Name : Atif ali

ID # 7886

Section : B

Semester : 6th

Subject : Hydrulic engineering

Submitted to : Engr Fawad.

Q# 01
Part (A)

Given data:-

Discharge $Q = 7886$ Lit/sec

$\frac{7886}{1000} = 7.886\ m^3/sec$

Width $= b = 8m$

Mean velocity $= V = 7886 - 220$

$= \frac{7666}{3.28} = 2337.19\ m^3/sec$

Height of hydrauli Jump:-

As we know that

$q = Q/b$

$q = 7.886/8$

$q = 0.9857\ m^2/sec$

=> Critical depth:-

$y_c = \left(\frac{q^2}{g}\right)^{1/3} = \left(\frac{(0.9857)^2}{9.81}\right)^{1/3}$

$\boxed{y_c = 0.46267\ m}$

=> Critical velocity:-

As we know that

$q = Vy \Rightarrow V = q/y$

$V_c = q/y_c$

$$V_c = \frac{0.9857}{0.46267}$$

$$\boxed{V_c = 2.13046 \text{ m/sec}}$$

Depth of water on upstram side of Hydraulic Jump.

As we know that

$Q = AV \Rightarrow Q = (b \times y)V$

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

$$y_1 = \frac{7.886}{2.13046 \times 8} = \boxed{0.4598}$$

To find water depth on dow stream side by using that formular.

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

$$y_2 = \frac{0.4598}{2} + \sqrt{\frac{(0.4598)^2}{4} + \frac{2(0.4598)(2.13046)^2}{9.81}}$$

$$\boxed{y_2 = 0.92151 \text{ m}}$$

Difference in depth:-

$\Delta y = y_2 - y_1$

$\Delta y = 0.92151 - 0.4598$

$\Delta y = 0.46171\,m$

By discharge formula:-

$Q_1 = Q_2$

$A_1 V_1 = A_2 V_2$

$b y_1 . V = b y_2 . V_2 \qquad ; b = b_1 = b_2$

$V_2 = \frac{y_1 V_1}{y_2} = \frac{0.4598 \times 2337.19}{0.92151}$

$V_2 = 1166.1728\ m/sec$

Since,

$\Delta E = E_1 - E_2$

$E_1 - E_2 = \left(y_1 + \frac{V_1^2}{2g}\right) - \left(y_2 + \frac{V_2^2}{2g}\right)$

$= \left(0.4598 + \frac{(2337.19)^2}{2 \times 9.81} - \left(0.92151m + \frac{(1166.1728)^2}{2 \times 9.81}\right)\right)$

$\Delta E = 209097.3006$

Power Dissipation in Hydraulic Jump:-

As we know that

$\Delta P = \rho g Q [E_1 - E_2]$

$\Delta P = (1000)(9.810)(9.886)(209097.3006)$

$\Delta P = 2.02786031 \times 10^{10}$ Watts Ans

Q#01

Part (B) Given data:-

Channel width $= b = 4m$

Discharge $Q = 7886\ ft^3/sec$

$$Q = \frac{7886}{1000} = 7.886\ m^3/sec$$

Depth of upstream side $= 2.9m$

Depth of downstream side $= 1.1m$

Solution:-

→ Downstream Velocity:-

As from Specific energy equation specif energy remain same on both stream.

$$E_1 = E_2$$

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

Also we know that

$$Q = AV$$

$$A_1V_1 = A_2V_2$$

$$b y_1 \cdot V_1 = b y_2 \cdot V_2$$

$$y_1 V_1 = y_2 V_2$$

$$V_2 = \frac{y_1 \cdot V_1}{y_2} = \frac{2.9}{1.1} V_1$$

$$V_2 = 2.63 V_1$$

Q#2
Part (A) **Given data:-**

channel depth = 1.8m
Discharge Q = 7886 ft^3/sec
Discharge = 221.32 m^3/sec
Width of channel = 66ft

$$= \frac{66}{3.28} = 20.12m$$

Required:-

Weir height = P = ?

Solution:-

As we know that

$Q = AV$

$V = Q/A$

$$V_1 = Q/b \times y = \frac{221.32}{20.12 \times 1.8}$$

$$\boxed{V_1 = 6.11 \text{ m/sec}}$$

Critical depth:-

As we know that

$q = Q/b$

$$q = \frac{221.32}{20.12}$$

$q = 11 \text{ m}^2/\text{sec}$

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

$$y_c = \left(\frac{(11)^2}{9.81}\right)^{1/3}$$

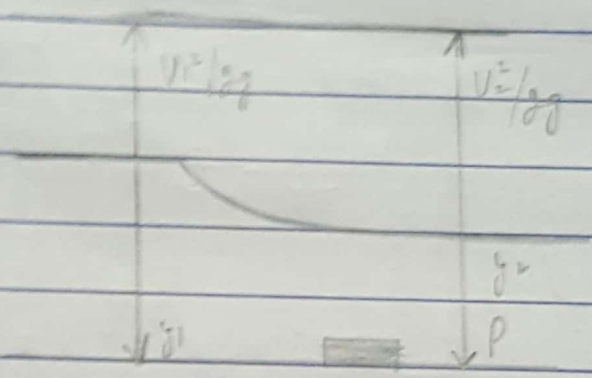
$$\boxed{y_c = 2.31m}$$

P # 06

Also, $V = \sqrt{gy}$

$V_c = \sqrt{g y_c} = \sqrt{9.81 \times 2.31}$

$V_c = 4.76$ m/sec



According to the given figure

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

$$\frac{6.11}{2 \times 9.81} + 1.8 = \frac{4.76}{2 \times 9.81} + 2.31 + P$$

$$1.902 + 1.8 = 1.1548 + 2.31 + P$$

$$\boxed{P = 0.237\,m}$$

So the weir should have height of 0.237m measured from the channel bed.

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Put the value in equ (A)

$$y_1 + \frac{V_1^2}{2g} = y_2 + \frac{V_2^2}{2g}$$

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

$$\frac{V_1^2}{2\times 9.81} - \frac{6.91\,V_1^2}{2\times 9.81} = 1.1 - 2.9$$

$$\frac{V_1^2 - 6.91\,V_1^2}{19.62} = -1.8$$

$$+5.91\,V_1^2 = +(1.8)(19.62)$$

$$\sqrt{V_1^2} = \sqrt{\frac{(1.8)(19.62)}{5.91}}$$

$$\boxed{V_1 = 2.44\ m/sec}$$

Put the value of V_1 in equ (A)

$$V_2 = 2.63\,(V_1)$$

$$V_2 = 2.63\,(2.44)$$

$$\boxed{V_2 = 6.41\ m/sec}$$

=> Type of flow on upstream side:-

By froud number

$$F_{r1} = \frac{V}{\sqrt{gy_1}} = \frac{2.44}{\sqrt{9.81 \times 2.91}}$$

$F_{r1} = 0.45$

$F_r < 1 \rightarrow$ Sub critical flow

=> Type of flow on downstream side:-

$$F_{r2} = \frac{V_2}{\sqrt{gy_2}} = \frac{6.41}{\sqrt{9.81 \times 1.1}}$$

$F_{r2} = 1.95$

$F_r > 1 \rightarrow$ Super critical flow

Q# 2

Part (B) Given data:

Breath = b = 2.8m

Depth = d = 1.5m

H_1 = 5m

H_2 = 5+1.5 = 6.5m

~~H = 5+6.5~~

H = 5+0.6 = 5.6

Cd = 0.781

Solution:-

→ Discharge through submerged portion.

By using formula

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

$Q_1 = 0.781 \times 2.8 \times (6.5 - 5.6) \times \sqrt{2(9.81)(5.6)}$

$Q_1 = 20.62$

→ Discharge through free portion:-

As we know that

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

$= 2/3(0.781) \times 2.8 \sqrt{2 \times 9.81} \times [5.6^{3/2} - 5^{3/2}]$

$Q_2 = \boxed{13.37\ m^3/sec}$

Now total discharge will be

$Q = Q_1 + Q_2$

$Q = 20.62 + 13.37$

$Q = 33.99\ m^3/se$

Q#03

Part (A) Given data:-

$d_1 = R - 200$ $d_2 = R + 3000$

$d_1 = 7886 - 200$ $d_2 = 7886 + 3000$

$d_1 = 7686mm$ $d_2 = 10886mm$

Discharge, $Q = 0.95\ m^3/sec$

Pressure in large pip $= R + 800$

$= 7886 + 800$

$= 8686\ N/m^2$

Solution:-

Headloss due to sudden Enlargment.

$d_1 = 7686\ mm = 7.686m$

$A_1 = \frac{\pi}{4} d_1^2 = \frac{\pi}{4}(7.686)^2$

$A_1 = 46.37355 m^2$

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

$A_2 = \frac{\pi}{4}(10886)^2$

$A_2 = 93026421.8$

As we know that

$Q = AV \Rightarrow V = Q/A$

$V_1 = Q/A_1 = 0.95/46.37355$

$V_1 = 0.020$

As, $V_2 = Q / A_2$

$= 0.95 / 93026492.8$

$V_2 = 1.021215244 \times 10^{-6}$

As sudden enlargment:-

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

$$h_e = \left(1 - \frac{46.37355}{93026491.8}\right) \times \left(\frac{(0.020 - 1.021215244 \times 10^{-6})}{2g}\right)$$

$h_e = 1.019315434 \times 10^{-3}$

Power loss due to sudden Englargment:-

As we know that

$P = \rho g Q h_e$

$P = (1000)(9.81)(0.95)$ [illegible] $(1.019315434 \times 10^{-3})$

$P = 9.4995$

Pressure in smaller pipe:-

Using Bernouli equation:

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

$$\frac{P_1}{1000 \times 9.81} + \frac{(0.020)^2}{2 \times 9.81} = \frac{P_2}{1000 \times 9.81} + \frac{(1.021215244 \times 10^{-6})^2}{2 \times 9.81} + 1.019315434 \times 10^{-3}$$

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$$\frac{P_1}{9810} + 0.0000203 = \frac{8686}{9810} + 5.1153299218 \times 10^{-12} + 1.019315434 \times 10^{-3}$$

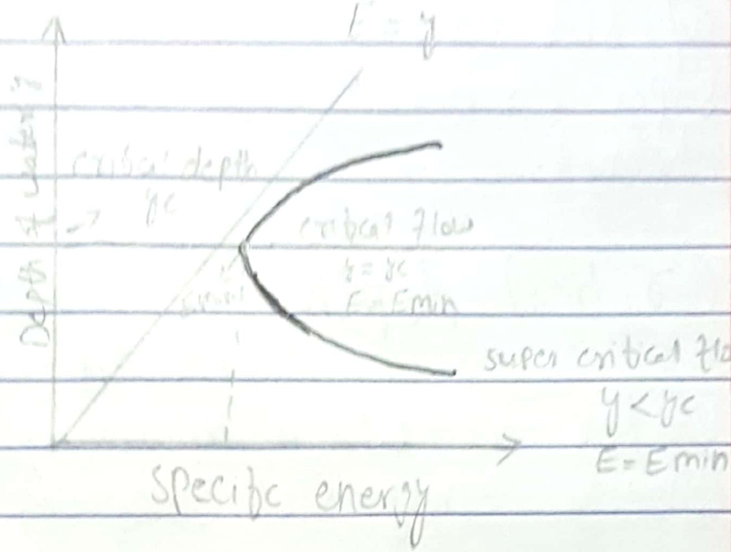
$$\frac{P_1}{9810} + 0.0000203 = 0.8864$$

$$\frac{P_1}{9810} = 0.8864 - 0.0000203$$

$$\frac{P_1}{9810} = 0.8863$$

$$\boxed{P_2 = 8695.384} \text{ Ans}$$

Q# 03
Part (B)
Ans



Black Curve:-

→ from the given figure, The black Curve is the 3-degree Polynomial curve which show the flow is critical, Sub-critical and super critical flow.

=> The Middle Point show the depth of water is equal to minimum energy so the flow is critical flow.

$y = y_c$ and $E < E_{Min}$

Specific energy:-

Specific energy is the parameter that can be used to clarify the meaning of Sub-Critical, Critical and Super-Critical flow is an open channel.

Critical depth:-

Depth of Water at which minimum Specific energy is obtained.

Equation of specific energy:-

$$(E-y)y^2 = q^2/2g \rightarrow$$

E = Specific energy
y = depth of Water
q = discharge per unit width it unit is m^2/sec

:<———————>: