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Section :- "B"

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Assignment :- Hydraulic Engineering

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Assignment 1

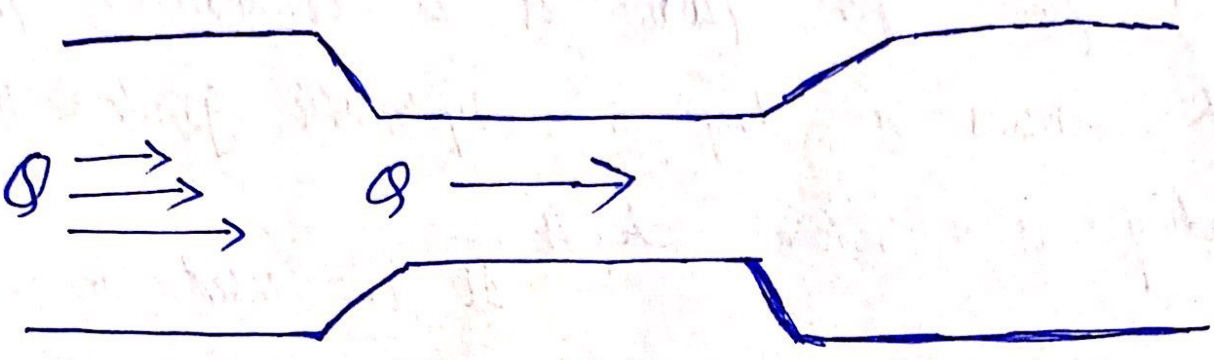
QNo1:- what is venture flume? Explain with details?

Ans:- **Venturi Flume:-**

A venturi flume is a critical flow open flume is a constricted flow which causes a drop in dydraulic grade line, creating a critical depth. It is used in flow measurement of very large flow rate, usally gives in million of cubic unit. A venturi meter would normally measurement in millimeters. whereas a venturi flume measure in meters.

Measurement of discharge with venturi flume require two measurement, one upstream and one at a throat. if flow passes in a sub-critical state through flume. if flume are designed so as to pass flow from sub-critical to sub-critical state. while passing through flume a single measurement at thraat is sufficient for computation of discharge.

To ensure occurance of critical depth at throat Flume are usally design in such a way to forms a hydraulic pump on down stream side of structure. These Flumes are called "standing wave Flumes". It causes drop in hydraulic gradeline.



Flow through a Venturi Flume.

Q No 2: A 3m wide Channel Carries a total discharge of $12 m^3/sec$

Calculate
i) Critical Depth
ii) Minimum specific Energy
iii) Alternate depth when E-4m.

Given data:-

width of Channel (b) = 3m

Discharge Q = $12 m^3/sec$

Required:-
(a) critical Depth
(b) minimum specific Energy
(c) Alternate depth when E=4m

Sol:-

Critical Depth

As $q = Q/b$

$q = 12/3$

$q = 4 m^2/sec$

using Formula

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

$$= \left(\frac{(4^2)}{9.81}\right)^{1/3} = 1.77m$$

(b) **The Minimum Specific Energy:-**

$$Q = Av \rightarrow Eq (1)$$

and $Q = qb \rightarrow (2)$

Equation (1) and (2)

$$Q = Q$$

$$Av = qb$$

$$byv = qb$$

$$vy = q$$

$$v = q/y_c$$

$$v = \frac{4}{1.177} = 3.398 m/sec$$

$$E_{min} = y + \frac{v^2}{2g}$$

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

$$E_{min} = 1.76m$$

(c) **The alternate depth when E = 4m :-**

As $E > E_c$, there are two possible depth for a given specific energy.

$E = h + \frac{v^2}{2g}$ where $v = \frac{Q}{A} = \frac{q}{h}$ (for rectangular channel)

$E = h + \frac{q^2}{2gh^2}$

Substituting values in meter - Second unit.

$4 = h + 0.8155/h^2$

For the sub-critical (slow, deep) solution, the first term associated with potential Energy dominates, so rearrange as

$h = 4 - \frac{0.8155}{h^2}$

Iteration from h=4 gives $h = 3.948m$

From the Sub-critical (fast, shallow) solution the second term associated with kinetic energy dominates so rearrange as

$h = \sqrt{\frac{0.8155}{4-h}}$

Iteration from $h=0$ gives $h = 0.4814m$

Alternate depth are 3.95 and

0.481

Prob # 01 :- water flow at depth of 10cm wide velocity of 6m/s in rectangular Channel. Is flow Critical or sub critical? what is its alternate depth?

Given data :-

Depth = 10cm

velocity = 6 m/s

Required :-

Types of flow

Alternate Depth

Solution :-

~~Fast~~ First we have to check Froude Number

$$Fr = \frac{V}{\sqrt{gy}} = \frac{6m/s}{\sqrt{9.81m/s^2 \times 0.1}}$$

$$= 6.06 > 1.$$

So flow is Super critical.

Alternate Depth :- As we know

$$E = y + \frac{V^2}{2g}$$

$$= 0.1 + \frac{6^2}{2 \times 9.81} = 1.935m$$

The alternate depth for E - 1.935m yields $y_{alt} = 1.93m$

Assignment 2

Prob # 02:-

Water flow with a velocity of 2m/s and depth of 3m .... 100 sec?

Given data:-

Velocity = 2m/s
Depth = 3m
Down step = 15cm = 0.15m
elevation = 60cm = 0.6m

Required:-

Depth and elevation changes
Max size of upstep.

Solution:-

As we know

$$E_1 = y_1 + \frac{V_1^2}{2g}$$

$$= 3 + \frac{2^2}{2 \times 9.81}$$

$$E_1 = 3.20m$$

Now

$$E_2 = E_1 - \Delta z = 3.20m - 0.60m = 2.60m$$

Also

$$E_y = y_2 + \frac{q^2}{2gy_2^2} = \frac{y^2 + (6m^3/s)^2}{2.981\,m/s^2 \cdot y_2^2} = 2.60m$$

So $y_2 = 2.24m$, $\Delta y = y_2 - y_1 = -0.76m$ so water surface drops 0.16m

For a downward step of 15cm we have :-

$E_2 = E_1 - \Delta z = 3.20m - (-0.15) = 3.35m.$

Giving $y_2 = 3.17$ and $\Delta y = y_2 - y_1 = 0.17m$ so water surface rises 0.02m

The maximum up step possible before affecting upstream water surface level is for

$$y_2 = y_c$$

$$y_c = \sqrt[3]{\frac{q^2}{g}} = \sqrt[3]{\frac{6^2}{9.18}}$$

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

Problem:-

A water Passing from Slice gate in Dam.
----- 3.9m

Determine
(a) Discharge
(b) Froud number upstream And Downstream.

Given data:-

Depth of upstream side $y_1 = 3.6m$
Depth of DownsFream Side $y_2 = 0.9m$
width of Slice gate $\Rightarrow b = 3.9m$

Required:-

Discharge
Froud number upstream & downstream.

Solution:-

As we Know that

$$E_1 = E_2$$

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

Also

$$Q = A_1 v_1 = A_2 v_2$$

$$b_1 y_1 v_1 = b_2 y_2 v_2$$

$$y_1 v_1 = y_2 v_2$$

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

$$v_2 = \frac{3.6}{0.9} \times v_1$$

$V_2 = 4V_1 \rightarrow Eq (2)$

Putt in Eq (1)

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

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

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

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

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

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

$$\sqrt{V_1^2} = \sqrt{\frac{2.7 \times 2(9.81)}{15}}$$

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

Putting value of "V_1" in Eq (2)

$V_2 = 4V_1$

$V_2 = 4(1.879) = 7.516 \, m/sec.$

As $Q = A_1V_1 = by_1V_1$

$= 3.9 \times 3.6 \times 1.879 = 26.38 \, m^3/sec$

Assignment 3

$$Q = Q_1 = Q_2 = 26.38\, m^3/sec$$

(1) **Fraud Number at upstream Side:-**

$$F_{r1} = \frac{v_1}{\sqrt{g y_1}} = \frac{1.879}{\sqrt{9.81 \times 3.6}} = 0.31 \text{ (sub-critical Flow)}$$

(2) **Froud Number at down stream Side:-**

$$F_{r2} = \frac{v_2}{\sqrt{g y_2}} = \frac{7.51}{\sqrt{9.81 \times 0.9}} = 2.52 \text{ (super critical Flow)}$$