Assignment

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SEC # A

Subject # Hydraulic Engineering

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Q NO : 01

Part : A

Given Data :-

Rectangular Channel Discharge = 7812 lit/sec

$\because$ As $1\,m^3 = 1000$ Lit

$$\frac{7812}{1000} \Rightarrow 7.812\,m^3$$

Width = 8 m

mean velocity = 7812 − 220

$$= \frac{7592}{3.28} \Rightarrow 2314.6\,m/sec$$

Solution :-

Hydraulic Jump Height :

we know That

"q" is discharge per unit width

So,

$$q = Q/b$$

$$\frac{7.812}{8} \Rightarrow 0.9765\,m^2/sec$$

$$\boxed{q = 0.9765\,m^2/sec}$$

P-T-O →

$\Rightarrow$ Critical Depth (y_c) is

$$y_c = \left(\frac{q^2}{g}\right)^{\frac{1}{3}} \Rightarrow \left(\frac{(0.9765)^2}{9.81}\right)^{\frac{1}{3}}$$

$$\boxed{y_c = 0.459 m}$$

$\Rightarrow$ Critical Velocity:

As, $q = Vy \quad \Rightarrow V = q/y$

$$V_c = q/y_c \Rightarrow V_c = \frac{0.9765}{0.459}$$

$$\boxed{V_c = 2.127 m/sec}$$

So

$V_1 > V_c$

Super - Critical flow

$\Rightarrow$ Water Depth on upstream Side in of Hydraulic pump:

$Q = AV \qquad \because A = by$

$Q = (by) \cdot v$

$$y = \frac{Q}{V \cdot b} \Rightarrow y_1 = \frac{Q}{V_1 \cdot b}$$

$$y_1 = \frac{7.812}{2.127 \times 8}$$

$$\boxed{y_1 = 0.459 m}$$

Now by using formula we get;

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

$$= -\frac{0.459}{2} + \sqrt{\frac{(0.459)^2}{2} + \frac{2(0.459)(2.127)^2}{9.81}}$$

$$= -\frac{0.459}{2} + 0.7271$$

$$\boxed{y_2 = 0.4976 m}$$

⇒ **Depth in Difference:-**

$$\Delta y = y_2 - y_1$$

$$= 0.4976 - 0.459$$

$$\Delta y = \boxed{0.0386 m}$$

As;

$$\Delta E = E_1 - E_2$$

Also

$$Q_1 = Q_2$$

$$A_1 v_1 = A_2 V_2$$

$$b_1 y_1 \cdot v_1 = b_2 y_2 \cdot v_2 \qquad \because b = b_1 = b_2$$

$$\cancel{b} \cdot y_1 \cdot v_1 = \cancel{b} \cdot y_2 \cdot v_2$$

$$v_2 = \frac{y_1 v_1}{y_2} \Rightarrow \frac{0.459 \times 2314.6}{0.4976}$$

$$\boxed{v_2 = 2135.05\, m/sec}$$

$$\Longrightarrow \quad \Delta E = E_1 - E_2$$

$$= \left(y_1 + \frac{v_1^2}{2g}\right) - \left(y_2 + \frac{v_2^2}{2g}\right)$$

$$E_1 - E_2 = \left(0.459 + \frac{(2314.6)^2}{2(9.81}\right) - \left(0.4976 + \frac{(2135.05)^2}{2(9.81)}\right)$$

$$= 273057.195 - 232336.8127$$

$$E_1 - E_2 = \boxed{40720.3823}$$

P-T-O →

⟹ Power Dissipation in Hydraulic Jump:

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

$$= (1000)(9.81)(7.812)(40720.3823)$$

$$\Delta P = 3120635816$$

$$\boxed{\Delta P = 3120635.816 \text{ KW}}$$

QNO: 02 :

Part A

Given Data :

Discharge(R) = Q => 7812 ft^3/sec

Channel width = B => 66 ft

Depth of Channel (y_1) = 1.8 m

$= \frac{1.8}{3.28} \Rightarrow 5.9$ ft

Solution:

Velocity:

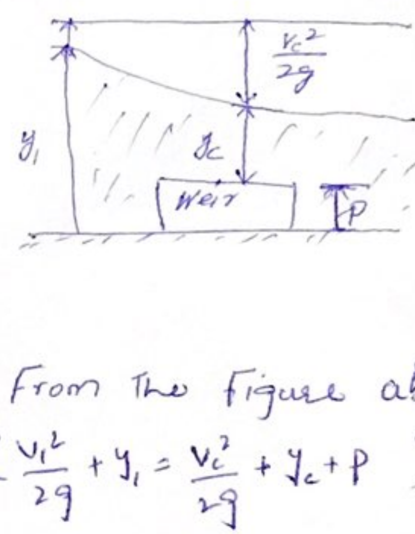
$$V_1 = \frac{Q}{A} = \frac{Q}{b \times y} = \frac{7812}{66 \times 5.9} \Rightarrow 20.1 \text{ ft/sec}$$

$$y_c = \left[\frac{Q^2}{gB^2}\right]^{\frac{1}{3}} \Rightarrow y_c = \left(\frac{(7812)^2}{9.81 \times (66)^2}\right)^{\frac{1}{3}}$$

$$y_c = 11.26 \text{ ft}$$

$\because y_2 = y_c = 11.26$ ft

$$V_2 = V_c = \frac{Q}{y_c B}$$



$$= \frac{7812}{11.26 \times 66}$$

$$V_c = 10.51 \text{ ft/sec}$$

From the figure above

$$P = y_1 + \frac{V_1^2}{2g} - y_c - \frac{V_c^2}{2g} \quad \left(\frac{V_1^2}{2g} + y_1 = \frac{V_c^2}{2g} + y_c + P\right)$$

Now putting the values

P-T-O →

$$P = 5.9 + \frac{(20.1)^2}{2\times 9.81} - 11.26 - \frac{(10.51)^2}{2\times 9.81}$$

$$= 26.491 - 11.26 - 5.62$$

$$= 9.611 \text{ ft}$$

$$\frac{9.611}{3.28} \Rightarrow \boxed{2.93 \text{ m}}$$

Minimum Height = 2.93m Ans

$\boxed{\text{Part B}}$:

Given Data:

Depth = 1.5m

width = 2.8m

Height = $H_1 \Rightarrow 5$m

$Cd = 0.7812$

$H = H_1 + 0.6$

$= 5 + 0.6 \Rightarrow 5.6$m

$H_2 = 1.5 + H_1$

$= 1.5 + 5 = 6.5$m

Solution:

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

$$= 0.7812 \times 2.8 \times (6.5 - 5.6) \times \sqrt{2(9.8)(5.6)}$$

$$Q_1 = 20.62 \text{ m}^3/\text{sec}$$

P-T-O→

Free portion :

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

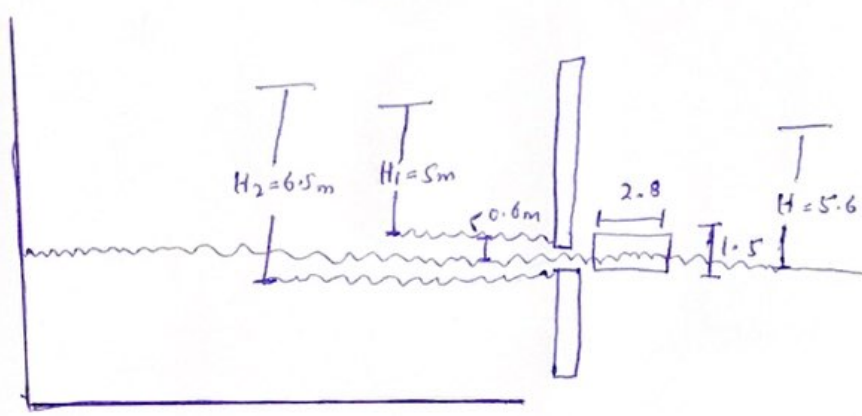
$$Q_2 = \frac{2}{3}(0.7812) \times 2.8\sqrt{2\times 9.81} \times \left[(5.6)^{\frac{3}{2}} - (5)^{\frac{3}{2}} \right]$$

$$Q_2 = 13.38\, m^3/sec$$

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

$$= 20.62 + 13.38$$

$$\boxed{Q = 34\, m^3/sec} \text{ Ans}$$



QNo: 03

part : A

Given Data :

Dia of pipe before enlargement (d_1)

$= R - 200m$

$= 7812 - 200 \Rightarrow 7612mm$

Dia of pipe after enlargement (d_2)

$= R + 3000mm$

$\Rightarrow 7812 + 3000 \Rightarrow 10812\ mm$

(Q) Rate of flow $= 0.95 m^3/sec$

pressure in Larger pipe $= R + 800 N/m^2$

$= 7812 + 800$

$\Rightarrow 8612\ N/m^2$

Solution :

(i) Loss of Head due to Sudden Enlargment :-

$\Rightarrow d_1 = 7612mm = 7.612m$ (As $1m = 1000mm$)

$A_1 = \pi/4 (7.612)^2 = 45.48 m^2$ (As $A = \pi/4 D^2$)

P-T-O →

Similarly

$\Rightarrow d_2 = 10812 \Rightarrow 10.812\,m$

$A_2 = \pi/_4 (10.812) = 91.76\,m^2$

As,

$Q = AV$

$V = Q/_A \Rightarrow V_1 = Q/_{A_1}$

by putting values

$V_1 = \dfrac{0.95}{45.48} \Rightarrow 0.02\,m/sec$

Similarly

$V_2 = Q/_{A_2}$

$V_2 = \dfrac{0.95}{91.76} \Rightarrow 0.01\,m/sec$

(a) By formula of Sudden Enlargement

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

Putting the values

P-T-O →

$$\left(1 - \frac{45.48}{91.76}\right)^2 \times \left(\frac{0.02 - 0.01}{2 \times 9.81}\right)^2$$

$$(0.2543) \times (2.597 \times 10^{-7})$$

$$he = \boxed{6.604171 \times 10^{-8}}$$

(2) Power Loss due to Sudden enlargment:

$$P = \rho g Q he$$

$$= (1000)(9.81)(0.95)(6.604171 \times 10^{-8})$$

$$(9319.5)(6.604171 \times 10^{-8})$$

$$= 6.154757163 \times 10^{-4}$$

(3) Pressure in the Smaller pipe:

By using Bernoulli's Equation

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

putting values

P-T-O →

$$\frac{P_1}{(1000)(9.81)} + \frac{(0.02)^2}{2(9.81)} = \frac{8612}{(1000)(9.81)} + \frac{(0.01)^2}{2(9.81)} + 6.604171\times10^{-}$$

$$\frac{P_1}{9810} + 0.0000203 = 0.8778 + 0.00000509 + 6.604\times10^{-8}$$

$$\frac{P_1}{9810} = 0.8778 + 0.00000509 + 6.604\times10^{-8} - 0.0000203$$

$$\frac{P_1}{9810} = 0.8780$$

$$P_1 = 0.878 \times 9810$$

$$\boxed{P_1 = 8613.18\ N/m^2}$$

Part : B

Ans: The blue Curve indicates The Specific energy Curves. It is The energy with Refrence to The bed of The Channel Mathematically It Can be written as

$$E = Y + V^2/2g$$

The bed of The Channel is Considered as datum line

⟹ It is observed from E–Y diagram drawn for a Constant Flow/discharge for any value of 'E', There would be two possible depths, Called "Y_1" and "Y_2" These depths are Known to be alternate depths.

→ While for Corresponding to minimum Specific energy for point "C" There will be only one depth "y_c" This "y_c" is Called as "Critical Depth"

⟹ Critical, Sub-critical and Super-Critical are Classified with "Froude Number" It denoted by "Fr" It is the Ratio of inertial force to gravitational Force It can be written as

$$Fr = \frac{V}{\sqrt{gh}}$$

V = average velocity of flow
h = Depth of flow and
g = acceleration due to gravity

If,

$Fr < 1 \rightarrow$ Flow will be Subcritical
$Fr = 1 \rightarrow$ Flow is Critical Flow
$Fr > 1 \rightarrow$ Flow is Super Critical