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SUBMITTED TO ENGR. FAWAD AHMAD

SUBJECT HYDRAULIC ENGINEERING

ID # 7836

SECTION B

MODULE 6th

ASSIGNMENT# 01

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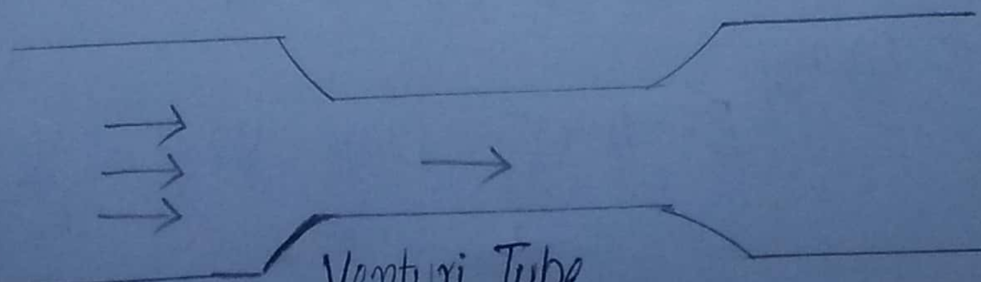
1. What is venture flume? Explain with detail?

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

It is used in flow measurement of very large flow rate, usually given in million of cubic units. A venturi meter would normally measure in mm, where as a venture flume measure in meters.

Measurement of discharge with venture flume requires two measurement one upstream and one at the throat, if the flow passes in a subcritical state through the flume. If the flume is designed so as to pass the flow from sub critical to super critical state while passing through the flume, a single measurement at a throat is sufficient for computation of discharge. To ensure the occurence of critical depth of the throat, the flumes are usually designed in such a way as to form a hydraulic jump on the downstream side of the structure. The flume is called standered wave flume.



Venturi Tube

2. A 3-m wide channel carries a total discharge of $12\ m^3/sec$.
Calculate:
a) The critical depth.
b) The minimum specific energy.
c) The alternate depths when $E = 4m$.

Sol: Given data:

$Q = 12\ m^3/sec$
$b = 3m$

a) As we know;

Discharge per unit width

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

→ For rectangular channel

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

$$\boxed{h_c = 1.177\ m}$$

b) For a rectangular channel

$$E_c = \frac{3}{2} h_c = \frac{3}{2}(1.177) = 1.766m$$

Min specific energy $= E_c = 1.766m$

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

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

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$\Rightarrow$ $E = h + \frac{q^2}{2gh^2}$ Substituting the value in meter-sec unit.

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

For a sub critical (slow, deep) so the first term associated with potential energy dominates so rearrange as

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

Iteration gives $h = 3.948m$ for the super critical (fast, shallow) so the second term associated with K.E dominates so rearrange as

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

Iteration (from, e.g, $h=0$) gives $h = 0.4814m$ alternate depth are 3.95 and 0.481m.

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1. Water flows at a depth of 10cm with a velocity of 6m/s in a rectangular channel. Is the flow subcritical or super-critical? What is the alternate depth?

Sol: First of all check froud Number

$$F_r = \frac{V}{\sqrt{gy}} = \frac{6m/s}{\sqrt{9.81 \times 0.1m}} = 6.06$$

$\therefore 6.06 > 1$

so the flow is super critical

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

$$\boxed{E = 1.935m}$$

solving the alternate depth for $E = 1.935m$ yields $y_{alt} = 1.93m$

2. Water flows with a velocity of 2m/s and at a depth of 3m in a rectangular channel ....?

Sol: $$E_1 = y_1 + \frac{V_1^2}{2g} = 3 + \frac{2^2}{2 \times 9.81} = 3.20m$$

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

Also
$$E_2 = y_2 + \frac{q^2}{2gy} = y_2 + \frac{6^2}{2 \times 9.81 \cdot y} = 2.60m$$

so $y_2 = 2.24m$. $\Delta y = y_2 - y_1 = 0.76m$ so water surface depth 0.16m. For a downward step of 15cm we have

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

giving $y_2 = 3.17m$ 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 $y_2 = y_1$

$$y_1 = \left(\frac{q^2}{g}\right)^{1/3} = \left(\frac{6^2}{9.81}\right)^{1/3} = 1.54m$$

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1. A water passing from the slice gate in Dam having a depth of water at upstream side is 3.6m, after passing through sluice gate the back water curve shows the depth of water at downstream side is 0.9m. The width of slice gate is 3.9m

Determine

a. Discharge Q

b. Froud Number upstream and downstream.

Sol: Given data

$y_1 = 3.6m$, $y_2 = 0.9m$, $b = 3.9m$

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

$$Q = A_1V_1 = A_2V_2$$

$$b_1y_1 V_1 = b_2y_2 \cdot V_2$$

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

$$y_1V_1 = y_2V_2$$

$$V_2 = y_1/y_2 \times V_1$$

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

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

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putting in equ ①

$$y_1 + \frac{v_1^2}{2g} = y_2 + \frac{V_2^2}{2g}$$

$$3.6 + \frac{v_1^2}{2g} = 0.9 + \frac{(4v_1)^2}{2g}$$

$$3.6 + \frac{v_1^2}{2g} = 0.9 + \frac{16v_1^2}{2g}$$

$$\frac{v_1^2}{2g} - \frac{16v_1^2}{2g} = 0.9 - 3.6$$

$$\frac{v_1^2 - 16v_1^2}{2g} = -2.7$$

$$\frac{+15v_1^2}{2g} = +2.7$$

$$v_1^2 = \sqrt{\frac{2.7 \times 2(9.81)}{15}}$$

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

putting the value of "v_1" in equ ② we get

$$V_2 = 4V_1$$

$$V_2 = 4(1.879)$$

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

→ As $Q_1 = A_1V_1 = by_1 \cdot v_1 = 3.9 \times 3.6 \times 1.879 = 26.38\ m^3/sec.$

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→ $Q_2 = A_2 . V_2 = b y_2 V_2 = 3.9 \times 0.9 \times 7.516 = 26.38\ m^3/sec$

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

1. Froud Number → At upstream side

$$F_{r_1} = \frac{V_1}{\sqrt{g y_1}} = \frac{1.879}{\sqrt{9.81 \times 3.6}} = 0.31$$

$F_{r_1} = 0.31 < 1$ so it is sub critical flow.

2. Froud Number

$$F_{r_2} = \frac{V_2}{\sqrt{g y_2}} = \frac{7.516}{\sqrt{9.81 \times 0.9}} = 2.52$$

$F_{r_2} = 2.52 > 1$ so super critical flow.

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