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Section: A

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Assignment: Hydraulic Engineering

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ASSIGNMENT-1

Q.1. What is venture flume? Explain with detail.

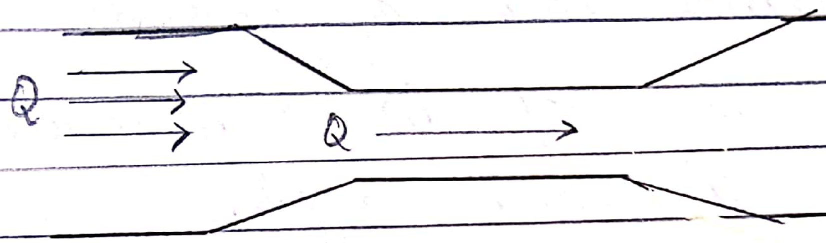
Ans:- Venturi flume:-

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

It is used in flow measurement of very large flow rates, usually gives in millions of cubic units. A venturi meter would normally measure in millimeters whereas a venturi flume measures in meters.

Measurement of discharge with venturi flume required two measurements, 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 super-critical state while passing through flume a single measurment at throat is sufficient for computation of discharge.

To ensure occurence of critical depth at throat flumes are usually designed in such a way to form a hydraulic pump on downstream side of structure. These flumes are called "Standing wave flumes".
It causes drop in hydraulic gradie line.



Flow through a Venturi Flume

Q.2:-
A 3m wide channel carries a total discharge of 12m³/sec
Calculate
i) Critical depth.
b) Minimum Specific energy.
c) Alternative depths when E-4m

Given data:-
Width of channel (b) = 3m.
Discharge Q = 12m³/sec

Required:-
a) critical depth.
b) Minimum Specific Energy.
c) Alternative depth when E=4m.

Assignment-1

Sol:-

Critical Depth:-

As $q = Q/b$

$\frac{12}{3} = q$

$q = 4 m^2/sec$

Using formula.

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

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

The Minimum Specific Energy: (For rectangular channel)

$Q = AV \rightarrow eq (i)$

and $Q = qb \rightarrow 2$

Equating eq (i) & (2)

$Q = Q$

$AV = qb$

$by\, v = qb$

$Vy = q$

$V = q/y_c$

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

$E_{min} = y + \frac{V^2}{2g} \Rightarrow 1.177 + \frac{(3.398)^2}{2(9.81)} \Rightarrow \boxed{E_{min} = 1.76m}$

Assignment = 1

The alternate depth when E = 4m.

As $E > E_c$, there are two possible depths 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 units.

$$4 = h + 0.8155/h^2$$

For the subcritical (slow, deep) solution, the first term associated with potential energy dominates, so re-arrange as

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

Iteration from h=4 gives h = 3.948m

From the subcritical (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

Answer:-

Alternate depth are 3.95 and 0.48m

Problem-1

Water flows at depth of 10cm with velocity of 6m/s in rectangular channel is flow critical or subcritical? what is its alternate depth?

Given data:-

Depth = 10 cm
Velocity = 6m/s

Required:-

Type of flow
Alternate depth

Sol:-

First we have to check Froude Number.

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

$$= 6.06 > 1$$

So flow is Supercritical.

Alternate depth:- As we know that

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

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

The alternate depth for E=1.935m yields

$y_{alt} = 1.93m$

Assignment 2

Problem-2

water flow with a velocity of 2m/s and depth of 3m .... losses?

Given Data:-

Velocity = $V_i = 2m/s$

Depth = $y_1 = 3m$

Elevation = Δz = 60cm = 0.6m

Downstep = 15cm = 0.15m

Required:-

Depth and elevation changes

Max sizes of upstep

Sol:- As we know that

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

$$E_1 = 3 + \frac{2^2}{2(9.81)}$$

$$\boxed{E_1 = 3.20m}$$

Now

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

Also

$$E_2 = y^2 + \frac{q^2}{2gy_2^2} = y^2 + \frac{(6m^3/s)^2}{2\ 981m/s^2 y_2^2} = \boxed{2.60m}$$

So, $y^2 = 2.24m$, $\Delta y = y_2 - y_1 = -0.76m$

So water surface drops 0.76m.

For a Downward step of 15cm we have:

$$E_2 = E_1 - \Delta z = 320m - (-0.15m) = 3.35m$$

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

The minimum upstep possible before affecting upstream water surface level is for.

$$y_2 = y_c$$

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

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

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

Problem:-

A water passing from slice gate in Dam
------- 3.9m.

Determine:-

a) Discharge

b) Froud number Upstream & Downstream.

Given Data:-

Depth at upstream side $(y_1) = 3.6m$

Depth at downstream side $(y_2) = 0.9m$

width of slice gate $= b = 3.9m$

Required:

Discharge

Froud number upstream & downstream.

Sol:-

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

$$Q = A_1V_1 = A_2V_2$$

$$b_1y_1V_1 = b_2y_2V_2$$

$$y_1V_1 = y_2V_2$$

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

$$V_2 = \frac{3.6}{0.9} \times V_1$$

$V_2 = 4V_1 \longrightarrow eq(2)$

Put in eq (1)

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

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

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

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

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

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

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

$V_1 = 1.879\ m/sec$

Put value of "V_1" in eq (2)

$V_2 = 4V_1$

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

As

$Q = A_1V_1 = by_1V_1$

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

$Q_2 = A_2V_2 = by_2V_2$

$= 3.9 \times \times 0.9 \times 7.516 = 26.38\ m^3/sec$

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

Assignment-3

1) Froud Number at upstream side-

$$Fr_1 = \frac{V_1}{\sqrt{gy_1}} = \frac{1.879}{\sqrt{9.81 \times 3.6}} = 0.31 \text{ (Sub-critical flow)}$$

(2) Froud number at downstream side-

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

$$Fr_2 = 2.52 \text{ (super critical flow)}.$$