Name:- Mulhaar
ID:- 7789
Section:- A
Semester:- 6th.
Hydraulic engineering.

ASSIGNMENT(I)

1) Venture Flume:-

The term flume is applied to devices in which the flow is locally accelerated due to

- ↳ A streamlined lateral contraction in channel sides.
- ↳ The combination of the lateral contraction, together with a streamlined hump in the invert (channel bed)

⇒ A venture flume is a critical flow open flume with a constricted flow which causes a drop in the hydraulic grade line, creating a critical depth.

⇒ Venture flumes are used in open-channels for the measurement of very large flow rates, usually given in millions of cubic units.

⇒ For measurement of discharge with venturi flumes, two measurements are required, which are one upstream and one at the throat, if the flow passes in a sub-critical state through the flumes.

⇒ To ensure the occurances of critical depth at the throat, the flumes are usually designed in such away as to form a hydraulic jump on the down-stream side of the structure. These are called standing wave flumes.

Question No:-2

Given Data:-

width of channel $(b) = 3m$

$Q = 12 m^3/sec$

Solution:-

1. Critical Depth :-

$q = Q/b = 12/3$ $\boxed{q = 4 m^2/sec}$

Also, the critical depth for rectangular channel is given by;

$$y_c = (q^2/g)^{1/3} = \left(\frac{(4)^2}{9.81}\right)^{1/3} \Rightarrow \boxed{y_c = 1.177m}$$

2. The minimum specific energy :-

$Q = A \cdot V$ — ①

$Q = q \cdot b$ — ②

But equating the above 2 equations.

$Q = Q$

$A \cdot V = q \cdot b$

$\cancel{b} y \cdot V = \cancel{b} \cdot q$

$q = y \cdot V \Rightarrow \boxed{V = q/y_c}$

putting values in equation.

$V = 4/1.177 \Rightarrow \boxed{V = 3.398 m/sec}$

As we know that;

$$y = y_c \;, \; V = V_c$$

Hence;

$$E_{min} = y_c + \frac{(V_c)^2}{2g}$$

$$= 1.177 + \frac{(3.398)^2}{2(9.81)}$$

$$\boxed{E_{min} = 1.76m}$$

3. Then Alternate Depth when E = 4m :

We know that,

$$E = y + \frac{V^2}{2g} \Rightarrow E = y + \frac{Q^2/A^2}{2g}$$

$$E = y + \frac{Q^2}{2g \cdot A^2} \Rightarrow E = y + \frac{Q^2}{2g \cdot B^2 y^2} = y + \frac{q^2}{2g \cdot y^2}$$

putting values;

$$E = y + \frac{(4)^2}{2(9.81) \times y^2} \Rightarrow 4 = y + \frac{(4)^2}{2(9.81)} \times \frac{1}{y^2}$$

$$y = 4 - \frac{16}{19.62} \times \frac{1}{y^2} \Rightarrow y = 4 - 0.815 \times \frac{1}{y^2}$$

$$\boxed{y = 4 - \frac{0.815}{y^2}}$$

From iteration at $y = 4m$ we get;

$$y = 3.948m \simeq \boxed{3.95m.}$$

=> From the super-critical solution, the 2nd term associated with k.E dominates.

So, rearrange as;

$$\sqrt{y^2} = \sqrt{\frac{0.815}{4-y}}$$

$$y = \sqrt{\frac{0.815}{4-y}}$$

From iteration at $y = 4m$. we get;

$y = 0.4814m \approx 0.482m$

Hence alternate depth are

3.95m and 0.482m

ASSIGNMENT (2) :- Q1

1) Given Data :-

Depth of water (d) = 10cm = 0.1m

Velocity, V = 6m/sec

Solution :-

Using Froud Number.

$$Fr = \frac{V}{\sqrt{gy}} \Rightarrow \frac{6}{\sqrt{9.81 \times 0.1}} \quad \boxed{Fr = 6.06}$$

As $Fr > 1$

$6.06 > 1 \rightarrow$ The flow is super-critical.

Now for alternate depth.

Using specific energy formula

$$E = y + \frac{V^2}{2g} = 0.1 + \frac{(6)^2}{2(9.81)}$$

$$\boxed{E = 1.9348}$$

So; E = 1.9348 yeild the depth y = 1.93m.

Q-2

Given Data:-

velocity, $v = 2m/sec$
water depth $(y) = 3m$
Change in bottom elevation $= 60cm = 0.6m$.
Gradual downward step $= 15cm$.

Solution:-

We know that;

$$E_1 = y_1 + \frac{v_1^2}{2g} = 3 + \frac{(2)^2}{2(9.81)} = \boxed{3.20m}$$

For downward step.

$$E_2 = E_1 - \Delta Z$$
$$= 3.20 - 0.60$$
$$\boxed{E_2 = 2.60m}$$

Now By using formula.

$$E_2 = y_2 + \frac{(v_2)^2}{2g}$$

$$E_2 = y_2 + \frac{(Q/A)^2}{2g} \Rightarrow E_2 = y_2 + \frac{Q^2}{2g \cdot A^2}$$

$$E_2 = y_2 + \frac{Q^2}{2g \cdot B^2 \cdot y^2} = y_2 + \frac{q^2}{2g \cdot y^2}$$

Now putting values

$$E_2 = y_2 + \frac{q^2}{2g \cdot y^2}$$

$$\left(\because q = vy \quad q = 2 \times 3 = 6\,m^2/sec \right)$$

$$2.60 = y_2 + \frac{(6)^2}{2(9.81)(y_2)^2}$$

$$\boxed{y_2 = 2.34m}$$

Hence, change in depths;

$$\Delta y = y_2 - y_1$$
$$= 2.34 - 3$$
$$\boxed{\Delta y = 0.76m}$$

So, the change in upset $= 0.76 - 0.6$
$= 0.16$

Hence water surface drops 0.16m.

=> Now for downward step,

$$E_2 = E_1 - \Delta Z$$
$$= 3.20 - (-0.15) \quad \text{(-ive sign of 0.15 due to downward direction).}$$
$$\boxed{E_2 = 3.35m}$$

Also from above formula.

$$E_2 = y_2 + \frac{q^2}{2g \cdot (y_2)^2} \Rightarrow 3.35 = y_2 + \frac{(6)^2}{2(9.81) \times y_2^2}$$

$$\boxed{y_2 = 3.17m}$$

So, $\Delta y = 3.17 - 3 = \boxed{0.17m}$

Also the water in downstep $= 0.15 - 0.17 = \boxed{0.02}$

Hence water rises to 0.02m.

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Now, the maximum upstep possible before affecting upstream water lesser is for

$$y_2 = y_c$$

Hence;

$$y_c = \sqrt[3]{\frac{q^2}{g}}$$

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

$$y_c = \left(\frac{(6)^2}{9.81}\right)^{1/3}$$

$$\boxed{y_c = 1.54m}$$

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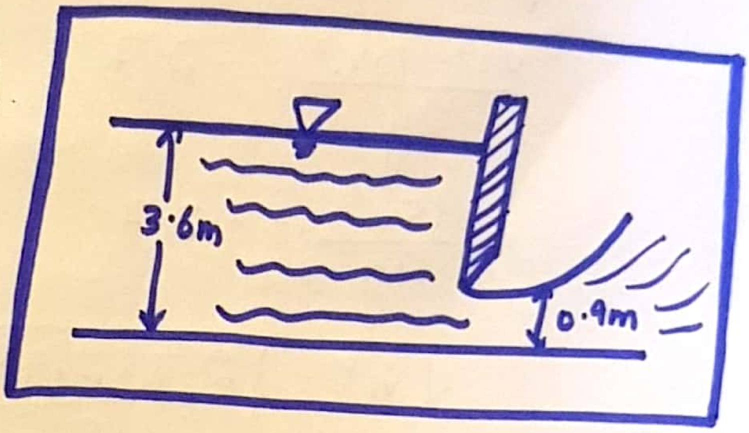
Assignment(III):-

Given Data:-

Water depth on upstream side(y_1) = 3.6m
Water depth at downstream side(y_2) = 0.9m.
Width of sluice gate (b) = 3.9m

Solution:-

As we know that.



$$E_1 = E_2$$

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

Also, by discharge formula;

$$Q = A_1V_1 = A_2V_2$$

$$b_1y_1V_1 = b_2y_2V_2 \qquad \therefore \boxed{b = b_1 = b_2}$$

$$\cancel{b}y_1V_1 = \cancel{b}y_2V_2$$

$$y_1V_1 = y_2V_2$$

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

$$= \frac{3.6}{0.9} \times V_1$$

$$\boxed{V_2 = 4V_1} \quad \text{—(2)}$$

putting values in eq (1).

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

$$3.6 + \frac{V_1^2}{2g} = 0.9 + \frac{(4V_1)^2}{2g}$$

$$3.6 + \frac{V_1^2}{2g} = 0.9 + \frac{16V_1^2}{2g}$$

$$\frac{V_1^2}{2g} - \frac{16V_1^2}{2g} = 0.9 - 3.6$$

$$\frac{V_1^2 - 16V_1^2}{2g} = -2.7$$

$$\frac{\cancel{-}15V_1^2}{2g} = \cancel{-}2.7$$

$$\sqrt{V_1^{\cancel{2}}} = \sqrt{\frac{2.7 \times 2(9.8)}{15}}$$

$$\boxed{V_1 = 1.879 m/sec}$$

putting value of V_1 in eq (2)

$$V_2 = 4V_1$$

$$V_2 = 4(1.879)$$

$$\boxed{V_2 = 7.516 m/sec}$$

Also;

$$Q_1 = A_1 V_1$$

$$= b y_1 V_1 = 3.9 \times 3.6 \times 1.879$$

$$\boxed{Q_1 = 26.38 m^3/sec}$$

$Q = Q_1 = Q_2 = 26.38 m/sec$

Now;

Froud no. on upstream side:-

$$Fr_1 = \frac{V_1}{\sqrt{gy_1}} = \frac{1.879}{\sqrt{9.81 \times 3.6}}$$

$$\boxed{Fr_1 = 0.31}$$

As $Fr_1 < 1$

$0.31 < 1 \rightarrow$ subcritical flow.

Froud no. on downstream side:-

$$Fr_2 = \frac{V_2}{\sqrt{gy_2}} = \frac{7.516}{\sqrt{9.81 \times 0.9}}$$

$$\boxed{Fr_2 = 2.52}$$

As $Fr_2 > 1$

$2.52 > 1 \rightarrow$ supercritical flow.

$\longleftrightarrow$

End!