Name	ShohAB malook
id	7878
Section	A
Semester	6th
Subject	Hydraulic Engineering
Submitted	Engr. Fawad Ahmad.

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Name ShahAB Shahzook
Id 7878
Section A

Q1A

Let Suppose a rectangular channel discharges R liter/sec of water into a 8m wide apron with Zero Slop. Mean velocity is R-220 ft/sec

1) Height of hydroulic Jump (in unit of meter)
2) Power absorbed due to hydraulic Jump (in unit of kw)

Given data

Discharge = 7878 liters/sec = $7.878\ m^3/sec$

Width of apron = 8m

Mean velocity = 7878 - 220 = 7658 ft/sec

$= \frac{7658}{3.28}$

= 2334.7m/se

1) Height of hydraulic Jump:.

As "q" is discharge per unit weidth

$q = Q/b$

$= \frac{7.878}{8}$

$\boxed{q = 0.984}$

As critical depth (y_c) is

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

$= \left(\frac{(0.984)^2}{9.81}\right)^{1/3}$

$= (0.098700)^{0.3}$

$\boxed{y_c = 0.45\ cm}$

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Q1A (2)

Critical velocity

As $q = vy \Rightarrow v = q/y$

$V_c = \frac{q}{y_c} \Rightarrow V_c = \frac{0.984}{0.45}$

$V_c = 2.18\ m/sec$

As $V_1 > V_c$
Super critical flow.

Water depth on up stream side is to Hydraulic Jump.

$Q = AV$

$Q = (by) \cdot v$

$y = Q/v \cdot b \Rightarrow y_1 = \frac{Q}{v \cdot b}$

$y_1 = \frac{7.878}{2.18 \times 8}$

$\frac{7.878}{17.44}$

$y_1 = 0.45\ m$

By formula.

$$y_2 = \frac{-y_1}{2} + \sqrt{\frac{y_1^2}{4} + \frac{2 y_1 v_1^2}{g}}$$

$$= \frac{-0.45}{2} + \sqrt{\frac{(0.45)^2}{4} + \frac{2(0.45)(2.16)^2}{9.81}}$$

$$y_2 = -0.225 + \sqrt{0.050625 + 0.4280366972}$$

$$-0.225 + \sqrt{0.4782891972}$$

$y_2 = 0.46\ m$

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Q1A (3)

Difference in depths

$\Delta y = y_2 - y_1$

$y_2 = 0.46 - 0.45$

$= 0.01\ m$

As $\Delta E = E_1 - E_2$

Also $Q_1 = Q_2$

$A_1 V_1 = A_2 V_2$

$b_1 y_1 \cdot V_1 = b_2 y_2 \cdot V_2$

$b \cdot y_1 \cdot V_1 = b \cdot y_2 \cdot V_2$ $\quad b = b_1 = b_2$

$V_2 = \frac{y_1 V_1}{y_2} = \frac{0.45 \times 2334.7}{0.46}$

$V_2 = 2283.94$

=> $\Delta E = E_1 = E_2$

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

$= \left(\left(0.45 + \frac{(2334.7)^2}{2(9.81}\right) - \left(0.46 + \frac{(2283.94)^2}{2(9.81)}\right)\right)$

$= \left(0.45 + \frac{5450824.09}{19.62}\right) - \left(0.46 + \frac{5216381.92}{19.62}\right)$

$= 277820.2303 - 265871.0981$

$E_1 - E_2 = 11949.132$

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power Dissipation in hydraulic jump.

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

$$(1000)(9.81)(7.878.)(11949.132)$$

$$\Delta P = 923466919.2$$

$$\boxed{\Delta P = 923466.9192}$$

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(5)

Q1B A Sluice gate controls the flow in a channel of width 4m if the discharge is R ft^3/sec and The unstream and downstream water depth is 2.9m and 1.1m respectivel calculate the downstream velocity.

Also state the type of flow at upstream and downstream side using any equations.

Given data.

Channel width (b) = 4m.
Discharge = 7878 ft^3/sec.
height of upstream side = 2.9m.
height of downstream side = 1.1m.

1- Downstream velocity:-

As specific energy is

$$E_1 = E_2$$

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

also from Discharge.

$$Q = AV$$

$$\Rightarrow A_1 V_1 = A_2 V_2$$

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

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

$$y_1 V_1 = y_2 V_2$$

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

$$V_2 = \frac{2.9}{1.1} V_1 = \boxed{V_2 = 2.63 V_1}$$

put in eq (1)

flow.

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

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

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

$$\not- \frac{5.91V_1^2}{2g} = \not- 1.8$$

$$5.91V_1^2 = 1.8 \times 2(9.81)$$

$$V_1 = \sqrt{\frac{1.8 \times 2(9.81)}{5.91}}$$

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

put in V_2 equation

$$V_2 = 2.63(2.44)$$

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

Type of flow using froud Number on upstream Side

$$Fr_1 = \frac{V_1}{\sqrt{gy_1}} = \frac{2.44}{\sqrt{9.81 \times 2.9}} = 0.45$$

$Fr_1 < 1$ Sub critical flow out.

on Down Stream Side.

$$Fr_2 = \frac{V_2}{\sqrt{gy_2}} = \frac{6.41}{\sqrt{9.81 \times 1.1}} = 1.95$$

$Fr > 1$

Super Critical flow.

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Q2A

What is the minimum height (in unit of meter) of broad crested weir if it is to function critical depth on the crest if water flows along a rectangular channel at a depth of 1.8m with a discharg of R ft^3/sec the channel width is 66ft.

Given data.

depth of channel = 1.8m

Discharge = 7878 ft^3/sec $\frac{7878}{(3.28)^3} = 223.25 \, m^3/sec$

Width of channel = $\frac{66ft}{3.28}$ = 20.1 m

Sol:.

As $Q = AV$

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

$V_1 = \frac{223.25}{20.1 \times 1.8} = \boxed{6.17 \, m/sec}$

→ Critical Depth.

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

As $q = Q/b$ $\quad 223.25/20.1 = \boxed{11.1 \, m^2/sec}$

$$y_c = \left(\frac{(11.1)^2}{9.81}\right)^{1/3} = 2.32m$$

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

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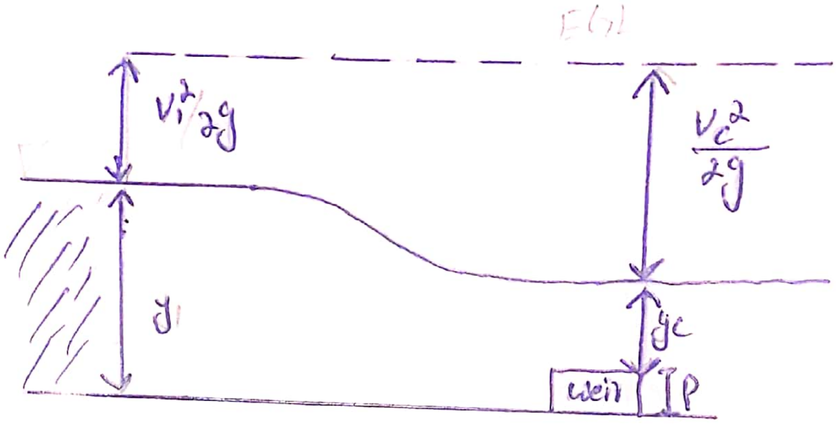
Also $V = \sqrt{gy}$

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

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

$$V_c = 4.77 \, m/sec$$

from the figure



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

$$\frac{(6.17)^2}{2 \times 9.81} + 1.8 = \frac{(4.77)^2}{2 \times 9.81} + 2.32 + P$$

$$1.940 + 1.8 = 1.159 + 2.32 + P$$

$$3.74 = 3.479 + P$$

$$P = 0.261 \, m$$

The weir should have height of 0.261m measured from the channel bed.

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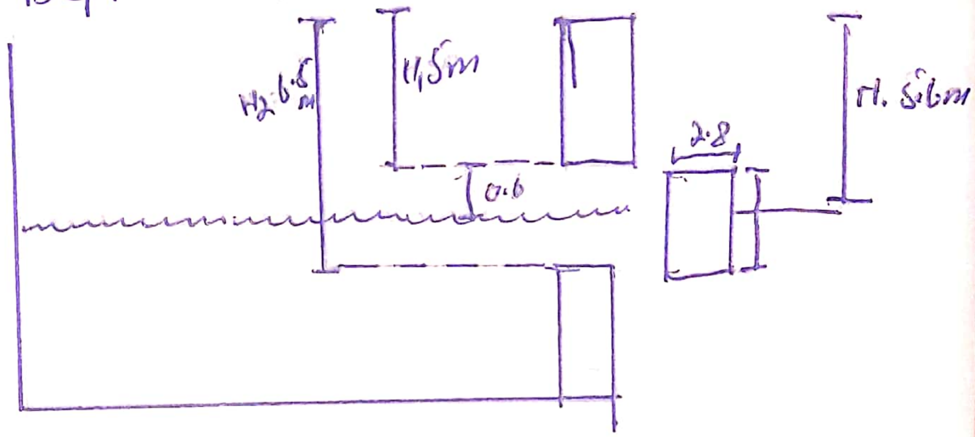
Q2B An orifice in one side of large tank is rectangular in shape 2.8m broad and 1.5m deep the water level on one side of oriffice is 5meter above its top edge. The water level on the other side of the orifice is 0.6m below its top side of the orifice edge calculate the discharge through the orifice if coefficent of discharge is cd = 0.R.

Given data.

Breath = 2.8m

Depth = 1.5m.



$H_1 = 5m$

$H_2 = 6.5$

$H = 5.6$

$cd = 0.7878$

Sol.

Submerged position.

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

$= 0.78 \times 2.8 (6.5 - 5.6) \times \sqrt{2(9.81)(5.6)}$

$Q_1 = 20.60\ m^3/sec$

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Free portion.

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

$Q_2 = 2/3 (0.78)(2.8)\sqrt{2(9.81)} \times (5.6^{3/2} - 5^{3/2})$

$0.66 \times 2.184 \times 4.42 \times 13.25 - 11.18$

$0.66 \times 2.184 \times 4.42 \times 2.07$

$Q = 13.18 \ m^3/sec$

Total $= Q_1 + Q_2$

$Q = 20.60 + 13.18$

$Q = 33.78 m^3/sec.$

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(11)

Q3A The diameter of a water pipe on suddenly enlarged from R-200m R+3000mm The rate of flow through is 0.95 m^3/sec and the pressure in the larger pipe is R+800 N/m^2
calculate::
1) The loss of Head due to sudden enlargement
2) The power Lost due to sudden enlargement.
3) The pressure in the smaller pipe (if the pipe is horizontal).

Given data.

d_1 = R - 200mm = 7878 - 200
= 7678 mm.
d_2 = R + 3000mm = 7878 + 3000
= 10878 mm.
flowrate (Q) = 0.95 m^3/sec
pressure in larger pipe = R + 800 N/m^2
7878 + 800 = 8678 N/m^2

Sol::

Loss of Head due sudden enlargment
d_1 = 7678 = 7.678 m.
$A_1 = \frac{\pi}{4}(7.678)^2$
$0.785(7.678)^2$ = **46.2 m^2**
d_2 = 10878 mm = 10.878
$A_2 = \frac{\pi}{4}(10.878)^2$
$0.785(10.878)^2$ = **92.889 m^2**

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As $Q = AU$

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

$V_1 = \frac{0.95}{46.2 m^2} = \boxed{0.020 m/sec}$

Similarly:-

$V_2 = Q/A_2$

$V_2 = \frac{0.95}{92.889} = \boxed{0.0102 m/sec}$

By formulas of sudden enlargement

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

$\left(\left(1 - \frac{46.2}{92.889}\right)\right)^2 \times \frac{(0.020 - 0.0102)^2}{2 \times 9.81}$

$0.2526 \times 4.8950 \times 10^{-6}$

$\boxed{he = 1.236 \times 10^{-6}}$

b. power Loss due to sudden enlargement

$P = \rho g Q he$

$(1000)(9.81)(0.96)(1.236 \times 10^{-6})$

$\boxed{0.011 W}$

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C pressure in the Smaller pipe By using Bernoulli's equation.

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

$$\frac{P_1}{(1000)(9.81)} + \frac{(0.020)^2}{2(9.81)} = \frac{8678}{1000(9.81)} + \frac{0.0102}{2(9.81)} + 1.236\times10^{-6}$$

$$\frac{P_1}{9810} = 2.038\times10^{-5} = 0.8846075433 + 5.19877\times10^{-4} + 1.236\times10^{-6}$$

$$\frac{P_1}{9810} = 0.885128656 3 - 2.038\times10^{-5}$$

~~$P_1 = 0.8851286563 \times 9810$~~

$$P_1 = 0.885106183 \times 9810$$

$$\boxed{P_1 = 8682.89\ N/m^2}$$

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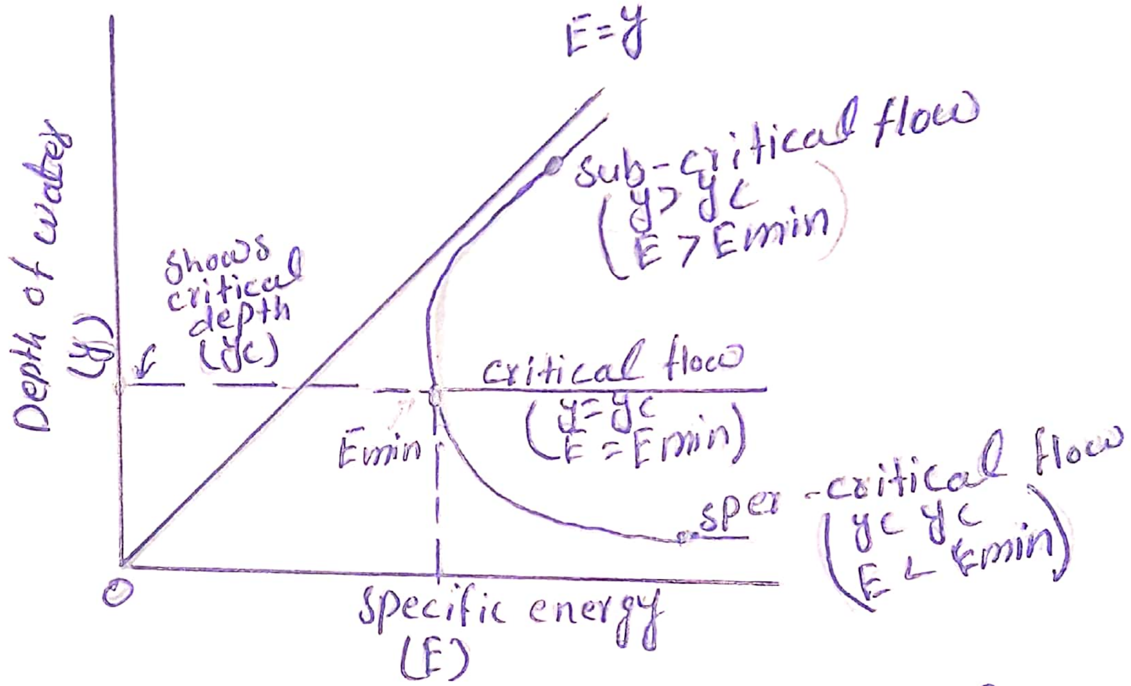
Section A.

Q3b::

define Specific energy

The Specific energy is a parameter that Can used to the crarity at the meaning of Super critical and Sub critical and critical flow in the open channel



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

↳ $y = y_c$. $E = E_{min}$ (critical flow)

↳ $y < y_c$. $E < E_{min}$ (super critical flow)