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Section: "A"

Semester: "6th"

Paper Subject: Hydraulic Engineering

Mid Exam

QNo: 1 (a)

Given Data

Discharg = 7276 lit/sec
= 7.876 m^3/sec
width of apron = 8m
Mean velocity = 7876 − 220
= 7656 ft/sec

$$= \frac{7656}{3.28} = 2334.1 \text{ m/sec}$$

Required

Height of hydraulic jump
Power absorbed due to hydralic jump

Solve:

⇒ Hight of hydralic Jump
As "q" is discharge per unit width

$$q = Q/b$$

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

$$\boxed{q = 0.9845 \text{ m}^2/\text{sec}}$$

⇒ Critical Depth (y_c)

we know that

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

$$= \left(\frac{(0.9845)^2}{9.8}\right)^{1/3}$$

$$y_c = 0.4624 \text{ m}$$

So Now

Critical velocity

we also know that

$$q = Vy$$

$$V = q/y$$

$$V_c = q/y_c$$

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

$$V_c = 2.14 \text{ m/sec}$$

Now

As $U_1 > V_c$

So it is super critical flow

P.T.O

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Water depth on upstream side:

As We Know that

$$Q = AV$$
$$Q = (by)(V)$$

$$y = Q/Vb$$

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

$$y = 0.455\ m$$

We Also Know that

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

$$y_2 = -\frac{0.455}{2} + \sqrt{\frac{(0.455)^2}{4} + \frac{2(0.455)(2.16)^2}{9.8}}$$

$$-0.225 + 0.69$$

$$y_2 = 0.466\ m$$

PTO

Difference in Depth

$$\Delta y = y_2 - y_1$$
$$= 0.466 - 0.455$$
$$\Delta y = 0.011 \text{ m}$$

And

$$\Delta E = E_1 - E_2 \quad \text{—— (A)}$$

So as we have

$$Q_1 = Q_2$$
$$A_1 V_1 = A_2 V_2$$
$$b_1 y_1 V_1 = b_2 y_2 V_2$$
$$V_2 = \frac{y_1 V_1}{y_2}$$

$$V_2 = \frac{0.455(2334.1)}{0.466} \qquad \boxed{b = b_1 = b_2}$$

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

So us 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 have

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

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

$\Delta P = (1000)(9.8)(7.876)(12968.5)$

$\Delta P = 1000971079\ W$

$\Delta P = 1000971079\ KW$

$\Delta P = 1000971.079\ KW$

QNo: 1 (b)

Problem Given data:

Channel width = b = 4m
Height of unstream side = 2.9m
Height of downstream side = 1.1 m
And
Discharge = 7876 ft³/sec

Required:

Downstream Velocity = ?

Solve.

• Specific energy is = E1 = E2

$$E_1 = E_2$$

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

And as we know that

$$Q = AV \qquad [b = b_1 = b_2]$$

$$A_1 V_1 = A_2 V_2$$

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

$$b y_1 V_1 = b y_2 V_2$$

$$y_1 V_1 = y_2 V_2$$

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

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

$$V_2 = 2.63 V_2 \text{ —— eq (B)}$$

Put the V_2 in eq-(A)

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

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

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

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

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

Taking squer root

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

$V_1 = 2.44$ 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 Number

1- Upstream Side

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

Putting

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

$Fr_1 = 0.45$

$Fr < 1$ So it is sub-critical flow

On Down stream side

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

$Fr_2 = 1.95$

As $Fr > 1$ So it is super-critical flow

Q NO: 2.(a)

Data

Discharge = 7876 ft³/sec

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

Discharge = 223.19 m³/sec

Depth of chanel = 1.8m
Width of channel = 66 ft = 20.1 m
= 20.1m

P = weir height = ?

Solve :-

As we have

$Q = AV$

$V_1 = Q/A$

$V_1 = Q/b \times y$

$V_1 = \frac{223.19 \text{ m}^3/\text{sec}}{20.1 \times 1.8}$

$V_1 = 6.16$ m/sec

⇒ Critical Depth

We have

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

As

$$q = Q/b$$

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

$$q = 11.1 \text{ m}^2/\text{sec}$$

Now as we put in (A)

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

$$y_c = 2.32 \text{ m}$$

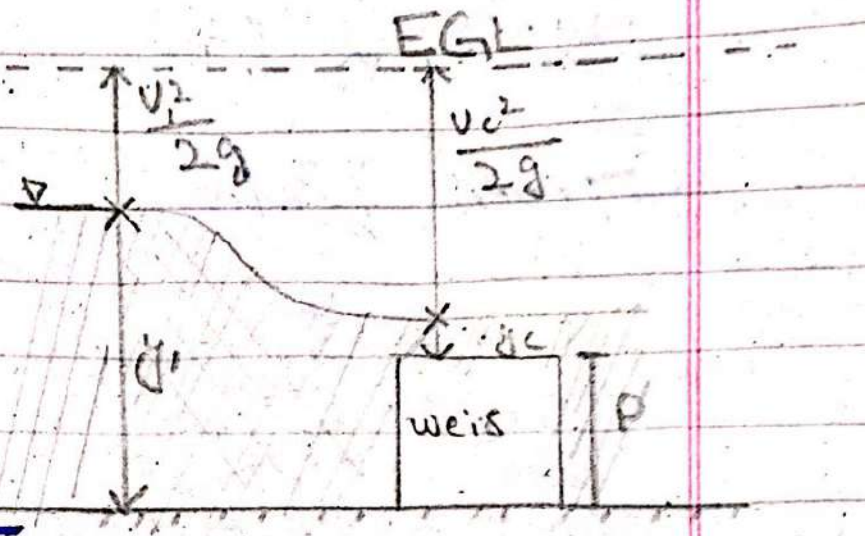
And also we have

$$V = \sqrt{gy}$$

$$V_c = \sqrt{gy_c}$$

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

$$V_c = 4.77$$



By the Fig,

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

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

$$1.936 + 1.8 = 1.159 + 2.321 + P$$

$$\boxed{P = 0.256\,m}$$

QNo: 2 (b)

Given Data

$b = 2.8 m$

$H_1 = 5 m$

$H_2 = 6.5 m$

$H = 5.6 m$

$Cd = 0.7876$

Depth = 1.5 m

Solve

Submerged Position

As we know that

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

$Q_1 = 0.7876 \times 2.8 (6.5 - 5.6) \times (\sqrt{2(9.8)(5.6)})$

$Q_1 = 20.80 m^3/sec$

Now Free Portion

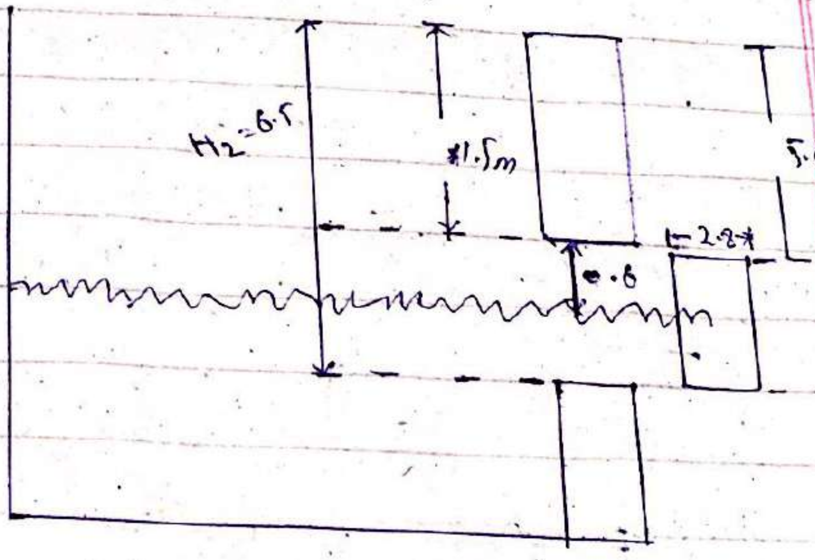
We have

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

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

$Q_2 = 13.48 m^3/sec$

P.T.O



Total discharge

$Q = Q_1 + Q_2$

$Q = 20.80 + 13.48$

$Q = 34.28\ m^3/sec$

QNo: 3 (a)

Given Data

$d_1 = R_1 - 200m$
$= 7876 - 200$
$= 7676\ mm$

$d_2 = R + 3000$
$7876 + 3000$
10876

Flow rate $= Q = 0.95\ m^3/sec$
Pressure in large pipe $= R + 800\ N/m^2$
$= 7876 + 800$
$= 8676\ N/m^2$

~~Solve~~
Required
1: Loss of head due to sudden enlargment = ?

2: Power loss due to sudden enlargmt = ?

3: Power in smaller pipe = ?

Solve:

1: Head loss due to sudden Enlarement

$d_1 = 7876\,mm$
$= 7.87\,m$

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

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

$A_1 = 46.18\,m^2$

And now

$d_2 = 10876\,mm = 10.876\,m$

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

$A_2 = \frac{3.14}{4}(10.876)^2$

$A_2 \; 92.8\,m^2$

P.T.O

By Discharge

$Q = AV$

$V = Q/A \Rightarrow V_1 = Q/A_1$

$V_1 = \frac{0.95}{46.18}$

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

Similarly

$V_2 = Q/A_2$

$= 0.95/92.8$

$\boxed{V_2 = 0.010 \text{ m/sec}}$

⇒ By Formoula of Sudden Enlgmt

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

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

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

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

2: Power loss Due To sudden Enlargment

We have formula

$P = \rho g Q h_e$

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

$\boxed{P = 0.0119\ W}$

3 Pressure in Smaller Pipe:

By using Bernoulli's equation we have

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

$$\frac{P_1}{(1000)(9.81)} + \frac{(0.020)^2}{2(9.81)} = \frac{8676}{(1000)(9.81)} + \frac{(0.010)^2}{2(9.81)} + 1.284 \times 10^{-6}$$

$$\frac{P_1}{9810} + 0.0000203 = 0.8844 + 0.00000509 + 0.000001284$$

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

$$P_1 = 0.8843(9810)$$

~~$P_1 = 8675.82\ N/m^2$~~

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

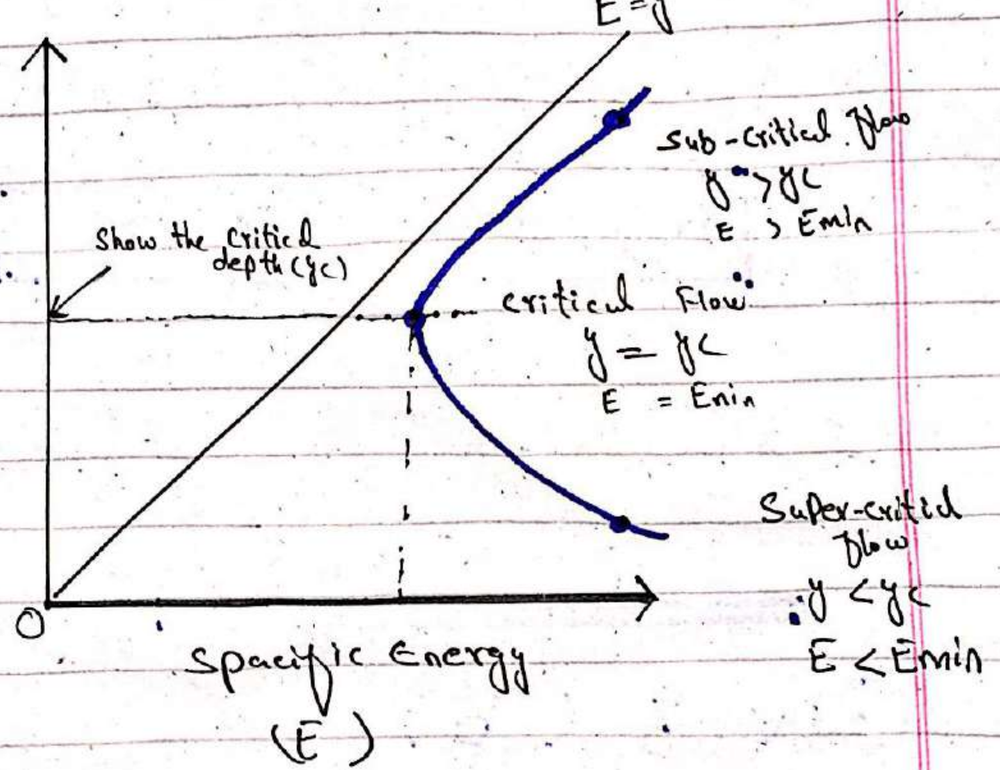
8843

Q.No 3 (b)

Defin the specific energy

The spacific energy is a parameter can be used clarity out the meaning of super critical and subcritical and critical flow in the open channel.

P.T.O



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

⇒ $y = y_c$, $E > E_{min}$ then it is Critical flow

⇒ $y < y_c$, $E < E_{min}$ then it is super critical flow