Name	M. Muqaddas Khan
ID	7787
Section	A
program	BE (civil)
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Instructor	Engr. Fawad Ahmad
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Q No # 01
(Part A)

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 calculate
1. Height of hydraulic jump (in unit meter)
2. power absorbed due to hydraulic jump (in unit KW)

Given Data:-
→ Discharge $Q = 7787$ lit/sec
$= \frac{7787}{1000} \Rightarrow 7.787\ m^3/sec$

→ Breadth $b = 8m$
→ Mean velocity $v = 7787 - 220$
$= \frac{7567\ ft/sec}{3.28}$

$\left(\frac{1 ft}{3.28} = 1m \right)$

$= 2307.012\ m/sec$

Now
1. Height of Hydraulic jump:-
As "q" Discharge per unit breadth
So we get
$q = \frac{Q}{b}$
$= \frac{7.787}{8}$
$q = 0.973\ m^2/sec$

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↳ critical depth :-
We have formula

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

$$= \left(\frac{(0.973)^2}{9.81}\right)^{1/3}$$

$$\boxed{y_c = 0.46\ m}$$

↳ Critical velocity :-
As we know that

$$q = vy$$

&

$$v = q/y$$

we can say

$$v_c = q/y_c$$

So

$$v_c = \frac{0.973}{0.46}$$

$$\boxed{v_c = 2.120\ m/sec}$$

↳ Depth of water on upstream side :-
of Hydraulic jump

→ By the same Discharge

$$Q = AV$$

Further

$$Q = (b \times y) \cdot v$$

& so

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

So

$$y_1 = \frac{7.787}{2.12 \times 8}$$

$$\boxed{y_1 = 0.46m}$$

By formula
water depth on downstream side
is

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

$$y_2 = -\frac{0.46}{2} + \sqrt{\frac{(0.46)^2}{4} + \frac{2(0.46)(2.12)^2}{9.81}}$$

$$\boxed{y_2 = 0.458m}$$

↳ Difference in Depth :-

$$\Delta y = y_2 - y_1$$

$$\boxed{\Delta y = 0.01m}$$

Also By Formula

$$Q_1 = Q_2$$

Further

$$A_1 V_1 = A_2 V_2$$

$$(b_1 \cdot y_1) \cdot v_1 = (b_2 \cdot y_2) \cdot v_2 \qquad (b_1 = b_2 = b.$$

$$y_1 \cdot v_1 = y_2 \cdot v_2$$

$$v_2 = \frac{0.46 \times 2307.012}{0.45}$$

→ $$\boxed{v_2 = 2358.27 \ m/sec}$$

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Now $\Delta E = E_1 - E_2$

So it will be

$$E_1 - E_2 = \left(y_1 + \frac{v_2^2}{2g}\right) - \left(y_2 + \frac{v_2^2}{2g}\right)$$

$$= \left(0.46 + \frac{(2307.012)^2}{2(9.81)}\right) - \left(0.45 + \frac{(2358.27)^2}{2(9.81)}\right)$$

$$= 271269.79 - 283458.01$$

$$\boxed{E_1 - E_2 = 12188.22\ m}$$

Now

Power Dissipation in Hydraulic jump:-

By using Formula

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

$$= (1000)(9.81)(7.787)(12188.22)$$

$$\Delta P = 931064110.1\ W$$

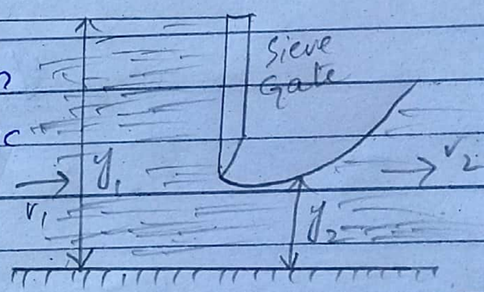
& in kW

$$\boxed{\Delta P = 931064.1101\ kW}$$

Q No #01
(Part B)

A Sluice gate control the flow in a channel of width 4m. If the discharge is R ft³/sec and the upstream and downstream water depth is 2.9m and 1.1m respectively
Calculate the downstream velocity.
Also state the type of flow at upstream and downstream side using any equation.

Given data :-



Channel width $b = 4m$

Discharge $= 7787 \ ft^3/sec$

$= \frac{7787}{(3.28m)^3}$

$= 220.67 \ m^3/sec$

Depth on upstream Side = 2.9m
Depth on downstream Side = 1.1m

Sol :→

Now at first we will find downstream velocity.

1- Downstream velocity:-

As from Specific Energy Equation, Specific Energy remain Same on both Streams So

$$E_1 = E_2$$

$$y_1 + \frac{v_1^2}{2g} = y_2 + \frac{v_2^2}{2g}$$

And from Discharge equation

$$Q = AV$$

$$\Rightarrow \quad Q = A_1 V_1 = A_2 V_2$$

Further

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

As

$$b = b_1 = b_2 \quad \text{So}$$

$$b \cdot y_1 \cdot V_1 = \not{b} \cdot y_2 \cdot V_2$$

$$y_1 V_1 = y_2 V_2$$

$$\Rightarrow \quad V_2 = V_1 y_1 / y_2$$

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

Now put the "V_2" equation in eq (1) we get

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

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

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

$$\Rightarrow \quad \frac{V_1^2}{2(9.81)} - \frac{6.91 V_1^2}{2(9.81)} = 1.1 - 2.9$$

$$\Rightarrow \quad \not{-} \frac{5.91 V_1^2}{19.62} = \not{-} 1.8$$

will get

$$\Rightarrow \quad 5.91 v_1^2 = 1.8 \times 19.62$$

$$\Rightarrow \quad v_1 = \sqrt{\frac{1.8 \times 19.62}{5.91}}$$

$$\Rightarrow \quad \boxed{v_1 = 2.44 \text{ m/sec}}$$

put this value to get v_2 in above eq

$$v_2 = 2.44(2.63)$$

$$\boxed{v_2 = 6.41 \text{ m/sec}}$$

2- Types of Flow Determination:-

↳ on upstream Side:-

By using Froud number

$$Fr_1 = \frac{v_1}{\sqrt{g y_1}} = \frac{2.44}{\sqrt{9.81 \times 2.9}} = 0.45$$

$$0.45 < 1$$

Sub-critical flow.

as $(Fr < 1)$

↳ on Downstream Side:-

using Fround number yet again

$$Fr_2 = \frac{v_2}{\sqrt{g y_2}} = \frac{6.41}{\sqrt{9.81 \times 1.1}} = 1.95$$

$$1.95 > 1$$

★ Super critical flow ★

★

Q.No 2
(part-A)

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

Given Data :-

channel Depth d = 1.8m

Discharge = 7787 ft^3/sec

$= \frac{7787}{(3.28m)^2} = \frac{2374}{(3.28m)^2}$

will get

$= 220.67\ m^3/sec$

width of the channel (b) = 66 ft

$= 66/3.28 = 20.1m$

Required:

weir height (P) = ?

Sol:-

By using discharg formula

$Q = AV$

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

or $V_1 = Q/b \times y$

$V_1 = \frac{220.67}{20.1 \times 1.8}$

$\boxed{V_1 = 6.09\ m/sec}$

Critical Depth:-

By formula

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

where $q = Q/b$

$$= \frac{220.67}{20.1}$$

$$q = 10.97 \ m^2/sec$$

So

$$y_c = \left(\frac{(10.97)^2}{9.81}\right)^{1/3}$$

$$\boxed{y_c = 2.14 m}$$

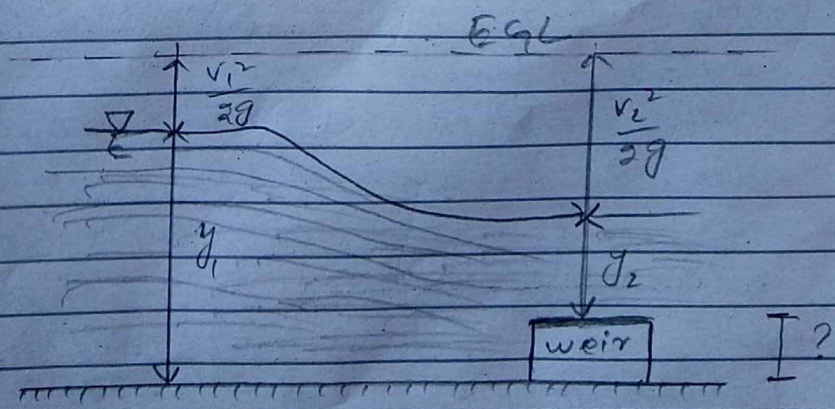
Also

$$v = \sqrt{gy}$$

$$v_c = \sqrt{gy_c}$$

$$v_c = \sqrt{9.81 \times 2.14}$$

$$\boxed{v_c = 4.58 \ m/sec}$$



According to the figure,

$$\frac{v_1^2}{2g} + y_1 = \frac{v_c^2}{2g} + y_c + P$$

$$= \frac{(6.09)^2}{2 \times 9.81} + 1.8 = \frac{(4.58)^2}{2 \times 9.81} + 2.14 + P$$

$$\Rightarrow 1.89 + 1.8 = 1.06 + P + 2.14$$

So $P = 1.89 + 1.8 - 1.06 - 2.14$

$$\boxed{P = 0.49m}$$

So the weir should be a height of 0.49 m measured from the channel bed.

Q No # 02
(part B)

An orifice in one side of large task is regularly in shape as reetanglular. 2.8m broad and 1.5m deep. The water level on one side of the orifice is 5m above its top edge. The water level on the other side of the orifice is 0.6m below its top edge. Calculate the discharge through the orifice if coefficient of Discharge is $cd = 0.7787$

Given data :-

Breadth $b = 2.8m$

Depth $(d) = 1.5m$

$H_1 = 5m$

$H_2 = 5m + 1.5m = 6.5m$

$H = 5m + 0.6m$

So $H = 5.6m$

$Cd = 0.77$

Sol. →

1 → Discharge Through Sub-merged Portion :-

By using formula

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

$= 0.77 \times 2.8 \, (6.5 - 5.6) \times \sqrt{2(9.81)(5.6)}$

$Q_1 = 20.33 \, m^3/sec$

2 - Discharge Through Free Portion.

By using formula.

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

$= \frac{2}{3}(0.77) \times (2.8)\sqrt{2 \times 9.81} \times [(5.6)^{3/2} - (5^{3/2})]$

$Q_2 = 12.99$

Now Total Discharge will be

$$Q = Q_1 + Q_2$$

$$= 20.33 + 12.99$$

$$\boxed{Q = 33.32 \ m^3/sec}$$

Q No # 03
(Part A)

The diameter of water pipe on Suddenly enlarged from R - 200 mm to R + 3000mm. The rate of flow through is 0.95 m^3/sec and the pressure in the large pipe is R + 800 N/m^2 calculate

1. The loss of head due to Sudden enlargment.
2. The power lost due to Sudden enlargment
3. The pressure in the Smaller Pipe (if the pipe is horizontal)

Given Data :-

d_1 = R - 200 mm
= 7787 - 200
= 7587 mm

d_2 = R + 3000mm
= 7787 + 3000
= 10787 mm

Flowrate $Q = 0.95\ m^3/sec$

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

$= 7787 + 800$

$= 8587\ N/m^2$

Sol:-

1- Head loss Due to Sudden Enlargment:-

As $d_1 = 7587mm$ or $7.58\ m$

So

$A_1 = \frac{\pi}{4}(d_1^2) = \frac{3.14}{4}(7.58)^2$

$A_1 = 45.10\ m^2$

And

$d_2 = 10787mm = 10.78\ m$

So

$A_2 = \frac{\pi}{4}(d_2)^2 = \frac{\pi}{4}(10.78)^2$

$A_2 = 91.22\ m^2$

By Discharge formula

$Q = AV$

$V = Q/A$

$\Rightarrow v_1 = Q/A_1 = \frac{0.95}{45.1}$

$V_1 = 0.021\ m/sec$

Similarly

$$V_2 = Q/A_2$$

$$= \frac{0.95}{91.22}$$

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

=> By Sudden enlargment formula :-

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

$$= \left(1 - \frac{45.1}{91.2}\right)^2 \times \left(\frac{(0.021 - 0.010)^2}{2 \times 9.81}\right)$$

$$= (0.255)(5.096 \times 10^{-6})$$

$$\boxed{h_e = 1.302 \times 10^{-6} \text{ m}}$$

2- Power Loss Due to Sudden Enlargment :-

By formula

$$P = \rho g Q h_e$$

$$= (1000)(9.81)(0.95)(1.302 \times 10^{-6})$$

$$\boxed{P = 0.012 \text{ W}}$$

3 - Pressure in Smaller Pipe :-

By using Bernoulli's Equation

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

So

$$\frac{P_1}{1000 \times 9.81} + \frac{(0.021)^2}{2 \times 9.81} = \frac{P_2}{1000 \times 9.81} + \frac{0.010}{2 \times 981} + h_e$$

$$\frac{P_1}{9810} + 2.03 \times 10^{-5} = \frac{7587}{9810} + 5.09 \times 10^{-5} + 1.3 \times 10^{-6}$$

$$\frac{P_1}{9810} = 0.773$$

$$P_1 = 0.773 \times 9810$$

$$\boxed{P_1 = 7587.31 \ N/m^2}$$

Q no # 3
(part B)

As we know that

Specific Energy is a parameter that can be used to clarify the meaning of Sub-Critical, Super critical and critical flow in a open channel.
So in this figure we will discuss about how it work.