ASSIGNMENT 01, 02, 03

SUBJECT : HYDRAULIC ENGINEERING.

SECTION : B

MODULE : 6th

ID : 7857

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QUESTION 01:

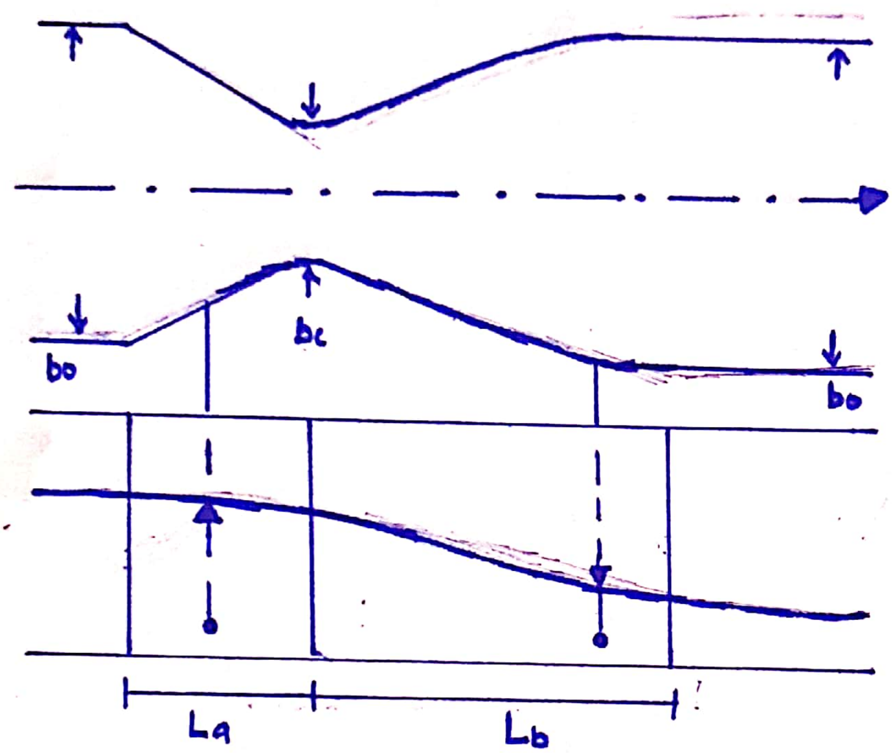
What is venture flume? Explain with detail?

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.

⇒ It is used in flow measurement of very large flow rate, usually given in millions of cubic units. A venture flume meter would normally measure in millimeters whereas a venturi flume measures in meters.

⇒ Measurement of discharge with venture flume 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 flume are designed so as to pass the flow from subcritical 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 flume are usually designed in such way as to form a hydraulic jump on the down stream side of the structure. These flume are called standing wave flumes.



QUESTION 02

A 3-m wide channel carries a total discharge of 12 m³/sec

Calculate:

a) The critical depth

b) The minimum Specific energy

c) The alternative depth when E = 4m.

Given Data:

$b = 3m$

$Q = 12\, m^3/s$

Solution:

a) Discharge per unit width.

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

Then, for a rectangular channel

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

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

critical depth = 1.18m.

b) Minimum Specific Energy:

For Rectangular channel

$$E = \frac{3}{2} h$$

$$= \frac{3}{2} (1.18)$$

$$E = 1.766 \, m.$$

c) Alternative Depth.

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

$$E = h + \frac{V^2}{2g} \qquad \therefore V = \frac{Q}{A} = \frac{q}{h}. \quad \left(\text{For a rectangular channel}\right)$$

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

Subsituting Values in meter-second units.

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

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

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

=> For the supercritical solution, the second term, associated with kinetic energy dominates, so rearrange as,

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

Iteration (From, e.g, h=0) gives h= ~~0.84~~ 0.4814m.

⇒ Alternatives depths are 3.95m and 0.4814m

PROBLEM 01

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

Given Data:

Velocity = 6 m/s

depth = 10 cm

Required :

Flow = ?

Alternative depth = ?

SOLUTION:

Check Froude Number

$$Fr = \frac{V}{\sqrt{gy}}$$

$$= \frac{6}{\sqrt{9.81 \times 0.1}}$$

$$Fr = 6.06 > 1$$

So flow is super critical.

Now

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

$$= 0.1 + \frac{(6)^2}{2g}$$

$$= 0.1 + \frac{(6)^2}{2(9.81)}$$

$$E = 1.935m$$

PROBLEM 02:

SOLUTION:

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

$$= 3m + \frac{(2)^2}{2 \times 9.81}$$

$$E_1 = 3.20m$$

Also

$$E_2 = E_1 - \Delta z$$

$$= 3.20 - 0.60$$

$$E_2 = 2.60m$$

Also

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

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

$$E_2 = 2.60$$

So $y_2 = 2.24m$,

$$\Delta y = y_2 - y_1 = -0.76$$

So water surface drops 0.16m.

For a downward step of 15cm we have

$$E_2 = E_1 - \Delta z$$

$$= 3.20 - (-0.15) = 3.35m.$$

giving $y_2 = 3.17m$ and $\Delta y = y_2 - y_1 = 0.17$

So water rises 0.02m

→ The minimum upstep possible before affecting upstream water surface is for.

$y_2 = y_c$

$$y_c = \sqrt{\frac{q^2}{g}} = \sqrt{\frac{(6)^2}{9.81}}$$

$y_c = 1.54m$

PROBLEM

A water passing from the sluice 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 sluice gate is 3.9m.

GIVEN DATA:

$y_1 = 3.6m$

$y_2 = 0.9m$

$b = 3.9m$

REQUIRED:

a) Discharge $Q = ?$

b) Froud Number at upstream and downstream = ?

SOLUTION:

Specific energy at upstream and downstream

$E_1 = E_2$

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

Also $Q = A_1V_1 = A_2V_2$

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

$$y_1 V_1 = y_2 V_2$$

$$(3.6) V_1 = (0.9) V_2$$

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

$$\boxed{V_2 = 4 V_1} \rightarrow (2)$$

Subsituting values in eq (1)

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

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

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

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

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

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

$$\sqrt{V_1^2} = \sqrt{3.53}$$

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

Putting value of V_1 in eq (2) to find V_2.

$$V_2 = 4(V_1)$$

$$V_2 = 4(1.879)$$

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

Discharge: $Q = A_1V_1$

$$Q_1 = b\,y_1 V_1$$

$$Q_1 = (3.9)(3.6)(1.879)$$

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

Now

$$Q_2 = A_2V_2$$

$$= b\,y_2 V_2$$

$$= (3.9)(0.9)(7.516)$$

$$\boxed{Q_2 = 26.38116 \text{ m}^3/\text{sec}}$$

Froud Number:

$$F_{r_1} = \frac{V_1}{\sqrt{2gy_1}} = \frac{1.879}{\sqrt{2(9.81)(3.6)}} \Rightarrow \boxed{F_{r_1} = 0.22}$$

$$F_{r_2} = \frac{V_2}{\sqrt{2gy_2}} = \frac{7.516}{\sqrt{2(9.81)(0.9)}} \Rightarrow \boxed{F_{r_2} = 1.7886}$$