QNO1:-

part A:-

given:-

Discharge = 7795 lit/sec = 7.795 m^3/sec

width of apron = 8m

mean velocity = 7795 − 220

= 7575 ft/sec

= 7575/3.28 = 2309.4 m/sec

Req:-

⇒ Height of hydraulic jump

⇒ power absorbed due to hydraulic jump

Sol:- As

Height of hydraulic Jump:-

As q is discharge per unit width

q = Q/b

= 7.795/8 = $\boxed{q = 0.974\ m^2/sec}$

⇒ As critical depth (yc) is

$y_c = (q^2/g)^{1/3} = \left(\frac{(0.974)^2}{9.81}\right)^{1/3}$

$\boxed{y_c = 0.45m}$

⇒ **critical velocity:-**

As q = vy ⇒ v = q/y

$v_c = \frac{q}{y_c}$ ⇒ $v_c = 0.974/0.45$

$\boxed{v_c = 2.16\ m/sec}$

As $u_1 > v_c \Rightarrow$ super-critical flow

water depth on upstream side:-

$Q = AV$

$Q = (by) \cdot V \Rightarrow y = Q / V \cdot b$

$\Rightarrow y_1 = Q / v_1 \cdot b$

$= 7.795 / 2.16 \times 8$

$\boxed{y_1 = 0.45}$

by formula

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

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

$$= -\frac{0.45}{2} + 0.691$$

$\boxed{y_2 = 0.466 m}$

Difference in depth:-

$\Delta y = y_2 - y_1$

$= 0.466 - 0.45 = \boxed{0.010 m}$

As

$\Delta E = E_1 - E_2$

$= \Delta y$

Also, $Q_1 = Q_2$

$A_1 V_1 = A_2 V_2$

$b_1 y_1 \cdot v_1 = b_2 \cdot y_2 \cdot v_2$ $\quad \therefore b = b_1 = b_2$

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

$$v_2 = \frac{y_1 v_1}{y_2}.$$

$$= \frac{0.45 \times 2309.4}{0.466}$$

$$\boxed{V_2 = 2230.1 \text{ m/sec}}$$

$\Delta E = E1 - E2$

$$\left(y_1 + \frac{v_1^2}{2g}\right) - \left(y_2 + \frac{v_2^2}{2g}\right)$$

$$= \left(0.45 + \frac{(2309.4)^2}{2 \times 9.81}\right) - \left(0.466 + \frac{(2230.1)^2}{2 \times 9.81}\right)$$

$$= 0.45 + 271831.2 - 0.466 + 253483.48$$

$E1 - E2 = 271831.65 - 253483.866$

$$\boxed{E1 - E2 = 18347.79}$$

=) power dissipation of hydraulic jumps–

$$\Delta P = \rho g Q (E1 - E2)$$

$$= (1000)(9.81)(7.795)(18347.79)$$

$$= 1403036236 \text{ W}$$

$$\boxed{\Delta P = 1403036\ 236 \text{ KW}}$$

part B:–

givens:–

channel width (b) = 4 m

Discharge : 7795 ft³/sec

height of upstream side = 2.9 m

height of downdownstream side = 1.1 m

Req:-

Down stream velocity = ?

Sol:-

As

specific energy is

$E_1 = E_2$

$y_1 + \frac{v_1^2}{2g} + y_2 + \frac{v_2^2}{2g} \rightarrow (1)$

Also from discharge

$Q = AV$

$A_1 v_1 = A_2 v_2$

$b_1 y_1 v_1 = b_2 y_2 \cdot v_2$ $\therefore b = b_1 = b_2$

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

$y_1 v_1 = y_2 v_2$

$v_2 = \frac{y_1 v_1}{y_2}$

$v_2 = \frac{(2.9) v_1}{1.1}$

$\boxed{v_2 = 2.63 v_1}$ put in eq (1)

$2.9 + \frac{v_1^2}{2(9.81)} = 1.1 + \frac{(2.63 v_1)^2}{2(9.81)}$

$2.9 + \frac{v_1^2}{2(9.81)} = 1.1 + \frac{6.91 v_1^2}{2(9.81)}$

$\frac{v_1^2}{2(9.81)} - \frac{6.91 v_1^2}{2(9.81)} = 1.1 - 2.9$

$\cancel{-} \frac{5.91 v_1^2}{2(9.81)} = \cancel{-} 1.8$

$5.91 v_1^2 = (1.8)(2)(9.81)$

$$v_1 = \sqrt{\frac{(1.8)2(9.81)}{5.91}}$$

$v_1 = 2.44$ m/sec

put in eq (v)

$v_2 = 2.63(2.44)$

$v_2 = 6.42$ m/sec

Type of flow using froud number—

⇒ on upstream side:—

$$Fr_1 = \frac{v_1}{\sqrt{gy_1}} = \frac{2.44}{\sqrt{9.81 \times 2.91}}$$

$= 0.45$

$Fr < 1$ sub-critical flow

⇒ on downstream side—

$$Fr_2 = \frac{v_2}{\sqrt{gy_2}} = \frac{6.42}{\sqrt{9.81 \times 1.1}}$$

$= 1.95$

$Fr > 1$

super-critical flow.

Q No 2
Part A:-
Given:-

Depth of channel = 1.8 m
Discharge 7795 ft³/sec = 7795 / $(3.28)^3$ = 220.8 m^3/sec
Width of channel = 66 ft = 20.1 m

Req:-
P = weir height = ?

Sol:- As
$Q = AV$
$V = Q/A \Rightarrow V_1 = Q_1/A$
$= Q/by$

$$V_1 = \frac{220.18}{20.1 \times 1.8} = \boxed{6.11\ m/sec}$$

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

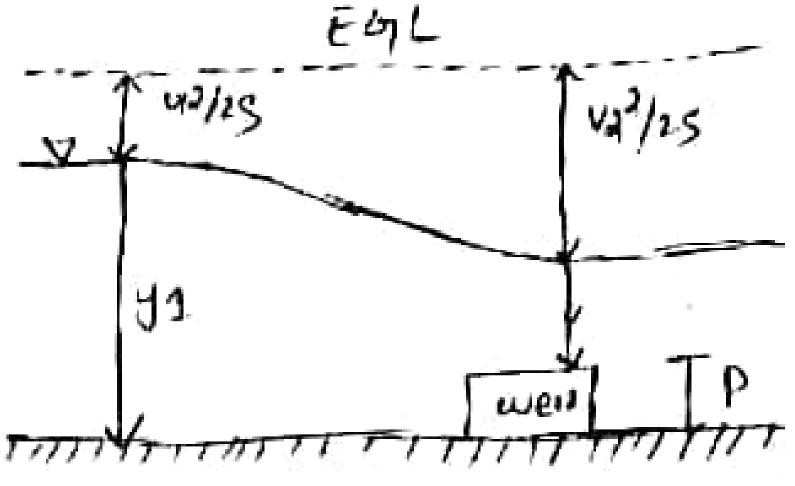
As, $q = Q/b$
$= 220.8/20.1$
$= 10.9\ m^2/sec$

$$y_c = \left(\frac{(10.9)^2}{9.81}\right)^{1/3} = \boxed{2.29 m}$$

Also $V = \sqrt{gy}$
$V_c = \sqrt{g y_c}$
$V_c = \sqrt{9.81 \times 2.29}$

$$\boxed{V_c = 4.73\ m/sec}$$

From the figure



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

$$\frac{(6.10)^2}{2\times9.81} + 1.8 = \frac{(4.73)^2}{2\times9.81} + 2.29 + P$$

$$1.89 + 1.8 = 1.14 + 2.29 + P$$

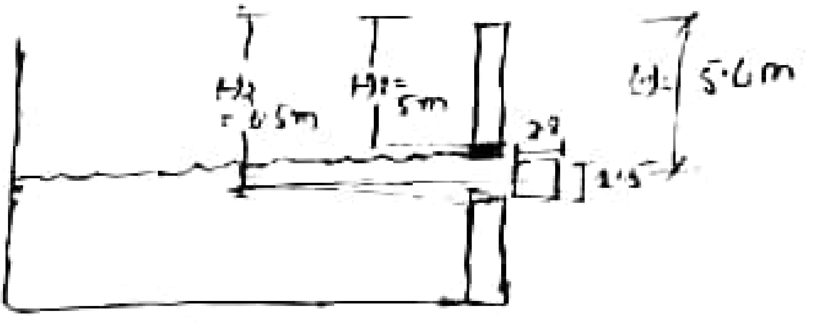
$$3.69 = 3.43 + P$$

$$\boxed{0.26m = P}$$ The weir should have height of 0.26m.

QNo 2
Part B:-
Given:-

width = 2.8m
depth = 1.5m

H1 = 5m
H2 = 6.5m
H = 5.6m
Cd = 0.7795



Sol:-
submerged portion

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

$$Q_1 = 0.7795 \times 2.8 (6.5 - 5.6) \times \sqrt{2(9.8)(5.6)}$$

$$\boxed{Q_1 = 20.53\ m^3/sec}$$

Free portion:-

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

$Q_2 = \frac{2}{3} (0.7795) \times (2.8) \sqrt{2(9.81)} \times \left[5.6^{3/2} - 5^{3/2}\right]$

$Q_2 = (1.46)(4.429)(13.25 - 11.18)$

$Q_2 = (6.466)(2.07)$

$Q_2 = 13.38 \ m^3/sec$

Total = $Q_1 + Q_2$

$Q = 20.53 + 13.38$

$Q = 33.91 \ m^3/sec$

QNO3:-

Part A:-

Given:-

$d_1 = R - 200 \ mm$
$= 7795 - 200 = 7595 \ mm$

$d_2 = R + 3000 \ mm$
$= 7795 + 3000 \ mm = 10795 \ mm$

Flow rate $(Q) = 0.95 \ m^3/sec$

pressure in large pipe
$= P + 800 \ N/m^2$
$= 7795 + 800$
$= 8595 \ N/m^2$

Req:-

⇒ The loss of head due to sudden enlargment.
⇒ The power loss due to sudden enlargment.
⇒ The pressure in the smaller pipe.

Sol:- As

⇒ loss of head due to sudden enlargment:-

⇒ $d_1 = 7595 \text{ mm} = 7.59 \text{ m}$

⇒ $A_1 = \frac{\pi}{4}(7.59)^2 = 45.22 \text{ m}^2$

⇒ $d_2 = 10795 \text{ mm} = 107.95 \text{ m}$

⇒ $\frac{\pi}{4}(107.95)^2 = 84.74 \text{ m}^2$

As, $Q = AV$

$V = Q/A$ ⇒ $V_1 = Q/A_1$

$V_1 = \frac{0.95}{45.22} = \boxed{0.021 \text{ m/sec}}$

Similarly

$V_2 = Q/A_2$

$V_2 = 0.95/84.74 = \boxed{0.011 \text{ m/sec}}$

Formula of sudden enlargment:-

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

$$= \left(1 - \frac{45.22}{84.74}\right)^2 \times \left(\frac{0.021 - 0.011}{2 \times 9.81}\right)^2$$

$= (0.217)(5.09 \times 10^{-6})$

$he = 1.106 \times 10^{-6}$ m

2. power loss due to sudden enlargment:-

$P = \rho g Q he$

$= (1000)(9.81)(0.95)(1.106 \times 10^{-6})$

$P = 0.010$ W

3) pressure in smaller pipe:-

by using bernoullis equation

$$\frac{P_1}{\rho g} + \frac{u_1^2}{2g} = \frac{P_2}{\rho g} + \frac{u_2^2}{2g} + he$$

$$\frac{P_1}{\rho g} + \frac{(0.021)}{2g} = \frac{8595}{\rho g} + \frac{(0.011)^2}{2g} + 1.106 \times 10^{-6}$$

$$\frac{P_1}{(1000)(9.81)} + 2.24 \times 10^{-5} = 0.876 + 6.16 \times 10^{-6} + 1.106 \times 10^{-6}$$

$$\frac{P_1}{9810} = 0.875$$

$P_1 = 0.875 \times 9810$

$P_1 = 8583.75$ N/m²

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QNo3

Part B:-

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 the depth corresponding to maximum specify energy.

$\Rightarrow$ $y > y_c$; $E > E_{min}$ (sub-critical flow)

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

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

we know that

$(E-y)\,y^2 = \text{cons}\ q^2/2g \rightarrow (3)$

q, and 2g constant and this equation is used to prepare a plot of specific energy.