Name : M. Shawal khan

Id 7813

Section A

Semester 6th

Assigment Hydraulic Engineering

Submitted to : Sir Fawad

Assignment 1

Q1. What is venture flume? Explain with detail.

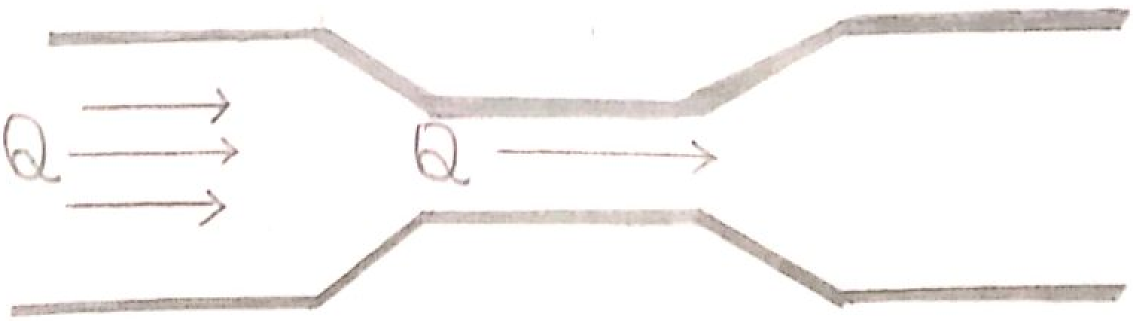
Venturi Flume:-

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

It is used in flow measurment 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.

Measurment of discharge with venturi flume requires two measurments, 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 gradeline.



Flow through a venturi Flume

Q 2

A 3m wide channel carries a total discharge of $12 m^3/sec$

Calculate

i) Critical Depth

b) Minimum Specific energy.

c) Alternative depths 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) Alternative depth when E = 4m.

Sol:-

Critical Depth

As $q = Q/b$

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

$$q = 4 m^2/sec$$

Using formula.

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

$$= \left(\frac{4^2}{9.81}\right)^{1/3} = 1.177 m.$$

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 $V = qb$

$Vy = q$

$V = q/y_c$

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

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

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

$E_{min} = 1.76 \, m.$

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 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 $h = 0.4814m$

Answer:- Alternate depth are 3.95 and 0.481m

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 = 10cm.
Velocity = 6m/s.

Required:-

Type of flow
Alternate depth.

Sol:-

First we have to check Froude Number.

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

$$= 6.06 > 1$$

So flow is supercritical.

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

$y_{alt} = 1.93m$

Problem 2

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

Given Data:-

Velocity $= V_1 = 2m/s$.
Depth $= y_1 = 3m$.
Elevation $\Delta z = 60cm = 0.6m$.
Downstep $= 15cm = 0.15m$.

Required:-

Depth and elevation changes
Max size of upstep.

Sol:- As we know.

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

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

$E_1 = 3.20m$.

Now

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

Also

$$E_2 = y_2 + \frac{q^2}{2gy_2^2} = y_2 + \frac{(6m^3/s)^2}{2 \cdot 9.81\ m/s^2 \cdot y_2^2} = 2.60m.$$

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.**

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

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

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

$$y_2 = y_c$$

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

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

$$y_c = 1.54m$$

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
Froude number Upstream & downstream.

Sol:-

As we know

$E_1 = E_2$

$$y_1 + \frac{V_1^2}{2g} = y_2 + \frac{V_2^2}{2g} \rightarrow eq\ 1.$$

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

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

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

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

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

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

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

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

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

Put value of "V_1" in eq 2

$$V_2 = 4V_1$$

$$V_2 = 4(1.879) = 7.516 \text{ m/sec.}$$

As

$$Q = A_1V_1 = by_1V_1$$

$$= 3.9 \times 3.6 \times 1.879 = 26.38 \text{ m}^3\text{/sec.}$$

$$Q_2 = A_2V_2 = by_2V_2$$

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

$$Q = Q_1 = Q_2 = 26.38 \text{ m}^3\text{/sec.}$$

1) Froud Number at upstream side:-

$$Fr_1 = \frac{V_1}{\sqrt{g y_1}} = \frac{1.879}{\sqrt{9.81 \times 3.6}} = 0.31 \text{ (Sub-critical flow)}$$

2) Froud number at downstream sider

$$Fr_2 = \frac{V_2}{\sqrt{g y_2}} = \frac{7.516}{\sqrt{9.81 \times 0.9}} = 2.52 \text{ (Super Critical flow)}$$