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Section A (i)

Q2(a) Let suppose a rectangular channel - - - ?

Data:-

Discharge = 7786 lit/Sec = 7.786 m^3/Sec

Width of apron = 8m

mean velocity = 7786 − 220 = 7566 lit/Sec
= 2306.7 m/Sec

Req:-

Height of hydroulic jump = ?

Power absorbed due to hydraulic jump

SOLUTION:-

Height of hydraulic jump:-

As q is discharge per unit width

$q = Q/b$: $7.786/8$ => $0.97325\ m^2/Sec$

=> As critical depth is

$y_c = (q^2/g)^{1/3}$ = $\left(\frac{(0.97325)^2}{9.81}\right)^{1/3} = (0.0965)^{1/3}$

It's critical depth $(y_c) = 0.4587m$

Critical velocity :-

$q = vy$, $v = q/y$ => $V_c = q/y_c$

$v_c = 0.9732/0.4587$, $V_c = 2.1216\ m/Sec$

Water depth on Upstream Side :-

$Q = Av$, $Q = (by)v$ => $y = Q/vb$

$y_1 = Q/v_1 . b$, $y_1 = 7.786/2.1216 \times 8$

$y_1 = 0.4588$

by formula

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

$$y_2 = -\frac{0.458}{2} + \sqrt{\frac{0.458^2}{4} + \frac{2(0.458)(2.12)}{9.81}}$$

$$y_2 = -\frac{0.458}{2} + 0.68$$

$$y_2 = -0.229 + 0.68$$

$$y_2 = 0.451m$$

Difference in depth:-

$\Delta y = y_2 - y_1 \Rightarrow$ [redacted] -

$\Delta y = 0.461 - 0.458$

$\Delta y = 0.003m$

As $\Delta E = E_1 - E_2$ and Also $Q_1 = Q_2$

$A_1V_1 = A_2V_2 \Rightarrow b_1y_1v_1 = b_2y_2v_2 \Rightarrow y_1v_1 = y_2v_2$

$v_2 = y_1v_1/y_2$

$v_2 = (0.458)(2306.7)/0.461 \Rightarrow 2291.68 m/sec$

$E_1 - E_2 = \left(0.458 + \frac{2306.7^2}{2(9.81)}\right) - \left(0.461 + \frac{2291.68^2}{2(9.81)}\right)$

$E_1 - E_2 = 266043.7025 - 262590.3221 = 3453.38m$

$E_1 - E_2 = 3453.3803m$

Power dissipation of Hydraulic jump:-

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

$\Delta P = (1000)(9.81)(7.786)(3453.3803)$

$\Delta P = 263771466.5W$

$\Delta P = 263771kW$

(Part B) :- DownStream & Upstream velocity

Channel width $(b) = 4m$

Discharge $= 7786 \ ft^3/sec$

height of upstream side $= 2.9m$

hight of downstream side $= 1.1m$

Down stream velocity $= ?$

Formula + SOLUTION:-

Specific energy is $E_1 = E_2$

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

from Discharge $Q = Av$

$A_1V_1 = A_2V_2$

$b_1y_1v_1 = b_1y_2v_2$

$V_2 = y_1v_1/y_2$

$V_2 = \frac{(2.9)}{1.1} V_1 \Rightarrow V_2 = 2.63 V_1$ (Put values of "V" in "A")

$2.9 + \frac{V_1^2}{2g} = 1.1 + \frac{(2.63V_1)^2}{2g} \Rightarrow 2.9 + \frac{V_1^2}{2g} = 1.1 + \frac{6.91V_1^2}{2g}$

$\frac{V_1^2}{2g} - \frac{6.91V_1^2}{2g} = 1.1 - 2.9 \Rightarrow \frac{5.91V_1^2}{2g} = -1.8$

$5.91V_1^2 = 1.8 \times 2(10) \Rightarrow V_1 = \sqrt{\frac{1.8 \times 20}{5.91}} \Rightarrow V_1 = 2.44 m/sec$

$V_2 = 2.63(2.44) \Rightarrow 6.41 m/sec$

flow type:-

Upstream Side:-

By using Fraud Number $F_{r1} = \frac{V_1}{\sqrt{gy_1}} \Rightarrow \frac{2.44}{\sqrt{9.8 \times 2.9}}$

$F_{r1} = 0.45 \Rightarrow F_r < 1$

At upstream side the flow is subcritical.

ON DOWNSTRAM SIDE:-

$F_{r2} = \frac{V_2}{\sqrt{gy_2}} = \frac{6.41}{\sqrt{10 \times 1.1}} \Rightarrow 1.94$

$F_r > 1$ on Downstream side flow is supercritical.

Q2 What is the minimum hight...?

a) **Data:-**

Discharge = $7786 ft^3/sec \Rightarrow 220.69 m^3/sec$ :: m→ft

Depth of Channel = 1.8 m

Width of channel = 66 ft ⇒ 66/3.28 ⇒ 20.1 m

height = ?

Formula + Solution:-

As we know that $Q = AV$

$V = Q/A \Rightarrow V_1 = Q/by \Rightarrow V_1 = \frac{220.69}{20.1 \times 1.8} \Rightarrow 6.11 m$

$V_1 = 6.11 m/sec$

Critical depth:-

$y_c = \frac{q^2}{g}$

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

$y_c = \frac{220.69^2}{20.1^2 \times 10} \Rightarrow (12.05)^{1/3} \Rightarrow 2.290$

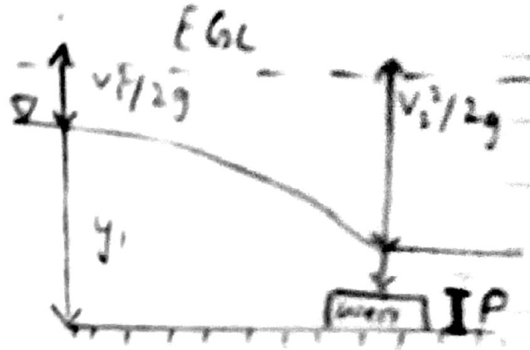
$y_c = 2.290\,m$

As $v = \sqrt{gy} \Rightarrow V_c = \sqrt{g y_c} \Rightarrow$

$V_c = \sqrt{9.81 \times 2.29} \Rightarrow \sqrt{21.56} \Rightarrow 4.645$

$V_c = 4.6\,m/sec$

$\frac{V_1^2}{2g} + y_1 = \frac{V_c^2}{2g} + y_c + P$ (from fig)



$\frac{(6.11)^2}{(2 \times 9.8)} + 1.8 = \frac{(4.6)^2}{2 \times 10} + 2.290 + P$

$3.66 = 3.348 + P$

$P = 3.66 - 3.48 = 0.18$

$P = 0.18\,m$

The weir hight is of 0.18m

Q2
(b)

Data:-

Width = 2.8m
depth = 1.5m
C_d = 0.7786
H_1 = 5 m
H_2 = 6.5 m
H = 5.6 m

Formula + Solution:-

Submerged portion

$Q_1 = C_d \times b (H_2 - H_1) \times \sqrt{2gH}$

$Q_1 = 0.7786 \times 2.8 (6.5 - 5.6) \sqrt{2(10)(5.6)}$

$Q_1 = 20.32\,m^3/sec$

Free Portion:-

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

$Q_2 = \frac{2}{3}(0.778) \times 2.8\sqrt{2(9.8)} \times [5.6^{3/2} - 5^{3/2}$

$Q_2 = 13.36 m^3/Sec$

Total discharge $Q = Q_1 + Q_2 \Rightarrow$ 20.32 [redacted] $+ 13.36$

[redacted]

$Q = 33.68 m^3/Sec$

Q3 [redacted] Part A :-

Data :-

$d_1 = R - 200mm = 7586mm$

$d_2 = R + 3000 mm = 7786 + 3000 = 10786 mm$

flow rate $Q = 0.86 m^3/sec$

Pressure in large Pipe $= R + 800 N/m^2$

$= 7786 + 800 = 8586 N/m^2$

The loss of head due sudden enlargement = ?

The pressure loss due to sudden enlargement = ?

Pressure in smaller pipe = ?

Formula & Solution:.

loss of head due to enlargement :-

$d_1 = 7.58m$, $A_1 = \pi/4 (7.58)^2 = 45.10 m^2$

$d_2 = 107.86m$, $A_2 = \pi/4 (107.86)^2 = 84.74m$

$Q = AV$, $V = Q/A$, $V_1 = Q/A_1$

$V_1 = 0.86/45.20 = 0.019 m/Sec$

Similarly, $V_2 = 0.86/84.72$

$V_2 = 0.010 m/Sec$

Formula of Sudden enlargement :-

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

$= \left(1-\frac{45.20}{84.74}\right)^2 \times \left(\frac{0.019-0.010}{2\times10}\right)^2$

$= 0.21808 \times 0.00000016$

$h_e = 3.48 \times 10^{-8}$

Power loss due to sudden enlargement:-

$P = \rho g q h_e$

$P = 1000 \times 9.81 \times (0.86)(3.48\times10^{-8})$

$P = 0.0002935 W$

Pressure in smaller Pipe :-

by using bernoulli equation

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

$\frac{P_1}{(1000)9.81} + \frac{0.019^2}{2(10)} = \frac{8586}{(1000)(9.8)} + \frac{0.010^2}{2(10)} + 0.000000034$

$\frac{P_1}{9800} + 0.000018 = 0.876 + 0.0000503$

$P_1/9800 = 0.87605 - 0.000018$

$P_1 = 0.876023 \times 9800$

$P_1 = 8585.116 \ N/m^2$

Q3 (PartB)

Define Specific energy:-

Specific Energy:-

Specific energy is a parameter that can be used to clearify the meaning of super critical, sub critical and critical flow in an open channel.

Critical depth is depth corresponding to maximum 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).

We know that

$(E-y)y^2 =$ ~~CAS~~ CAS $q^2/2g$

q and 2g constant this equation is used for specific energy plot:.