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Qs #01

## VENTURE FLUME:-

A venture Flume is a critical flow open flume with a constricted flow which causes a drop in the hydraulic grade line, creating a critical depth:

## Explanation:-

It is used in flow measurement of very large flow rates, usually given in millions of cubic units. A venturi meter would normally measures in millimeter whereas ~~a~~ a venturi Flume measures in meter

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Problem:-

Given Data:-

$b = 3m$

$Q = 12\ m^3.s^{-1}$

(a) Discharge Per unit width

$$q_v = \frac{Q}{b} = \frac{12}{3} = 4\,m^2\,s^{-1}$$

Then For a Rectangular channel

$$\cancel{E_c = \frac{3}{2}}\ h_c = \left(\frac{q_v^2}{g}\right)^{\frac{1}{3}} = \left(\frac{4^2}{9.81}\right)^{\frac{1}{3}} = 1.177m$$

Ans: critical depth is 1.18m

(b) For a Rectangular channel

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

Ans: Minimum Specific Energy = 1.77m

(c) As $E > E_c$, there are two possible depths for a given Specific Energy

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

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

Substituting values in meter-second units

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

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

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

Iteration ( from e.g h=4) gives $h = 3.948\,m$.

For the supercritical ( fast, shallow ) solution, the second term, associated with kinetic energy, dominates, so rearrage as

Iteration (from, e.g, h=0) gives $h = 0.4814\,m$

Alternate depth are 3.95m and 0.4814 m.

Q1 Problem

Solution:-

Check Froude Number

$$Fr = \frac{V}{\sqrt{gy}} = \frac{6\,m/s}{9.81 \times 0.1} = 6.06 > 1$$

So the flow is Supercritical

$$E = y + \frac{V^2}{2g} = 0.1m + \frac{6}{2 \times 9.81} = 1.935m$$

Solving for the alternate depth for an $E = 1.935m$ yields $y_{alt} = 1.93\,m$

$Q_2$ Problem

Solution:-

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

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

Also

$$E_2 = y_2 + \frac{q^2}{2gy_2^2} = y_2 + \frac{6}{2\times 9.81 \cdot y_2^2} = 2.60m$$

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 giving $y_2 = 3.17m$ and $\Delta y = y_2 - y_1 = 0.17m$ so water surface rises 0.09m

The Maximum upstep Possible affecting upstream water surface level is for $y_2 = y_c$

$$y_c = \sqrt[3]{\frac{q^2}{g}} = \sqrt[3]{\frac{6^2}{9.81}} = 1.54m$$

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problem 03:

A water passing from the Sluice gate in Dam:

Given data:

$y_1 = 3.6m \quad y_2 = 0.9m$

$b = 3.5m$

Sol:

as we know that

$E_1 = E_2$

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

Also $Q = A_1v_1 = A_2v_2$ $(b = b_1 = b_2)$

$b_1y_1v_1 = b_2y_2v_2$

$\cancel{b}y_1v_1 = \cancel{b}y_2v_2$

$y_1v_1 = y_2v_2$

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

$v_2 = \frac{3.6}{0.9} \times v_1 = 4v_1 \rightarrow (2)$

putting eq (1)    7869 (10)

$$y_1 + \frac{v_1^2}{2g} = y_2 + \frac{v_2^2}{2g} = y_2 + \frac{v_1^2}{2g} = 0.9 + \frac{(4v_1)^2}{2g}$$

$\boxed{v_1 = 1.879 \text{ m/sec}}$ putting eqn 3 into eqn 4

$v_2 = 4v_1$

$Q_1 = A_1 v_1 = b y_1 v_1$

$= 3.9 \times 3.6 \times 1.879$

$$\boxed{Q_1 = 26.38 \text{ m}^3/\text{sec}}$$

$\Rightarrow$ $Q_2 = A_2 v_2 = b y_2 v_2$   $0.9$   $7.516$

$= 3.9 \times 0.9 \times 7.516$

$$\boxed{Q_2 = 26.38 \text{ m}^3/\text{sec}}$$

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

(1) Froud number → At upstream side

$$F_{r1} = \frac{v_1}{\sqrt{g y_1}} = \frac{1.879}{\sqrt{9.81 \times 3.6}} = 0.31$$

Sub critical flow

(2) Froud number → At down stream side

$$F_{r2} = \frac{v_2}{\sqrt{g y_2}} = \frac{7.516}{\sqrt{9.81 \times 0.9}} = 2.58$$

Super critical flow

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