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Section A

Subject Hydraullic Engnr

Mid Term Exame

QNO.1)

(a):

Given Data:

Discharge = 7876 lit/sec

$= 7.876 m^3/sec$

Width of apron = 8 m

Mean velocity = 7876 − 220

= 7656 ft/sec

$= \frac{7656}{328} = 2334.1$ m/sec

Required:

Height of hydraulic jump

Power absorbed due to hydraulic jump.

Solve:

Height of hydraulic jump

As "q" is discharge per unit width

$q = Q/b$

$q = \frac{7.876}{8} = 0.9845$

$q = 0.9845 \, m^2/sec$

⇒ Critical Depth (y_c)

We know that

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

$$= \left(\frac{(0.4845)^2}{9.8}\right)^{1/3}$$

$y_c = 0.4624$ m

So critical velocity.

We also know that

$q = Vy$

$V = q/y$

$V_c = q/y_c$

$V_c = \frac{0.9845}{0.46} = 2.14$

$V_c = 2.14\ m/sec$

Now

As $V_1 > V_c$

So it is super critical flow

Water depth on upstream side;

As we know that

$Q = AV$

$Q = (by)(V)$

$y = Q/Vb$

$y = \frac{7.876}{2.16 \times 8}$

$y = 0.455m$

We also know that

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

$= -\frac{0.455}{2} + \sqrt{\frac{(0.4)^2}{4} + \frac{2(0.45)(2.14)^2}{9.8}}$

$= -0.225 + 0.69$

$y_2 = 0.466m$

Difference In Depth:

$\Delta y = y_2 - y_1$

$= 0.466 - 0.455$

$\Delta y = 0.011 m$

And

$\Delta E = E_1 - E_2$ — (A)

So as we have

$Q_1 = Q_2$

$A_1 V_1 = A_2 V_2$

$b_1 y_1 V_1 = b_2 y_2 V_2$

$V_2 = \frac{y_1 V_1}{y_2}$ $\boxed{b = b_1 = b_2}$

$V_2 = \frac{0.455 (2334.1)}{0.466}$

$\boxed{V_2 = 2279 \ m/sec}$

So eq — (A)

$\Delta E = E_1 - E_2$

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

$= \left(0.455 + \frac{(2334.1)^2}{2(9.8)}\right) - \left(0.466 + \frac{(2279)^2}{2(9.8)}\right)$

$\Delta E = 277960.8 - 264992.3$

$\Delta E = 12968.5 m$

Power Dissipation

As we Know

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

$\Delta p = (1000)(9.8)(7.876)(\Delta E)$

$= (1000)(9.8)(7.876)(12968.5)$

$\Delta p = 100097107.9 \ W$

$\Delta p = 1000971079 \ KW$

$\Delta p = 1000971.079 \ KW$

QNO. 1):

(b):

Given Data:

Channel width $= b = 4m$

Height of unstream side $= 2.9m$

Height of downstream $= 1.1 \ m$

Discharge $= 7876 \ ft^3/sec$

Required:

Discharge = ?

Downstream velocity = ?

Solution: specific energy $= E_1 = E_2$

$E_1 = E_2$

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

And as we know that

$Q = AV$ $\quad$ $\boxed{b = b_1 = b_2}$

$A_1 V_1 = A_2 V_2$

$(b_1 y_1) V_1 = (b_2 y_2) V_2$

$y_1 V_1 = y_2 V_2$

$$V_2 = \frac{y_1 V_1}{y_2}$$

$$V_2 = \frac{2.9 (V_1)}{1.1}$$

$V_2 = 2.63 V_2$ —— eq (B)

Put "V_2" value in eq - (B)

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

$$\frac{V_1^2}{2g} - \frac{6.9 V_1^2}{2g} = 1.1 - 2.9$$

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

$$V_1^2 = -\frac{1.8}{5.91}(2g)$$

$V_1 = 2.44 m/sec$

"V_1" put in eq - (B)

$V_2 = 2.63(2.44)$

$V_2 = 6.41 m/sec$

Type of flow using Froud Namber

1- Upstream side

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

$$= \frac{2.44}{\sqrt{9.81(2.9)}}$$

$Fr_1 = 0.45$

$Fr < 1$ So its sub-critical flow.

on Down Stream side

$$Fr_2 = \frac{V_2}{\sqrt{g y_2}} = \frac{6.41}{\sqrt{9.81 \times 1.1}}$$

$Fr_2 = 1.95$

$Fr > 1$ so its super-critical flow.

QNO. 2)

(a):

Data:

Discharge $= 7876\ ft^3/sec$

$$= \frac{7876}{(3.28\,m)^3}$$

Discharge $= 223.19\ m^3/sec$

Depth of channel $= 1.8\,m$

Width of channel $= 66\,ft = 20.1\,m$

Required: $P =$ weir height $= ?$

Solution: As we have

$Q = AV$

$V_1 = Q/A$

$V_1 = Q/_{b \times y}$

$$V_1 = \frac{223.19}{20.1 \times 1.8}\ m^2/sec$$

$V_1 = 6.16\ m/sec$

⇒ Critical Depth.

we have

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

As

$$q = Q/b$$

$$= \frac{223.19}{20.1}$$

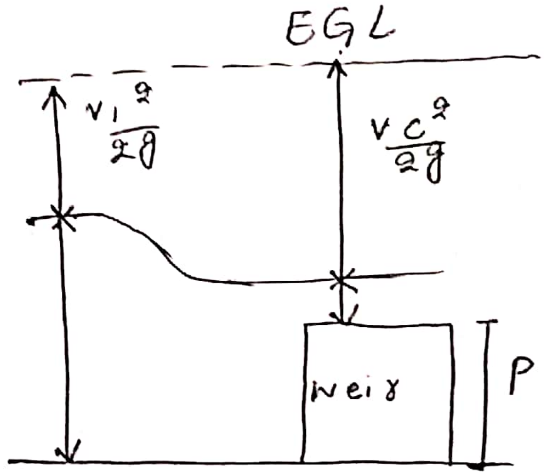
$$q = 11.1 \ m^2/sec$$

Now as we put in (A)

$$y_c = \left(\frac{(11.1)^2}{9.8} \right)^{1/3}$$

$$y_c = 2.32 \ m$$

And also we have



$$V = \sqrt{gy}$$

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

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

$$V_c = 4.77$$

By Fig:

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

$$\frac{(6.16)^2}{2(9.8)} + 1.8 = \frac{(4.77)^2}{2(9.8)} + 2.32 + P$$

$$P = 0.256 \ m$$

Q No. 2)
(b):
Given Data:

$b = 2.8\ m$

$H_1 = 5\ m$

$H_2 = 6.5m$

$H = 5.6m$

$Cd = 0.7876$

Depth $= 1.5m$

solution:

Submerged position

As we know that

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

$= 0.7876 \times 2.8(6.5 - 5.6) \times \sqrt{2(9.8)(5.6)}$

$Q_1 = 20.80\ m^3/sec$

Now Free position

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

$Q_2 = \frac{2}{3}(0.7876)(2.8\sqrt{2(9.81)})(5.6^{3/2} - 5^{3/2})$

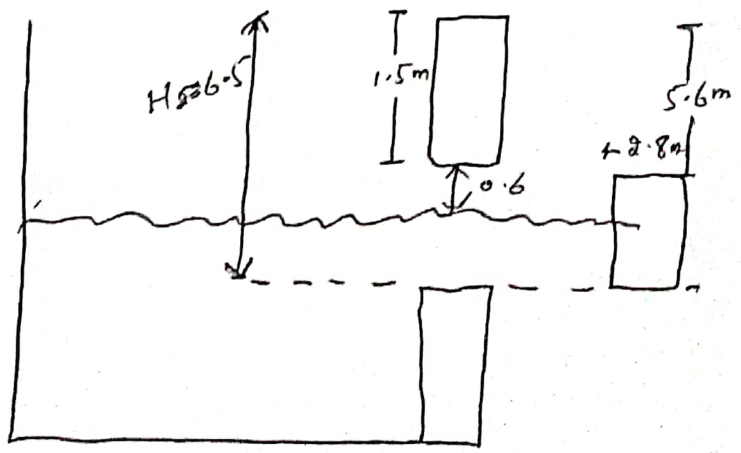
$Q_2 = 13.48\ m^3/sec$

Total discharge

$Q = Q_1 + Q_2$

$Q = 20.80 + 13.48$

$Q = 34.28\ m^3/sec$



Q No.3 (a):

Given Data:

$d_1 = R - 200\,mm$

$= 7876 - 200$

$= 7676\,mm$

$d_2 = R + 3000$

$= 7876 + 3000$

$= 10876$

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

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

$= 7876 + 800$

$= 8676\,N/m^2$

Required:

1- Loss of head due to sudden enlargment = ?

2- power Loss due to sudden enlargment?

3- power in smaller pipe = ?

Solution:

1- Head Loss due to sudden Enlargement

$d_1 = 7676\,mm$

$= 7.67\,m$

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

$= \frac{3.14}{4}(7.67)^2$

$\boxed{A_1 = 46.18\,m^2}$

$d_2 = 10876\,mm = 10.876$

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

$= \frac{3.14}{4}(10.876)^2$

$\boxed{A_2 = 92.8\,m^2}$

By Discharge

$Q = AV$

$V = Q/A$

$V_1 = Q/A_1 = \frac{0.95}{46.18}$

$\boxed{V_1 = 0.020 \ m/sec}$

Similarly

$V_2 = Q/A_2$

$= 0.95/92.8$

$V_2 = 0.010 \ m/sec$

By Formula of sudden Enlgmt

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

$he = \left(1 - \frac{46.18}{92.8}\right)^2 \times \left(\frac{(0.020 - 0.010)^2}{2(9.81)}\right)^2$

$he = (0.252)(5.096 \times 10^{-6})$

$\boxed{he = 1.284 \times 10^{-6} m}$

2- Power Loss Due to Sudden Enlargment

$P = \rho g Q he$

$= (1000)(9.81)(0.95)(1.284 \times 10^{-6})$

$\boxed{P = 0.0119 \ W}$

3- pressure In smaller pipe:

By using Bernoulli's eqn

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

$\frac{P_1}{(1000)(9.81)} + \frac{(0.020)^2}{2(9.81)} = \frac{8576}{(1000)(9.81)} + \frac{(0.010)^2}{2(9.81)} + 1.284 \times 10^{-6}$

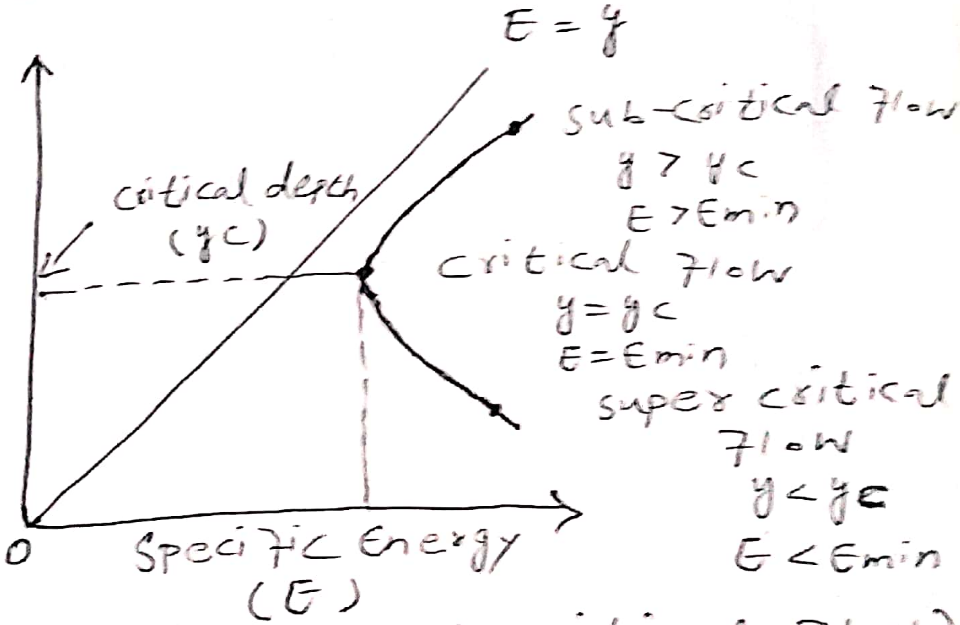
$$\frac{P_1}{9810} + 0.0000203 = 0.8844 + 0.00000509 + 0.00001984$$

$$\frac{P_1}{9810} = 0.8843$$

$$\boxed{P_1 = 8674.983\ N/m^2}$$

Q No. 3(b):

Ans: Specific Energy: The specific energy is a parameter can be used critically at the meaning of super critical and subcritical and critical flow in open channel.



$y > y_c$, $E > E_{min}$ (sub critical flow)

$y = y_c$, $E = E_{min}$ then critical flow

$y < y_c$, $E < E_{min}$ then super critical flow.