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Hydrology

Final Assignment :

Assignment NO 1

Venturi flame:

A venturi flame 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 mm whereas a venturi flame measure in meters.

Measurement of discharge with venturi flumes requires two measurement one upstream and one at the throat. If the flow passes in subcritical state though the flume. If the flumes are designed so as to pass the flow from subcritical to super critical state while passing through the flame, a single measurement at the throat is sufficient for computation of discharge. To ensure the occerence of critical deph at the throat the flumes, are usually designed in such away as to form.

Example:

A 3m wide channels carries a total discharge of $12 m^3 s^{-1}$ Calculate,

a the critical depth -

b the minimum specific Energy -

c the alternate depth when

$E = 4m$

$b = 3m$

$Q = 12 m^3 s^{-2}$

A:

Discharge per unit width

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

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

Answer:

Critical depth = 1.18m

Scanned with CamScanner

B:

For a rectangle channel

$E_c = \frac{3}{2} h_c = \frac{3}{2} \times 1.177 = 1.766m$

Answer-

Mênîomm Specific Energy $= 1.77m$

C:

As $E > E_c$ there are two possibles depth for a given specific energy

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

For a rectangle channel.

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

Subsituting value in meta-second units.

(5)

For the subcritical (slow deep) the first term associated with P.E

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

$$y = 3.45 ft.$$

Assignment No 02

PROBLEM: 4.22.

Water flows a depth of 10 cm with a velocity of 6 m/s in a rectanglar channel is the flow subcritical or supercritical, What is the alternate depth

Solution.

Check Froude number.

$$Fr = \frac{V}{\sqrt{gy}} = \frac{6\,m/s}{\sqrt{9.81/s^2\ 0.1m}} = 1.935m$$

So the flow is supercritical

$$E = y + \frac{V^2}{2g} = 0.1m + \frac{(6m/s^2)^2}{2.981\ m/s^2} = 1.935m$$

(7)

Solving for alternate depth for an $E = 1.935$ m yields $y_{alt} = 1.93$ m

PROBLE = 4.36:

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

Solution

$$E_1 = y_1 + \frac{V_1^2}{2g} = 3m + \frac{2m/s^2}{2 \cdot 9.81 m/s^2}$$

$$= 3.20m$$

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

Also

$$E_2 = y_2 + \frac{q^2}{2gy_2^2} = y_2 + \frac{(6m^3/sm)^2}{2 \cdot 9.81 \; m/s^2} = 2.60m$$

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 raises

0.02m.

The maxium upstep

possible before affecting upstream water surface levels is

for

$y_2 = y_c$

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

Assignment NO 03

PROBLEM:- 1.

A water passing from the sluice gate in dam ---?

GIVEN:

$y_1 = 3.8m$

$y_2 = 0.9m$

$b = 3.9m$

Solution:

We know that

$E_1 = E_2$

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

Also

$Q = A_1V_1 = A_2V_2$

$b_1y_1 - V_1 = b_2y_2 - V_2$

$\cancel{b}y_1V = \cancel{b}y_2 - V_2 \quad \because b = b_1 = b_2$

$$y_1 V_1 = y_2 V_2$$

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

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

$$V_2 = 4V_1$$

Put in eq (1)

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

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

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

Put in eq (2)

$$V_2 = 4V_1$$

$$Q = A_1 V_1 = b y_1 V_1$$

ate:

$\Rightarrow \quad 3.9 \times 3.6 \times 1.879$

~~$Q_1 \quad 2.6$~~

$\Rightarrow \quad Q_1 = 26.38 \ m^3/sec$

$Q_2 = A_2 V_2 = by_2 - V_2$

$Q_2 = 3.9 \times 0.9 \times 7.516$

$Q_2 = 26.38 m^3/se.$

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

1) Froud Number At down stream

$Fr_1 = \frac{V_1}{\sqrt{gy_1}} = \frac{1.879}{\sqrt{9.81 \times 3.6}} = 0.31$ ✓

subcritical flow

2) Froud Number At down steam.

Fr

$$F_{r2} = \frac{V_2}{\sqrt{g y_2}} = \frac{7.516}{\sqrt{9.81 \times 0.9}}$$

$= 2.52$ supercritical flow.