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Subject = Hydralic Engineering

Assignment = 01, 02, 03

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Assignment No: 1

Q No 1

Ans: Venturi Flume

A venturi flume is a critical flow open flume with a constricted flow which causes a drop in the hydralic 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 metter of waild normally measure in milimetres wheras a venturi flume measures in meters.

⇒ Measarment of discharge with venturi flume, requires two measurment, one upstream and one as 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 flame, a single measurment at the throat is sufficient for computation of discharge.

→ To ensure the occurence of critical depth at the throat, the flumes are usually designed in such away as to form a hydroulic jump on the downstream side of the structure. these flumes ~~Sid~~ are called "Standing wave flumes"

QNO2 :) A 3m wide channel corries a total discharge of $12\ m^3/sec$ Calculate.

* Critical depth.
* Minimum specific energy
* Alternate depth : $E = 4m$

Given data

Wide of channel = $b = 3m$

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

Solution

(a) Critical Depth

Discharge per unit width

$$q = Q/b = 12/3$$

$$\boxed{q = 4m^2/sec}$$

For Rectangular channel

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

$$\boxed{h_c = 1.18\ m}$$

(b) Minimum Specific Energy (E_c) = ?

For Rectangular Channel

$$E_c = \frac{3}{2} h_c = \frac{3}{2} \times 1.18$$

$$\boxed{E_c = 1.77\,m}$$

(C) The Altenate depth $E = 4m$

As $E > E_c$, there are two possible depth for a given Specific energy

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

(For Rectangular Channels)

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

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

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

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, shallows) 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 0.4814m.

Assignment # 2

QNo1 ⇒ Water flows at a depth of layers with a velocity of 6m/s in a rectangular channel. Is the flow subcritical or super critical? What is the alternate depth?

Solution

First of all we fine the froude number to forced the flow.

As we know that

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

$$Fr = 6.06 > 1$$

So the flow is supercritical

Alternate Depth.

As we know that

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

$$= 0.1 + \frac{6^2}{2 \times 9.81} = \boxed{1.935m}$$

The alternate depth for $E = \boxed{1.935m}$

yields $y_{altnate} = \boxed{1.93m}$

Q No 2

Given data

Velocity = V_1 = 2 m/s

depth = y_1 = 3 m

Elevation Δx = 60 cm = 0.6 m

downstep = 15 cm = 0.15 m

Solution

As we know that

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

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

$$\boxed{E_1 = 3.20 m}$$

Now $E_2 = E_1 - \Delta x$

$$= 3.2 - 0.6$$

$$\boxed{E_2 = 2.6 m}$$

Also

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

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

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

$\Delta y = y_2 - y_1$

$\Delta y = 2.24 - 3$

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

So water Surface drop = 0.16m

* for downward Step of 15cm or 0.15m we have

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

$\boxed{E_2 = 3.35 m}$

Now

$y_2 = 3.17 m$

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

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

So water Surface rises 0.02m

* The maximum upstep possible before effecting upstream water Surface level is for

$y_2 = y_c$

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

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

$\boxed{y_c = 1.54 m}$

Assignment # 03

QNo1

Given data

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

Solution

As we know that

$$E_1 = E_2$$

$$y_1 + \frac{V_1^2}{2g} = y_2 + \frac{V_2^2}{2g} \longrightarrow ①$$

Also,

$$Q = A_1 V_1 = A_2 V_2$$

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

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

$$y_1 \cdot V_1 = y_2 \cdot V_2$$

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

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

$$\boxed{V_2 = 4V_1} \longrightarrow ②$$

Putting in eq ①

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

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

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

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

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

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

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

$$\boxed{v_1 = 1.879\, m/sec}$$

Put in eq ②

$$V_2 = 4v_1$$

$$V_2 = 4(1.879)$$

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

As

$$Q_1 = A_1V_1 = by_1 \cdot v_1$$

$$3.9 \times 3.6 \times 1.879$$

$$\boxed{Q_1 = 26.38\, m^2/sec}$$

$$Q_2 = A_2V_2 = b \cdot y_2 \cdot v_2$$

$$= 3.9 \times 0.9 \times 7.516$$

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

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

(a) Froud Number → at upstream side

$$F_{r_1} = \frac{V_1}{\sqrt{gy_1}} = \frac{1.879}{\sqrt{9.81 \times 3.6}} = 0.31$$

(Subcritical Flow)

(b) Froud Number → at downward stream.

$$F_{r_2} = \frac{V_2}{\sqrt{gy_2}} = \frac{7.516}{\sqrt{9.81 \times 0.9}} = 2.52$$

(Super-critical Flow)