Name	Jamal Faraz
ID	7832
Dept	Be(civil) 6th Section B.
Subject	Hydraulic Engineering
To	Engr Fawad Saib
Exam	Mid Term
Date	23/04/2020

Q·NO 1 # (A)

Ans:-

Given Data:-

→ Channel width = b = 8m

→ Dischage = Q = 7832 $\frac{lt}{sec}$ ⇒ $\boxed{7.832\ m^3/sec}$

→ Mean velocity = v = R − 200 ⇒ 7832 − 200 = $\boxed{7632 \frac{lt}{sec}}$

⇒ 23268 m/sec

As we Know:-

$$\Rightarrow Q = qb \Rightarrow q = Q/b = \frac{7.832}{8} \Rightarrow \boxed{0.979\ \frac{m^3}{sec}}$$

Find "yc" $\Rightarrow y_c = \left(\frac{q^2}{g}\right)^{1/3} \Rightarrow \left(\frac{0.979^2}{9.81}\right)^{1/3} = \boxed{0.46057m.}$

This is rectengular Section:

$$\Rightarrow Q = qb \rightarrow (1)$$

$$\Rightarrow Q = Av \rightarrow (2)$$ Equating (1) and (2)

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

$$\Rightarrow V_c = \frac{q}{y_c} = \frac{0.979}{0.460} \Rightarrow \boxed{2.12\ m/sec}$$

V > Vc → Super Critical flow.

Height of the hydraulic Jump on the upstream side:-

$$Q = Av \qquad Q = byv \qquad y_1 = \frac{Q}{V_1 b}$$

$$\Rightarrow y_1 = \frac{7.832}{23268 \times 8} \Rightarrow \boxed{0.0004\ m^2}$$

(2)

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

$$\Rightarrow y_2 = \frac{-0.0004}{2} + \sqrt{\frac{0.0004^2}{4} + \frac{2(0.0004)(2326.8)}{9.81}}$$

$$\Rightarrow \boxed{y_2 = 0.4354\,m}$$

$$\Rightarrow \Delta y = y_2 - y_1 \Rightarrow 0.4354 - 0.0004 \Rightarrow \boxed{0.435m}$$

$\Rightarrow \Delta E = E_2 - E_1$ we Know $Q_1 = Q_2$ $\because b_1 = b_2 = b$

$$A_1v_1 = A_2v_2$$

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

$$\Rightarrow V_2 = \frac{0.0004 \times 2326.8}{0.4354} = \boxed{2.137\,m/sec}$$

Find $\Delta E = E_1 - E_2$

$$\Rightarrow E_1 - E_2 = \left(y_1 + \frac{v_1^2}{2g}\right) - \left(y_2 + \frac{v_2^2}{2g}\right) \Rightarrow \left(0.0004 + \frac{2326.8^2}{2\times9.81}\right) - \left(0.4354 + \frac{2.137^2}{2\times9.81}\right)$$

$$\Rightarrow 275942.826 - 0.6681 \Rightarrow \boxed{275942.158m}$$

power absorbed:

$$\text{formula} = \rho g Q(E_1 - E_2)$$

$$\Rightarrow 1000 \times 9.81 \times 7.832(275942.15)$$

$$\Rightarrow \Delta P = 2.120116519 \times 10^{10}\,W$$

(3)

B:

Given Data

- $b = 4m$, $Q = 7832 \frac{ft^3}{sec} = 221.94 \frac{m^3}{sec}$

$y_1 = 2.9m$ $y_2 = 1.1m$

Solution:

Specific energy at upstream and downstream side.

$E_1 = E_2$

$\Rightarrow y_1 + \frac{v_1^2}{2g} = y_2 + \frac{v_2^2}{2g} \rightarrow (1)$

$\Rightarrow Q = A_1 v_1 = A_2 v_2 \quad \because b_2 = b_1 = b$

$\Rightarrow v_2 = \frac{y_1 v_1}{y_2} = v_2 = \frac{2.9}{1.1} v_1$

$\Rightarrow \boxed{= V_2 = 2.6363 V_1 \rightarrow (2)}$

put values of eq(2) in (1)

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

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

$\Rightarrow 2.9 - 1.1 = 2.63$

$1.8 = 5.938 V_1^2$

$\Rightarrow \sqrt{V_1^2} = \sqrt{\frac{1.8 \times 19.62}{5.938}}$ $\boxed{V_1 = 2.44 \text{ m/sec}}$

Put the value of V_1 and eq ①

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

$$\Rightarrow 2.9 - 11 = \frac{v_2^2}{2g} - \frac{5.95}{2g}$$

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

$$\Rightarrow \sqrt{V_2^2} = \sqrt{41.266} \qquad \boxed{V_2 = 6.42\,m/sec}$$

using Froud No to Determine type of Flow.

Up Stream Side:

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

Sub Critical Flow.

Downstream Side:

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

Supercritical Flow.

Q.NO # 2 (A)

(5)

Given Data:

$Y_1 = 1.8$, $b = 66' = \frac{66}{3.28} = 20.12m$

$Q = \frac{7832}{3.28^3} \Rightarrow \boxed{221.94 m^3/sec}$

Required data:

Minimum height $Q = qv \Rightarrow V = Q/A = \frac{Q}{by} = \boxed{6.12 \frac{m}{sec}}$

$\Rightarrow q = Q/b$

$\Rightarrow q = \frac{221.94}{1.8} \boxed{\Rightarrow 11.023}$

e

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

$\Rightarrow y_c = \left(\frac{11.023^2}{9.81}\right)^{1/3} = 2.31m$

$\Rightarrow V_c = \sqrt{gy} \Rightarrow \sqrt{9.81 \times 2.31} = V_c = \boxed{4.76 \frac{m}{sec}}$

Now According to Specific energy $E_1 = E_2$

$$Y_1 + \frac{V_1^2}{2g} = Y_2 + \frac{V_2^2}{2g} + P$$

$$\Rightarrow 1.8 + \frac{6.12^2}{2 \times 9.81} = \frac{4.76^2}{2 \times 9.81} + 2.31 + P$$

$$\Rightarrow 3.7089 = 3.464 P$$

$$\Rightarrow P = 0.2449m$$

(6)

Q.NO # 2 B:

Given:
$b = 2.8m$ $d = 1.5m$ $H_1 = 5m$

$H_2 = 5+1.5 = 6.5m$ $H = 5+.06m = 5.6m$

$Cd = 0.7832$

Required:
$Q = ?$

Discharged through Submerged portion:

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

$Q_1 = 0.7832 \times 2.8 \times (6.5 - 5.6) \times \sqrt{2 \times 9.81 \times 5.6}$

$\boxed{Q_1 = 11.62 m^3/sec}$

Discharge of Free portion:

$Q_2 = \frac{2}{3} Cd \times b\sqrt{2g} \cdot \sqrt{H}^{3/2} - H_1^{3/2}$

$= \frac{2}{3}(0.7832 \times 2.8\sqrt{2 \times 9.81} \cdot \sqrt{5.6}^{3/2} - 5^{3/2}$

$\boxed{Q_2 = 16.12 m^3/sec}$

Total Discharge

$11.62 + 16.12 = 27.74 m^3/sec$

$\boxed{Q_T = 27.74 m^3/sec}$

(7)

Q.NO # 3 (A)

Given data:

$P_1 = R + 800 \Rightarrow 7832 + 800 = 8632\ N/m^2$

$d_1 = R - 200 \Rightarrow 7832 - 200 \Rightarrow 7632\ mm$

$\Rightarrow 7.632\ m$

$A_1 = \frac{\pi}{4} d_1^2 \Rightarrow \frac{\pi}{4}(7.632)^2 \Rightarrow 45.72\ m^2$

$d_2 = R + 3000 \Rightarrow 7832 + 3000 \Rightarrow 10832\ mm$

$\Rightarrow 10.832\ m$

$A_2 = \frac{\pi}{4} d_2^2 \Rightarrow \frac{\pi}{4}(10.832)^2 \Rightarrow 92.105\ m^2$

$\boxed{Q = 0.95\ m^3/sec}$

$\therefore Q = Av = v = Q/A \Rightarrow \frac{0.95}{45.72}$ $\boxed{\Rightarrow 0.020\ m/sec}$

$V_2 = \frac{0.95}{92.105} \Rightarrow \boxed{0.01\ m/sec}$

1. Head loss due to Sudden enlargment:

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

$= \left(1 - \frac{45.72}{92.105}\right)^2 \left(\frac{0.02 - 0.01}{2 \times 9.81}\right)^2$

$\Rightarrow 3.84 \times 10^{-4}\ m$

$\boxed{h_e \Rightarrow 0.000384\ m}$

(8)

2- power lost due to sudden enlargment.

$$P = \rho g Q h_e$$

$$= 1000 \times 9.81 \times 0.95 \times 3.84 \times 10^{-4} \Rightarrow P = 3.57\ W$$

3- pressure in the smallest pipe Appley Bernouliz equ.

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

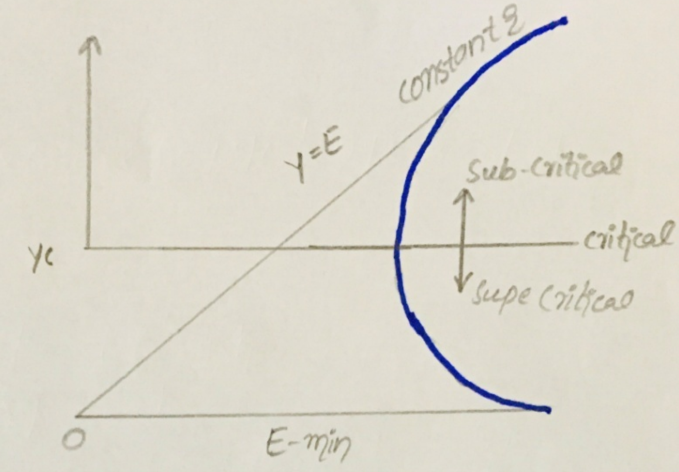
$$\frac{8632}{1000 \times 9.81} + \frac{0.02^2}{2(9.81)} = \frac{P_2}{1000 \times 9.81} + \frac{0.01^2}{2 \times 9.81} + 3.84 \times 10^{-4}$$

$$0.87 = \frac{P_2}{1000 \times 9.81} + 3.890 \times 10^{-4}$$

$$\Rightarrow \boxed{P_2 = 8662.23\ N/m^2.}$$

(9)

Part B:



Ans: The above graph is plot between depth flow(y) and Specific(E) it is made from three degree ploynomial equcation which shows us the depth flow which may be either.

1- Sub Critical
2- Critical
3- Super Critical

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

How is this Acheived:

Total Energy = P.E + K.E

$T_E = mgh + \frac{1}{2}mv^2$ $\quad \because W = mg$, $m = W/g$

$= Wh + \frac{1}{2}\frac{W}{g}v^2$

Ignoring the wt of water W

$T_E = h + \frac{v^2}{2g} \Rightarrow T_E = y + \frac{v^2}{2g} \rightarrow (1)$

As we Know that

$Q = Av \Rightarrow v = \frac{Q}{A}$ **Squaring b.s** $v^2 = \frac{Q^2}{A^2}$ put V in eq(1)

(10)

Lets Suppose the channel is rectangular.

$q = y \times b \rightarrow (1)$, $Q = qb \rightarrow (2)$

put the value of Y and q

$$E = y + \frac{Q^2}{y^2 b^2 2g}$$ **putting Y**

$$E = y + \frac{q^2}{y^2 2g}$$ **putting q**

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

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

*. As "q" and "g" are constant.

*. Critical depth is the flow depth corresponding to minimum Specific energy

$y > y_c \rightarrow$ Sub Critical flow

$y = y_c \rightarrow$ Critical flow

$y < y_c \rightarrow$ Super Critical flow.