Name	Sajid Saleem
ID #	7793
Section	A
Subject	Hydraulic Engineering.
Semester	6th

1

Ans1 (A) Given Data

- Discharge = 7793 lit/sec = 7.793 cubic meter/sec
- Width of apron = 8 meters
- Mean Velocity = 7793 − 220 = 7573 ft/sec = $\frac{7573}{328}$ = 2309.4 m/s

Required Data

- Height of Hydralic pump
- Power absorb due to hydralic jump

Solution

As height of hydralic jump :-

As q is discharge per unit width

$$q = \frac{Q}{b} = \frac{7.793}{8} = 0.974\ m^2/s$$

As Critical depth (Y_c)

$$Y_c = \left(\frac{q^2}{g}\right)^{1/3} = \left(\frac{0.974}{9.81}\right)^{1/3}$$

⇒ $Y_c = 0.45\ m$

Critical Velocity:

As $q = vy$

$$v = q/y$$

$$V_c = q/y_c \Rightarrow \frac{0.974}{0.45}$$

$$V_c = 2.16\ m/s$$

As $V_1 > V_c \Rightarrow$ Super Critical flow

WATER DEPTH ON UP-STREAM SIDE:-

$$Q = AV$$

$$Q = ByV$$

$$y = \frac{Q}{V.B}$$

$$y_1 = \frac{Q}{V_1 \cdot B} = \frac{7.783}{2.16 \times 8}$$

$$y_1 = 0.45$$

By formula:-

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

$$\Rightarrow \frac{-0.45}{2} + \sqrt{\frac{(0.45)^2}{4} + \frac{2(0.45)(2.16)^2}{9.81}}$$

$$\Rightarrow \frac{-0.45}{2} + 0.691$$

$$\Rightarrow y_2 = 0.466\ m$$

DIFFERENCE IN DEPTH:-

$$\Delta y = y_2 - y_1$$

$$\Rightarrow 0.466 - 0.45 \Rightarrow 0.016\ m$$

As: $\Delta E = E_1 - E_2$

Also $Q_1 = Q_2$

$$A_1 V_1 = A_2 V_2$$

$$b_1 y_1 v_1 = b_2 y_2 v_2 \Rightarrow \text{as } b_1 = b_2 \text{ Hence}$$

$$y_2 v_2 = y_1 v_1$$

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

$\Rightarrow \dfrac{0.45 \times 2309.4}{0.466}$

$V_2 = 2230.1\ m/s$

$\Rightarrow \Delta E = E_1 - E_2$

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

$\Rightarrow \left(0.45 + \dfrac{(2309.4)^2}{2 \times 9.81}\right) - \left(0.466 + \dfrac{(2230.1)^2}{2 \times 9.81}\right)$

$\Rightarrow 0.45 + 271831.2 - 0.466 + 253483.48$

$\Rightarrow 271831.65 - 253483.866$

$\Rightarrow E_1 - E_2 = 18347.78.$

POWER DISSICIPATION OF HYDRALIC JUMP:-

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

$\Rightarrow (1000)(9.81)(7.795)(18347.78)$

$\Rightarrow 1403036236\ W$

$\Delta P = 1403036.236\ KW$

Ans 1 $\Rightarrow$

PART B:-

GIVEN DATA:-

channel width $(b) = 4m$

Discharge $= 7795\ ft^3/sec$

Height of up-stream side = 2.9m

Height of down-stream side = 1.1m

⇒ **REQUIRED DATA:-**

Down stream velocity = ?

SOLUTION:-

As

Specific energy is

$$E_1 = E_2$$

$$\Rightarrow \quad y_1 + \frac{V_1^2}{2g} + y_2 + \frac{V_2^2}{2g} \Rightarrow ①$$

⇒ Also from discharge

$$Q = AV$$

$$\Rightarrow \quad A_1V_1 = A_2V_2$$

$$b_1 y_1 v_1 = b_2 y_2 v_2 \qquad \text{as } b_1 = b_2 = b$$

$$y_1 v_1 = y_2 v_2$$

$$V_2 = \frac{y_1 v_1}{y_2}$$

$$V_2 = \frac{(2.9)}{1.1} v_1 \Rightarrow V_2 = 2.63 V_1 \Rightarrow \text{put in } Eq ①$$

$$2.9 + \frac{V_1^2}{2(9.81)} = 1.1 + \frac{(2.63 V_1)^2}{2(9.81)}$$

$$\frac{2.9 + V_1^2}{2(9.81)} = 1.1 + \frac{6.91 V_1^2}{2(9.8)}$$

$$\frac{V_1^2}{2(9.81)} - \frac{6.81\,V_1^2}{2(9.81)} = 1.1 - 2.9$$

$$\frac{-5.81\,V_1^2}{2(9.81)} = -1.8$$

$$5.81\,V_1^2 = (1.8)(2)(9.81)$$

$$V_1 = \sqrt{\frac{(1.8)(2)(9.81)}{5.81}}$$

$V_1 = 2.44\ m/s$ put in Eq (iv)

$$V_2 = 2.63(2.44)$$

$$V_2 = 6.41\ m/sec.$$

TYPE OF FLOW USING FROUD NUMBER

On Up-stream Side:-

$$Fr_1 = \frac{V_1}{\sqrt{gy_1}} = \frac{2.44}{\sqrt{9.81(2.91)}}$$

$$= 0.45$$

$Fr_1 < 1 \Rightarrow$ sub-critical flow

On down-stream side :-

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

$Fr_2 > 1$ Super critical flow.

QUESTION ⇒ 02

PART A:-

GIVEN DATA:-

⇒ Depth of channel = 1.8m

⇒ Discharge = 7793 ft^3/s

⇒ Width of channel = 66 ft = 20.1 m

REQUIRED DATA:-

P = weir height = ?

SOLUTION:-

As

$Q = AV$

$V = Q/A \Rightarrow V_1 = Q_1/A = Q/by$

$$V_1 = \frac{221.98}{20.1 \times 1.8} = 6.11 m/sec$$

CRITICAL DEPTH:-

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

As $q = Q/b$

$\Rightarrow 220.8/20.1 \Rightarrow 10.9\ m/sec$

$$Y_c = \left(\frac{(10.9)^2}{9.81}\right)^{1/3} = 2.2m$$

Also $V = \sqrt{gy}$

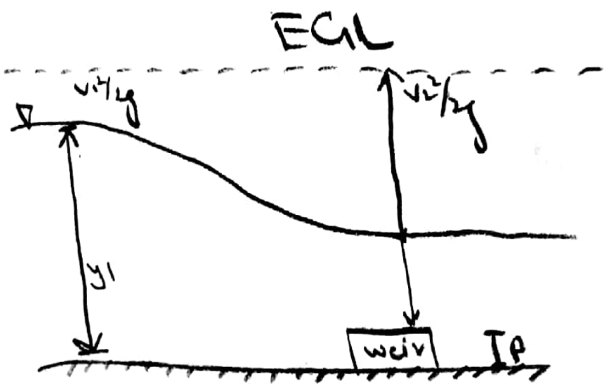
$V_c = \sqrt{gY_c}$

$V_c = \sqrt{9.81 \times 2.28} \Rightarrow V_c = 4.73\ m/s$

Scanned with CamScanner

FROM THE FIGURE:-

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



$$\frac{(6.10)^2}{2\times 9.81} + 1.8 = \frac{(4.73)^2}{2\times 9.81} + 2.28 + P$$

$$1.89 + 1.8 = 1.14 + 2.28 + p$$

$$3.69 = 343 + p$$

$$p = 0.26m$$

The weir should have height 0.26m

Ans (2)

PART B:-

GIVEN:-

Width = 2.8m

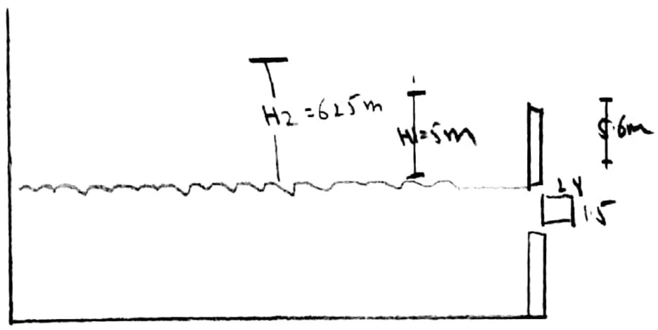
depth = 1.5 m

H_1 = 5m

H_2 = 6.5m

H = 5.6m

Cd = 0.7785



Solution:-

submerged portion

As

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

$$Q_1 = 0.7785 \times 2.81 (6.5 - 5.6) \times \sqrt{2(9.8)(5.6)} \Rightarrow \boxed{Q_1 = 20.53 \ m^3/s}$$

Free Portion:-

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

$$Q_2 = \frac{2}{3}(0.7785) \times (2.8)\sqrt{2(9.81} \times \left(5.6^{3/2} - 5^{3/2}\right)$$

$$Q_2 = (1.46)(4.429)(13.25 - 11.18)$$

$$Q_2 = (6.466)(2.07)$$

$$Q_2 = 13.38 \ m^3/s$$

$$\text{Total} = Q_1 + Q_2$$

$$Q = 2053 + 13.38$$

$$Q = 33.91 \ m^3/s$$

(A) Ans (3)

⇒ $d_1 = R - 200\,mm$

⇒ $d_1 = 7793 - 200 \Rightarrow 7593\,mm$

⇒ $d_2 = R + 3000\,mm$

⇒ $d_2 = 7793 + 3000 = 10793\,mm.$

⇒ Flowrate $(Q) = 0.95\,m^3/s$

Pressure in large pipe $= R + 800\,N/m^2$

$= 7793 + 800 \Rightarrow$ ~~8593~~ 10793 N/m^2

Solution:-

loss of head due to sudden enlargment

⇒ $d_1 = 7593\,mm = 7.593\,m$

⇒ $A_1 = \frac{\pi}{4}(7.593)^2 = 45.22\,m^2$

⇒ $d_2 = 10793\,mm = 10.793\,m$

⇒ $\pi/4\,(10.793)^2 = 84.37\,m^2.$

As $Q = A.V$

$V = \frac{Q}{A} \Rightarrow V_1 = Q/A_1 \Rightarrow \frac{0.95}{45.22} \Rightarrow 0.021\,m/s$

Similarly

$v_2 = Q / A_2$

$v_2 = 0.95 / 84.37 = 0.0118 \, m/s$

formula of sudden enlargement:-

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

$$\Rightarrow \left(1 - \frac{45.22}{840.37}\right)^2 \times \left(\frac{0.021 - 0.018}{2 \times 9.81}\right)^2$$

$$\Rightarrow (0.014)(9 \times 10^{-6} / 2 \times 9.81)$$

$e = 6.422 \times 10^{-9}$

⇒ Power loss due to sudden enlargement

$P = \rho g Q h_e$

$\Rightarrow (1000)(9.81)(0.95)(6.42 \times 10^{-9})$

$P = 8583.8 \times 10^{-5} \, W$

⇒ PRESSURE IN SMALLER PIPE:-

By using Bernoulli's equation

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

$$\frac{P_1}{(1000)(9.81)} + \frac{(0.021)^2}{2(9.81)} = \frac{8995}{(1000)(9.81)} + \frac{(0.018)^2}{2(9.81)} + 6.42$$

$$\frac{P_1}{9810} + 2.24\times10^{-5} = 0.876 + 1.65\times10^{-5} + 6.42\times10^{-9}$$

$$\frac{P_1}{9810} = 0.876 + 1.65\times10^{-5} + 0.42\times10^{-9} - 2.24\times10^{-5}$$

$$\frac{P_1}{9810} = 0.875$$

$$P_1 = 0.875\times9810$$

$$P_1 = 8583.50\ N/m^2$$

PART- B

Ans 3

First we define specific energy as "specific energy is a parameter that can be used to clarity the meaning of super critical, sub-critical and critical flow in an open channel.

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)

Equation (3) is three degree polynomial equation. It can be use to prepare a plot of specific energy. "E"