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"ASSIGNMENT: 1"

1. What is venture flume? Explain with detail?

Ans **VENTURE FLUME:**

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

It is used in flow measurement of very large flow rates, usually given in millions of cubic units. A venturi meter would normally measure in millimetres, whereas a venturi flume measures in metres. Measurement of discharge with venturi flumes requires two measurements, one upstream and one at the throat (narrowest cross-section), if the flow passes in a subcritical state through the flume. If the flumes are designed so as to pass the flow from sub critical to supercritical state while passing through the flume, a single measurement at the throat (which in this case becomes a critical section) is sufficient for computation of discharge. To ensure the occurrence of critical depth at the throat, the flumes are usually designed in such way as to form a hydraulic jump on the downstream side of the structure. These flumes are called "standing wave flumes".

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 $E = 4m$.

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

a) Discharge per unit width:
$$q = \frac{Q}{b} = \frac{12}{3} = 4 m^2/sec$$
Then, for a rectangular channel
$$h_c = \left(\frac{q^2}{g}\right)^{1/3} = \left(\frac{4^2}{9.81}\right)^{1/3} = 1.177m$$
Answer: critical depth = 1.18m

b) For a rectangular channel.
$$E_c = \frac{3}{2} h_c = \frac{3}{2} \times 1.177 = 1.766m$$
Answer: minimum specific energy = 1.77m

c) As $E > E_c$, there are two possible depths for a given specific energy.
$$E = h + \frac{V^2}{2g} \text{ where } V = \frac{Q}{A} = \frac{q}{h}$$ (for a rectangular channel)
$$\Rightarrow E = h + \frac{q^2}{2gh^2}$$
Substituting values in metre-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, $h=4$) given $h = 3.948m$.
For the supercritical (fast, shallow) solution, the second term, associated with kinetic energy, dominates, so arrange as:

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

Iteration (from, e.g, $h=0$) given $h = 0.4814m$.
Answer: alternate depths are 3.95m and 0.481m.

"ASSIGNMENT # 2"

"PROBLEM: 1"

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

SOLUTION:

Check Froude number

$$Fr = \frac{V}{\sqrt{gy}} = \frac{6\,m/s}{\sqrt{9.81/s^2 \times 0.1m}} = 6.0671$$

so the flow is supercritical.

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

The alternate depth for $E = 1.935m$ yields $\boxed{y_{altnate} = 1.93m}$

"PROBLEM: 2"

Water flows with a velocity of 2 m/s and at a depth of 3m in a rectangular channel. What is the change in depth and in water surface elevation produced by a gradual upward change in bottom elevation (upstep) of 60 cm? What would be the depth and elevation changes if there were a gradual downstep of 15 cm? What is the maximum size of upstep that could exist before upstream depth changes would result? Neglect head losses.

GIVEN DATA:

Velocity $= V_1 = 2m/s$
depth $= y_1 = 3m$
Elevation $\Delta z = 60cm = 0.6m$
downstep $= 15 cm = 0.15m$

SOLUTION:

As we know that

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

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

$$E_1 = 3.20m$$

Now

$$E_2 = E_1 - \Delta Z$$

$$E_2 = 3.2 - 0.6$$

$$E_2 = 2.60m$$

Also

$$E_2 = y_2 + \frac{q^2}{2g y_2^2}$$

$$260 = y_2 + \frac{6^2}{2 \times 9.81 \times y_2^2}$$

$$y_2 = 2.24m$$

$$\Delta y = y_2 - y_1$$

$$\Delta y = 2.24 - 3$$

$$\Delta y = -0.76m$$

So water surface drop = 0.16m

=> For a downward step of 15cm or 0.15m we have

$$E_2 = E_1 - \Delta Z = 3.20 - (-0.15)$$

$$E_2 = 3.35m$$

Now

$$y_2 = 3.17m$$

$$\Delta y = y_2 - y_1 = 3.17 - 3$$

$$\Delta y = 0.17m$$

So water surface rises 0.02m

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

$$y_2 = y_c$$

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

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

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

"ASSIGNMENT: 3"

PROBLEM:

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 that 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.

GIVEN DATA:

$y_1 = 3.6m$

$y_2 = 0.9m$

$b = 3.9m$

SOLUTION:

As we know that

$$E_1 = E_2$$

$$y_1 + \frac{V_1^2}{2g} = y_2 + \frac{V_2^2}{2g} \quad \text{— i}$$

Also

$$Q = A_1V_1 = A_2V_2$$

$$b_1 y_1 \times V_1 = b_2 y_2 \times V_2 \qquad (b = b_1 = b_2)$$

$$\cancel{b} \times y_1 \times V_1 = \cancel{b} \times y_2 \times V_2$$

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

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

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

$$V_2 = 4V_1 \quad \text{---} \quad ii$$

Putting in eq i

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

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

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

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

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

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

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

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

Putting in ii, we get

$$V_2 = 4V_1$$

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

As

$$Q_1 = A_1V_1 = by_1 \times V_1$$

$$= 3.9 \times 3.6 \times 1.879$$

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

$Q_2 = A_2 V_2 = b \times y_2 \times V_2$

$= 3.9 \times 0.9 \times 7.516$

$Q_2 = 26.38 \ m^3/sec$

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

1) Froud Number $\longrightarrow$ At upstream side

$Fr_1 = \dfrac{V_1}{\sqrt{g y_1}} = \dfrac{1.879}{\sqrt{9.81 \times 3.6}} = \boxed{0.31}$

sub-critical flow

2) Froud Number $\longrightarrow$ At Downstream side

$Fr_2 = \dfrac{V_2}{\sqrt{g y_2}} = \dfrac{7.516}{\sqrt{9.81 \times 0.9}} = \boxed{2.52}$

super-critical flow