{g}}$

$$y_2 = \frac{-0.00041}{2} + \sqrt{\left(\frac{0.00041}{4}\right)^2 + \frac{2(0.00041)(2388.71)^2}{9.81}}$$

$$y_2 = 21.838\ m$$

$$\Delta y = y_2 - y_1$$
$$= 21.838 - 0.00041$$
$$\Delta y = 21.837$$

$\because\ \Delta E = E_1 - E_2$

As we know that

$$Q_1 = Q_2$$
$$A_1 v_1 = A_2 v_2 \qquad \because b_1 = b_2 = b$$
$$\cancel{b} y_1 v_1 = \cancel{b} y_2 v_2$$
$$v_2 = y_1 v_1 / y_2$$

$$v_2 = \frac{0.00041 \times (2388.71)}{21.838} = 0.044\ m/sec$$

$$\Delta E = E_1 - E_2 = \left(y_1 + \frac{v_1^2}{2g}\right) - \left(y_2 + \frac{v_2^2}{2g}\right)$$
$$= \left(0.00041 + \frac{2388.71^2}{2(9.81)}\right) - \left(21.838 + \frac{0.044^2}{2(9.81)}\right)$$

$E_1 - E_2 = \cancel{2900}\ 290800.5611$

$\Rightarrow$ Power Absorbed:

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

$$\Delta P = 1000 \times 9.81 \times 7.835 (290800.56)$$

$$\Delta P = 22352323.62 \text{ kN}$$

Q No 1 part b

Given DATA :-

$$B = 4m$$

$$Q = 7835\ ft^3/sec = \frac{7835}{(3.28)^3} = 222.03\ m^3/sec$$

$$y_1 = 2.9m$$

$$y_2 = 1.1m$$

Let specific Energy at upstream and downstream side

$$E_1 = E_2$$

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

we know that $Q = A_1 V_1 = A_2 V_2$

$by_1v_1 = by_2v_2$ $\qquad \because b_2 = b_1 = b$

$v_2 = \frac{y_1v_1}{y_2}$

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

$v_2 = 2.634\,v_1$ — (2)

put the value of (eq) (2) in eq (1)

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

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

$$1.8 = \frac{6.938\,v_1^2 - v_1^2}{19.62}$$

$$1.8\times 19.62 = 5.938\,v_1^2$$

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

$v_1 = 2.44\,m/sec$

Now put the value of "v_1" in eq (1)

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

$$2.9 + \frac{2.44^2}{2g} = 1.1 + \frac{v_2^2}{2g}$$

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

$$1.8 = \frac{v_2^2 - 5.95}{2g}$$

$$1.8 \times 2 \times 9.81 = v_2^2 - 5.95$$

$$\sqrt{v_2^2} = \sqrt{41.266}$$

$$v_2 = 6.42 m/sec$$

using Froud No to Determine type of Flow

upstream side :-

$$Fr_1 = \frac{v_1}{\sqrt{gy_1}} = \frac{2.44}{\sqrt{9.81 \times 2.9}} = 0.457 < 1$$

(Subcritical flow)

Downstream side:-

$$Fr_2 = \frac{v_2}{\sqrt{gy_2}} = \frac{6.42}{\sqrt{9.81 \times 1.1}} = 1.95 > 1$$

(Supercritical flow)

Q NO 2

(A) Given Data :-

$y = 1.8\,m$

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

$Q = \frac{7835}{3.28^3} = 222.03\ m^3/sec$

Required DATA :-

Minimum Height (P) of weir

$Q = AV$

$V = \frac{Q}{A} = \frac{Q}{by} = \frac{222.03}{20.12 \times 1.8}$

$= 6.13\,m/sec$

As we know

$y_c = (q^2/g)^{1/3} = \left(\frac{11.04^2}{9.81}\right)^{1/3}$ ∵ $q = Q/b = \frac{222.03}{20.12} = 11.04\,m^2/s$

$y_c = 2.32\,m$

Also $V = \sqrt{gy}$

$$V_c = \sqrt{g y_c} = \sqrt{9.81 \times 2.32}$$

$$= 4.77 \text{ m/sec}$$

Now; According to specific energy

$$E_1 = E_2$$

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

$$1.8 + \frac{6.13^2}{2 \times 9.81} = \frac{4.77}{2 \times 9.81} + 2.32 + P$$

$$3.72 = 3.48 + P$$

$$P = 3.72 - 3.48$$

$$P = 0.24 \text{ m}$$

Also 2

(B) Given DATA

$b = 2.8$ m

$d = 1.5$ m

$H_1 = 5$ m

$H_2 = 5 + 1.5 = 6.5\,m$

$H = 5 + 0.6 = 5.6\,m$

$cd = 0.7835$

Required Data $Q = ?$

Discharge through submerged portion

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

$= 0.7835 \times 2.8 \times (6.5 - 5.6) \times \sqrt{2 \times 9.81 \times 5.6}$

$Q_1 = 20.69\,m^3/sec$

Discharge of free portion

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

$Q_2 = 2/3\, (0.7835) \times 2.8 \sqrt{2 \times 9.81}\, [5.6^{3/2} - 5^{3/2}]$

$Q_2 = 13.422\,m^3/sec$

Total Discharge

$Q = Q_1 + Q_2$

$Q = 20.69 + 13.422$

$Q = 34.11\,m^3/sec$

Q NO 3

(A) Given Data

$P_1 = R + 800 = 7835 + 800 = 8635\ N/m^2$

$d_1 = R - 200 = 7835 - 200 = 7635\ mm$
$= 7.635\ m$

$A_1 = \frac{\pi}{4} d_1^2 = \frac{\pi}{4}(7.635)^2 = 45.79\ m^2$

$d_2 = R + 3000 = 7835 + 3000 = 10835\ mm$
$= 10.835\ m$

$A_2 = \frac{\pi}{4} d_2^2 = \frac{\pi}{4}(10.835)^2 = 92.22\ m^2$

$Q = 0.95\ m^3/sec$

$\because Q = AV$

$V = Q/A$

$V_1 = \frac{Q_1}{A_1} = \frac{0.95}{45.79} = 0.021\ m/sec$

$V_2 = \frac{Q_2}{A_2} = \frac{0.95}{92.22} = 0.01\ m/sec$

(1) Head loss due to sudden Enlargement

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

$$= \left(1 - \frac{45.79}{92.22}\right)^2 \times \left(\frac{0.021 - 0.01}{2\times 9.81}\right)^2$$

$he = 1.56 \times 10^{-6}\ m$

$he = 0.0000015\ m$

② Power lost due to sudden Enlargment

$P = \rho g Q\, he$

$P = 1000 \times 9.81 \times 0.95 \times 1.5 \times 10^{-6}$

$P = 0.014\ W$

③ Pressure into smallest pipe

Apply Bernoulli's eq.

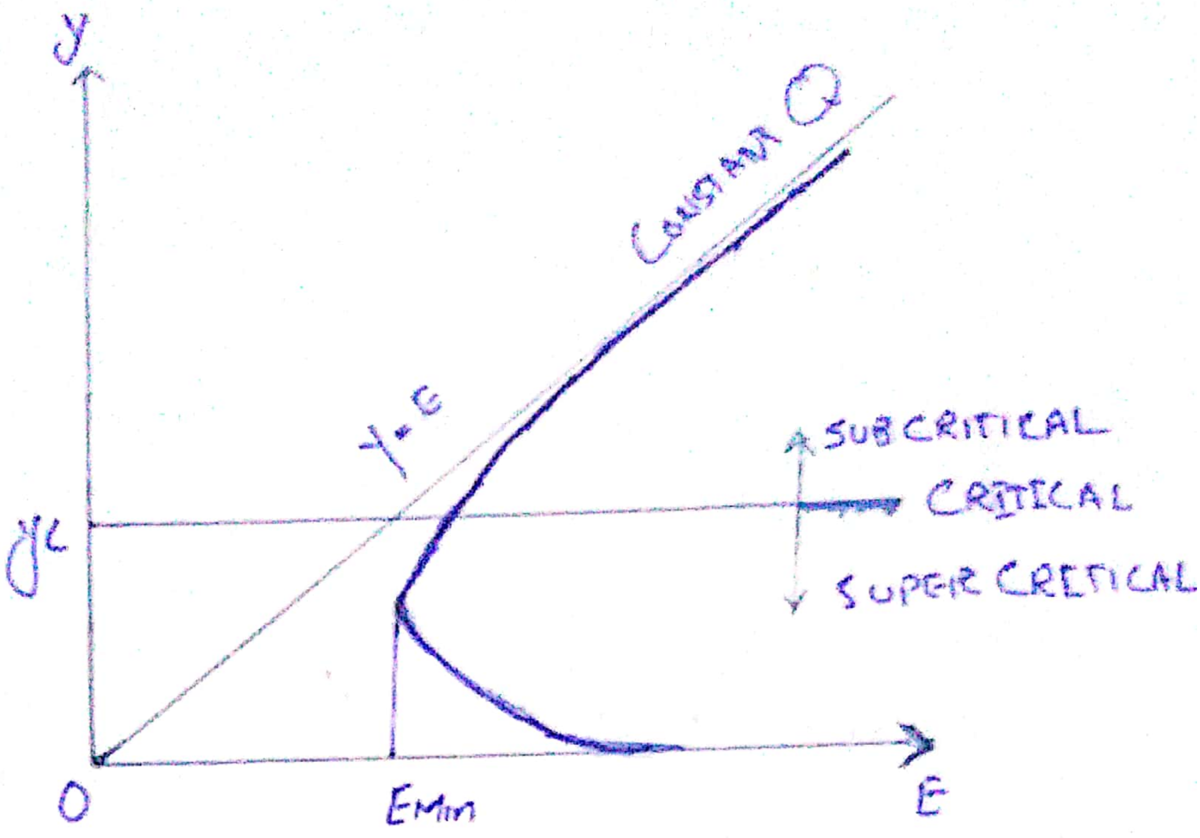
$$\frac{P_1}{\rho g} + \frac{v_1^2}{2g} = \frac{P_2}{\rho g} + \frac{v_2^2}{2g} + he$$

$$\frac{8635}{1000\times 9.81} + \frac{0.091^2}{2\times 9.81} = \frac{P_2}{1000\times 9.81} + \frac{0.01^2}{2g} + 1.56\times 10^{-6}$$

$P_2 = 0.879 \times 9810$

$P_2 = 8632.73\ N/m^2$

Q No 3
B



What does This blue Curve indicates. How it is obtained? Explain The above figure from each and Everypoint of veiw?

Ans The above graph is plot between depth flow (y) and specific Energy (E). It is made from three degree polynomial Equation which shows us the different specific Energy for the depth flow which may be either

1) Subcritical
ii) Critical
iii) Super critical

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

How is it Achieved :-

Total Energy = Potential Energy + Kinetic Energy

$$T.E = mgh + \frac{1}{2} mv^2 \qquad \because w = mg, \quad m = w/g$$

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

Ingnoring "w" weight of water

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

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

As we know that

$Q = VA$

$V = \frac{Q}{A}$ ∴ squaring b.s

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

put V^2 in eq (1)

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

let's suppose the channel is Rectangular

$A = y \times b \quad - (x)$

$Q = qb \quad = (y)$

putting value of (x) and (y) in (2)

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

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

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

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

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

As "q" and "g" are constants

critical depth is the flow depth corresponding to minimum specific Energy

$y > y_c \Rightarrow$ subcritical flow

$y = y_c \Rightarrow$ critical flow

$y < y_c \Rightarrow$ supercritical flow