SYED JAWWAD

7386

HYDRAULIC ENGINEERING

Assignment #1

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 a very large flow Rates, usually given in Millions of Cubic units. A venture meter would Normally measure in millimeters, whereas as venture flume measures in meters.

Measurement of Discharge with venture flume requires two Measurements, one upstream and one at throat (narrowest Cross-Section), If the flow Passes in a Sub-Critical to Super-Critical 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 a way as to form a hydraulic Jump on the downstream side of the Structure. These flumes are called Standing waves flumes.

Scanned with CamScanner

ASSIGNMENT # 1

PROBLEM # 2

Given Data:-

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

Solution:-

(a) Discharge per unit width

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

Then for a Rectangular Channel

$$h_c = \left(\frac{q^2}{g}\right)^{2/3} = \left(\frac{4^2}{9.81}\right)^{1/2} = 1.77m$$

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 $E > E_{cn}$ there are two Possible depths for a given Specific Energy

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

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

Substituting values for 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 re-arrange

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

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 re-arrange

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

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

Answer:- Alternate depths are $3.95\,m$ and $0.481\,m$.

ASSIGNMENT #2

(4)

PROBLEM #7

SOLUTION:-

Check froude Number

$$Fr = \frac{V}{\sqrt{gy}} = \frac{6m/s}{\sqrt{9.81/s^2 \cdot 0.1m}} = 6.06 > 1$$

So the flow is Supercritical

$$E = y + \frac{v^2}{2g} = 0.1m + \frac{(6[m/s^2])}{2 \cdot 9.81\ m/s^2} = 1.935m$$

Solving for Alternate Depth for an $E = 1.935m$ Jields $y_{alt} = 1.93m$

Assignment #2

Problem : 2

Solution:-

$$E_1 = y_1 + \frac{v_1^2}{2g} = 3m + \frac{(2m/s)^2}{2.981m/s^2} = 3.20m$$

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

Also

$$E_2 = y_2 + \frac{q^2}{2gy_2^2} = y^2 + \frac{(6m^3/s/m)^2}{2.981 m/s^2 \cdot y_2^2} = 2.60m$$

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

$$E_2 = E_1 - \Delta z = 3.20m - (-0.15m) = 3.35m$$

giving $y_2 = 3.17m$ and $\Delta y = y_2 - y_1 = 0.17m$ so water Surface rises 0.02m

The maximum upstep Possible before affecting Stream water Surface loss is for $y_2 = y_c$

$$y_c = \sqrt{\frac{q^3}{g}} = \sqrt{\frac{(6m^3/s/m)^2}{9.81m/s^2}} = 1.54m$$

Assignment # 3

Problem # 1

Given Data :-

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

$b = 3.9m$

Sol :-

As we know that

$E_1 = E_2$

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

Also

$Q = A_1 V_1 = A_2 V_2$

$b_1 y_1 . v_1 = b_2 y_2 . v_2$ $\quad$ $(b = b_1 = b_2)$

$\cancel{b} . y_1 . v_1 = \cancel{b} . y_2 . v_2$

$y_1 . v_1 = y_2 . v_2$

$v_2 = y_1 / y_2 \times v_1$

$$\boxed{V_2 = 4v_1} \quad -(2)$$

Putting in Eq

$$y_1 + \frac{v_1^2}{2g} = y_2 + \frac{v_2^2}{2g}$$

$$\Rightarrow 3.6 + \frac{v_1^2}{2g} = 0.9 + \frac{(4v_1)^2}{2g}$$

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

$$\frac{v_1^2}{2g} - \frac{16v_1^2}{2g} = 0.9 - 3.5$$

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

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

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

$$\boxed{v_1 = 1.879\,m/sec}$$ → putting it in Eq (2)

$$v_2 = 4v_1$$

$$v_2 = 4(1.879) \rightarrow \boxed{v_2 = 7.516\ m/sec}$$

As

$$Q_1 = A_1 v_1 = by_1 . v_1$$
$$= 3.9 \times 3.6 \times 1.879$$
$$\boxed{Q_1 = 26.38\,m^3/sec}$$

$$Q_2 = A_2 v_2 = b . y_2 . v_2$$
$$= 3.9 \times 0.9 \times 7.516$$
$$\boxed{Q_2 = 26.38\,m^3/sec}$$

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

(1) FRAUD NUMBER → At upstream side

$$Fr_1 = \frac{v_1}{\sqrt{gy_1}} = \frac{1.879}{\sqrt{9.81 \times 3.6}} = 0.31$$

Sub-critical flow

2) Fraud Number → At Downstram Side

$$Fr_2 = \frac{V_2}{\sqrt{gy_2}} = \frac{7.516}{\sqrt{9.81 \times 0.92}}$$ → At Downstream Side

$= 2.52$

→ Super Critical flow.