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Section A

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Subject Hydraulic Engineering

Assignment 01, 02, 03

Assignment (01)

Q.No.1)

Answer :- Venturi 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 of other would normally measure in millimeters whereas a venturi flume measures in meters.

→ Measurement of discharge with venturi flumes requires two measurement, one upstream and one at the throat (narrowest) cross section if the flumes flow goes 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 is sufficient for computation of discharge

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

Q no 01 : A 3m wide channel carries a total discharge of 12 m³/sec calculates

(i) Critical depth

(ii) Minimum specific energy

(iii) Alternate depth E = 4m

Given Data

Wide of Channel = b = 3m

Discharge = Q = 12 m³/sec

Solution

(i) Critical Depth:

Discharge per unit width

$q = Q/b = \frac{12}{3}$

$q = 4 m^3/sec$

For Rectangular Channel

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

$h_c = 1.18m$

(ii) Minimum Specific energy (E)?

As for Rectangular channel

E = 3/2 hc = 3/2 × 1.18

③ The Alternate depth $E = 4m$

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

$E = h + \frac{V^2}{2g}$ where $V = \frac{Q}{A} = q/h$

(for Rectangular channel)

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

$4 = h + \frac{0.8155}{h^2}$ for the subcritical solution the first term, associated with potential energy

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

⇒ Iteration (from $h=4$) gives $h = 3.948m$

for subcritical first, shallow solution. The second term associated with kinetic energy

.. dominates rearrange as

so

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

Iteration (from $h=0$) gives $h = 0.4814m$

So Alternate depth are 3.95m and 0.4814 m

Assignment #02

Q.No (1)

water flows at a depth of 0.3m with a velocity of 6m/s in a rectangular channel is the flow subcritical or supercritical is the alternate depth?

Solution

First of all we find the Froude number to find the flow

As we know that

$$Fr = \frac{V}{\sqrt{gy}} = \frac{6m/s}{\sqrt{9.81 \times 0.3}}$$

$$Fr = 6.0 > 1 \quad \text{supercritical}$$

Alternative Depth

We know that

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

$$E = 0.3 + \frac{6^2}{2 \times 9.81} = 2.135m$$

The alternative depth for $E = 1.95m$

Yields $y_{alternate} = 1.43m$

Q.No(3) Water flow with a velocity of 3m/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 (up step) to 60cm ? what would be the depth and elevation changes of step were a gradual down step of 15cm? what is maximum size of upstep that would exist before upstream depth changes would result ? Neglect head losses.

Given data:

Velocity $= V_1 = 3m/s$

depth $= y_1 = 3m$

Elevation $\Delta z = 60cm = 0.6m$

down step $= 15cm = 0.15m$

Solution

We know that

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

$$E_1 = 3 + \frac{9}{2 \times 9.81}$$ $\boxed{3.30m = E_1}$

Now

$E_2 = E_1 - \Delta z$

$E_2 = 3.3 - 0.6$

$\boxed{E_2 = 2.6m}$

Also

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

$$2.60 = y_2 + \frac{6^2}{2 \times 9.81 \cdot y_2^2}$$

$$\boxed{y_2 = 2.24m}$$

$$\Delta y = y_2 - y_1$$

$$\Delta y = 2.24 - 3$$

$$\boxed{\Delta y = 0.76m}$$

So water surface drops = 0.76m

(b) For downward step of 15cm or 0.15m we have

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

$$\boxed{E_2 = 3.35m}$$

Now

$$y_2 = 3.17m$$

and

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

$$\boxed{\Delta y = 0.17m}$$

So water surface rises 0.09m

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

$$y_2 = y_c$$

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

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

Assignment No (3)

Qno(1)

Given Data

$y_1 = 3\cdot 6m$

$y_2 = 0.9m$

$b = 3.9m$

Solution

As we know that

$E_1 = E_2$

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

Also

$Q = A_1V_1 = A_2V_2$ $\boxed{b = b_1 = b_2}$

$b_1y_1 \cdot v_1 = b_2y_2 \cdot v_2$

$b\, y_1 \cdot v_1 = b\, y_2 \cdot v_2$

$y_1 \cdot v_1 = y_2 \cdot v_2$

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

Putting in eq ①

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

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

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

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

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

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

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

$\boxed{V_1 = 1.879\ m/sec}$ putting in eq ②

$V_2 = 4V_1$

$V_2 = 4(1.879)$

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

As

$Q = AV_1 = by_1V_1$

$Q_1 = 3.9 \times 3.6 \times 1.879$

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

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

$Q_2 = 3.9 \times 0.9 \times 7.516$

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

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

(A) 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

(B) Froud Number → at downward stream

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