ASSIGMENTS

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Section: "B"

Semester: "6th"

Subject: Hydraulic Engineering

Assignments: NO's: 1, 2&3

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1 Assignment 1

Question # 01

Answer: Venturi Flume:

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

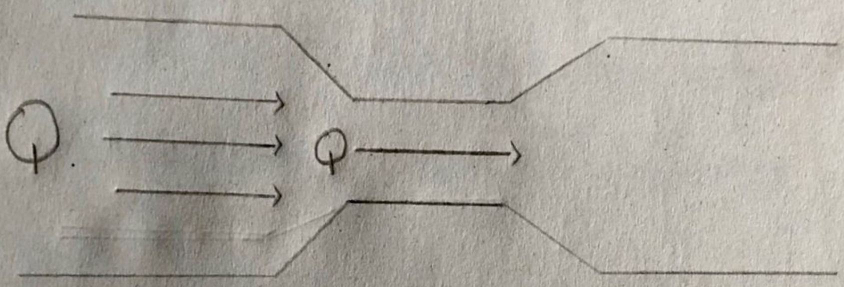
It is used in flow measurement of very large flow rates usually given in millions of cubic unites. A venturi meter would normally measure in millimeters whereas a venturi flume measure in meters.

Measurement of discharge in 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 measurement at throat is sufficient for computation of discharge.

02 Assignment # 1

To ensure occurance of critical depth at throat flumes are usually designed in such a way to form a hydraulic jump on downstream side of structure. These flumes are called "standing wave flumes".

→ It causes drop in hydraulic gradeline



Flow through a venturi Flume

Assignment 1

Question # 02

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

Solution:

Critical depth:

As $q = Q/b$

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

$q = 4 m^2/sec$

Using formula

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

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

Q4 Assignment 1

The minimum specific Energy: (For rectangular channel)

$$Q = AV \longrightarrow eq\ (1)$$

and

$$Q = qb \longrightarrow (2)$$

equating eq (1) and (2)

$$Q = Q$$

$AV = qb$

by $V = qb$

$Vy = q$

$V = q/y_c$

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

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

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

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

The Alternate depth when $E = 4m$

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

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

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

05

Assignment 1

Substituting values in metre-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 = 3.948 m.

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 = 0.4814 m

Answer: Alternate depth are 3.95 and 0.481m.

06

Assignment # 02

Problem 1

Given data:

Depth = 10cm

velocity = 6m/s

Required:

Type of flow

Alternate depth

Solution:

First we have to check Froude number.

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

$$= 0.06 > 1$$

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 yelds

$y_{alt} = 1.95m$

07 Assigment 2

Problem 2

Given data:

velocity = v_1 - 2m/s

Depth - y_1 = 3m

Elevation Δz = 60cm = 0.6m

Down step = 15cm = 0.15m

Required:

Depth and elevation changes

Max size of upstep.

Solution:

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

$E_2 = y_2 + \frac{q^2}{2gy_2^2} = y_2 = \frac{(16m^3/s)^2}{2.981m/s^2.60} = 2.60m$

08

Assignment 2

So $y^2 = 224m$, $\Delta y = y^2 - y^1 = 0.76m$

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

$y^2 = y_c$

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

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

$y_c = 1.54m$

09 # Assigment 03

Problem:

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 and downstream

Solution:

As we know

$E_1 = E_2$

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

Also

$$Q = A_1V_1 = A_2V_2$$

$$b_1y_1 = b_2y_2V_2$$

$$y_1V_1 = y_2V_2$$

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

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

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

Assignment 3

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

$Q = A_1V_1 = by_1V_1$

$= 3.9 \times 3.6 \times 1.8879 = 26.38 m^3/sec$

$Q_2 = A_2V_2 = by_2V_2$

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

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

11 Assignment 3

1) Froud number at upstream side:

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

2) Froud number at downstream side:

$$Fr_2 = \frac{V_2}{\sqrt{g y_2}} = \frac{7.516}{\sqrt{9.81 \times 0.9}} = 2.52$$ (super-critical Flow)

The End