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Sign:-

Q1 (A)

$R = 7544$



Let suppose Rectangular channel, discharges 7544 lit/s of water into 8m wide apron with zero slope mean velocity is 7324 ft/s.

Calculate

1:- Height of hydraulic Jump. (In unit of meter)

2:- Power absorbed due to hydraulic jump in unit of (KW)

## Given Data:-

We know,

$$Q = 7544 \text{ lit/s}$$

$$Q = \frac{7544}{1000} \text{ m}^3/\text{s}$$

$$\boxed{Q = 7.544 \text{ m}^3/\text{s}}$$

$$\text{Velocity, } V = 7324 \text{ ft/s}$$

$$= \frac{7324}{3.28} \text{ m/s}$$

$$V = 2232.3 \text{ m/s}$$

$$\text{Width of apron, } b = 8\text{m}$$

## Solution:-

$$Q = qb$$

$$q = \frac{Q}{b}$$

$$q = \frac{7.544}{8} = 0.943 \text{ m}^2/\text{s}$$

$$y_c = \left[\frac{q^2}{g}\right]^{\frac{1}{3}}$$

$$y_c = \left[\frac{0.943^2}{9.81}\right]^{\frac{1}{3}} = 0.449\ m$$

$$q = yv$$

$$V_c = \frac{q}{y_c}$$

$$V_c = \frac{0.943}{0.449} = 2.10\ m/s$$

Depth of water on upstream side. of Jump

As $Q = AV$

$Q = byv$

$y = \frac{Q}{bv}$

So,

$$y_1 = \frac{Q}{v_1 * b} = \frac{7.544}{2232.3 \times 8}$$

$$y_1 = 0.000422\ m$$

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

$$y_2 = -\frac{0.000422}{2} + \sqrt{\frac{0.000422^2}{4} + \frac{2 \times 0.000422 \times 2232.3^2}{9.81}}$$

$$y_2 = 20.6\ m$$

$$\Delta y = y_2 - y_1$$

$$\Delta y = 20.6 - 0.000422$$

$$\Delta y = 20.599 m$$

$$\Delta E = E_1 - E_2$$

As

$$Q_1 = Q_2$$

$$A_1 V_1 = A_2 V$$

$$b y_1 V_1 = b y_2 V_2$$

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

$$V_2 = \frac{0.000422 * 2232.3}{20.6}$$

$$\boxed{V_2 = 0.0457 \ m/s}$$

$$\Delta E = E_1 - E_2$$

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

$$= \left(0.00042 + \frac{2232.3^2}{2*9.81}\right) - \left(20.6 + \frac{0.0457^2}{2 \times 9.81}\right)$$

$$\Delta E = 253963 \ m$$

* Dissipation of Power in Hydraulic Jump.

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

$$= 1000 * 9.81 * 7.544 (253963)$$

$$\Delta p = 1.87 \times 10^{10} \, W$$

$$\Delta p = 1.8 * 10^{7} \, KW$$

QNo:1:(b) (5)

A sluice gate Controls the flow in channel of width 4m. if the discharge is 7544 C.ft/s and the upstream and downstream depth are 2.9 & 1.1m respectively.

* Calculate the downstream velocity
* Also State type of flow at upstream and downstream side use any equation.

## Given Data:-

$$Q = 7544 \ ft^3/s$$

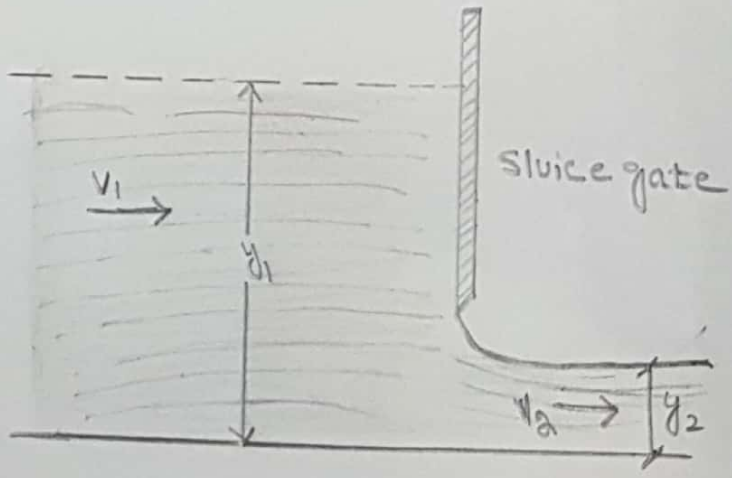
$$Q = \frac{7544}{(3.28)^3} \ m^3/s$$

$$Q = 213.62 \ m^3/s$$

width, $b = 4m$

$y_1 = 2.9m$

$y_2 = 1.1m$




## Solution:-

Specific energy at upstream and downstream is Same

$$E_1 = E_2$$

$$y_1 + \frac{V_1^2}{2g} = y_2 + \frac{V_2^2}{2g} \longrightarrow (1)$$

we know that

$$Q = A_1V_1 = A_2V_2$$

$\not{\gamma} y_1 v_1 = \not{\gamma} y_2 v_2$

$2.9 v_1 = 1.1 v_2$

$v_2 = 2.636 v_1 \longrightarrow (2)$

* Substitute value of "$v_2$" in eq (i)

$$2.9 + \frac{v_1^2}{2 \times 9.81} = 1.1 + \frac{(2.636 v_1)^2}{2 \times 9.81}$$

$$2.9 + 0.0509 v_1^2 = 1.1 + 0.354 v_1^2$$

$$0.30345 v_1^2 = 1.8$$

$v_1 = 2.4367\ m/s$ put in "2"

$$v_2 = 2.4367 * 2.636$$

$v_2 = 6.423\ m/s$

* To find flow type use froud no.

$$F_{r_1} = \frac{v_1}{\sqrt{g y_1}} = \frac{2.4367}{\sqrt{9.81 * 2.9}}$$

$\boxed{F_{r_1} = 0.456}$ flow at upstream side is sub-critical.

$$Fr_2 = \frac{V_2}{\sqrt{g y_2}}$$

$$Fr_2 = \frac{6.423}{\sqrt{1.1 \times 9.81}}$$

$$\boxed{Fr_2 = 1.955}$$

* flow at down stream is super-critical

Q2 What is the minimum heigh (in unit of meter) of broad crested weir, if it is to function (8)
(a) Critical depth on the crest if water flow along a rectangular channel at depth of 1.8 with a discharge of 7544 ft³/s. The channel width is 66 ft.

**Given Data:-**

$$Q = 7544 \ ft^3/s$$

$$Q = \frac{7544}{(3.28)^3} = 213.6 \ m^3/s$$

$$b = 66 ft = \frac{66}{3.28} \ m$$

$$b = 20.12 m$$

$$depth, \ y = 1.8 m$$

**Solution:-**

$$V_1 = \frac{Q}{A} = \frac{Q}{by}$$

$$V_1 = \frac{213.6}{1.8 \times 20.2} = 5.89 \ m/s$$

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

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

$$y_c = \left(\frac{213.6^2}{20.12^2 * 9.81}\right)^{\frac{1}{3}} = 2.256 m$$

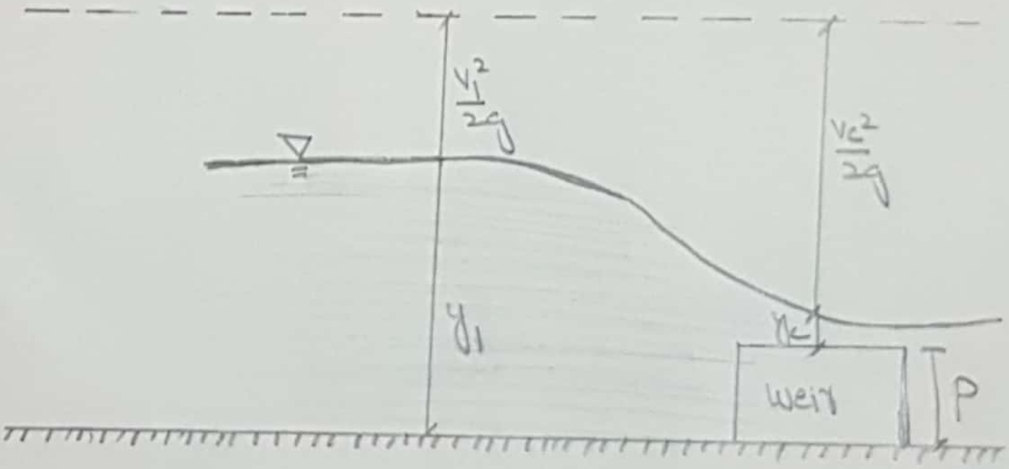
Also,

$$V = \sqrt{gy}$$

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

$$V_c = \sqrt{9.81 * 2.256}$$

$$\boxed{V_c = 4.70 \text{ m/s}}$$




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

$$\frac{5.89^2}{2 \times 9.81} + 1.8 = \frac{4.70^2}{2 \times 9.81} + 2.256 + P$$

$$3.568 = 3.381 + P$$

$$\boxed{P = 0.186 \text{m}}$$

Thus the weir should have height of 0.186m from bed level.

Q2 :- (b) 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 orific 5m above its top edge. The water level one other side of orifice is 0.6m below its top edge. Calculate discharge through orifice if Cd = 0.7544. (10)

**Given:-**

$b = 2.8m$

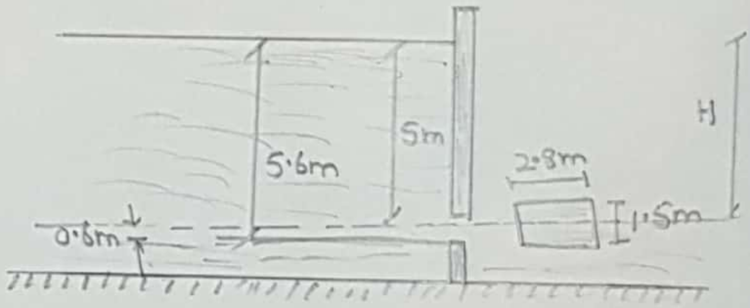
$d = 1.5m$

$H_1 = 5m$

$H_2 = 5 + 1.5 = 6.5m$

$H = 5 + 0.6 = 5.6m$

$Cd = 0.7544$




**Solution:-**

Discharge through Submerge portion

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

$$= 0.7544 * 2.8\,(6.5 - 5.6) * \sqrt{2 * 9.8 * 5.6}$$

$$\boxed{Q_1 = 19.92\ m^3/s}$$

* Discharge through free portion

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

$$Q_2 = \frac{2}{3} * 0.7544 * 2.8\sqrt{2*9.81*} \left[5.6^{3/2} - 5^{3/2}\right]$$

$$\boxed{Q_2 = 12.92 \ m^3/s}$$

Total discharge

$$Q = Q_1 + Q_2$$

$$Q = 19.92 + 12.92$$

$$Q = 32.84 \ m^3/s$$

Q3 (A) The diameter of water pipe is suddenly enlarge from (7544−200) = 7344 mm to (7544+3000) = 10544 mm. The rate of flow through is 0.95 $m^3/s$ and pressure in larger pipe is (7544+800) = 8344 $N/m^2$ (12)

Calculate :-

* The loss of head due sudden enlargement
* Power loss due to sudden enlargement
* The pressure in smaller pipe if the pipe in horizental.

**Given :-**

$P_2 = 8344\ N/m^2$

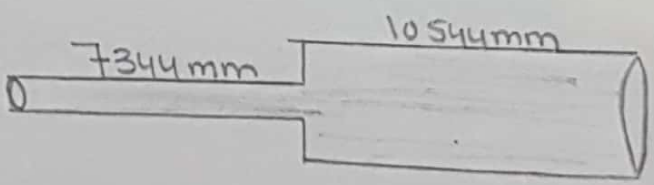
$d_1 = 7344\ mm = 7.344\ m$

$A_1 = \frac{\pi}{4}(7.344)^2 = 42.338\ m^2$

$d_2 = 10544\ mm = 10.544\ m$

$A_2 = \frac{\pi}{4}(10.544)^2 = 87.27\ m^2$

$Q = 0.95\ m^3/s$




**Solution:-**

$Q = AV$

$V_1 = \frac{Q}{A_1} = \frac{0.95}{42.33}$

$\boxed{V_1 = 0.022\ m/s}$

$$V_2 = \frac{Q}{A_2} = \frac{0.95}{87.27}$$

$$\boxed{V_2 = 0.0108\ m/s}$$

(a) head loss due to sudden enlargement

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

$$h_e = \left[1 - \frac{42.33}{87.27}\right]^2 \frac{(0.022 - 0.0108)^2}{2 \times 9.81}$$

$$\boxed{h_e = 1.695 * 10^{-6}\ m}$$

(b) power loss due to sudden enlargement.

$$P = \rho g Q h_e$$

$$P = 1000 * 9.81 * 0.95 * 1.695 * 10^{-6}$$

$$\boxed{P = 0.0157\ W}$$

(c) pressure in large pipe when $P = 8344$ in smaller pipe.

* Pipe in horizontal

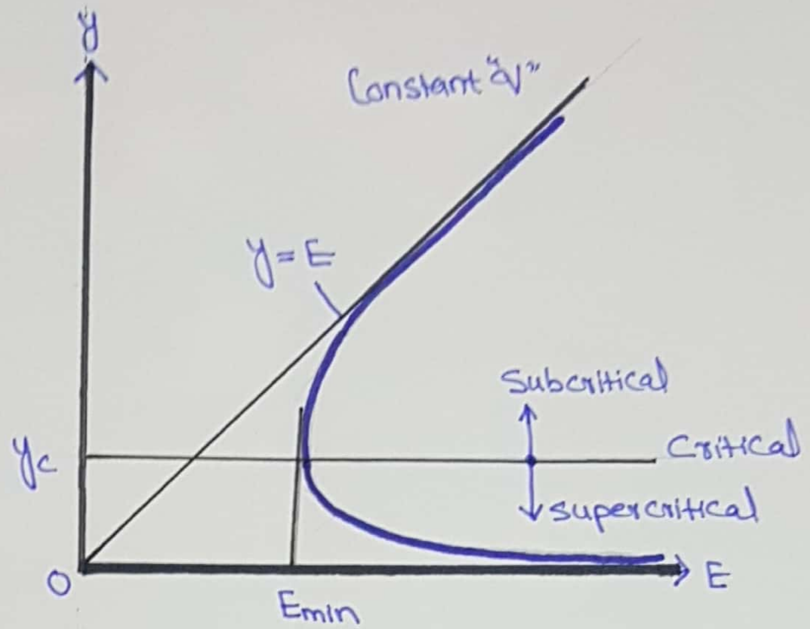
use Bernouli's theorm

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

$$\frac{P_1}{1000\times9.81} = \left[\frac{8344}{1000\times9.81} + \frac{0.0108^2}{2\times9.81} + 1.695\times10^{-6}\right] - \left[\frac{0.022^2}{2\times9.81}\right]$$

$$\boxed{P_1 = 8343\ N/m^2}$$

Q (3) B:-




(i) What does blue curve indicates. How it is obtained. Explain the above figure from each and every point of view.

**Answer:-**

* This diagram is called specific energy diagram or more precisely we can call it as E-y diagram

* Its a plot between specific energy vs height of water and keeping discharge per unit width (q) as constant.

* The blue line on the curve classify three 3 types of flow. i-e sub-critical, critical and super critical referring to E and y.

* First of all we locate a point where flow is critical i.e depth of water is critical depth ($y_c$) and energy is minimum ($E_{min}$)

* for rectangular channel

$$y_c = (q^2/g)^{1/3}$$

and $$E_{min} = \frac{3}{2} y_c$$

* After locating this point, its upper limb is subcritical flow and lower limb is super critical flow.

* for subcritical flow the velocity goes on decreasing and height goes on increasing and vice-versa for super critical flow.

* For each value of specific energy (E) we have 2-depths called as "alternate depth"

* for super critical flow we have to choose the depth with froud no. greather than 1 i.e $Fr > 1$ and for sub-critical flow, depth with froud no. less than 1 i.e $Fr < 1$ and for critical flow only one depth i.e $y_c$ as already discussed and for that $Fr = 1$ and

$$Fr = \frac{V}{\sqrt{gy}}$$

* Thus this Curve Classify the 3- types of flows with respect to specific energy and depth of flow.