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Section :→ A

Subject :→ Hydraulic Engineering

Semester :→ 6th

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Assignment No :→ 1, 2, 3

Assignment # 01

Q1:→ What is venture flume? Explain with details?

Ans:→ 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 rates usually give a millions of cubic units. A venturi meter would normally measure in millimeter where as a venturi flume measure in meters.

Measurement of discharge with venturi flumes require two measurements, one upstream and one at the throat (narrowest cross-section). If the flow passes in subcritical state through the flume. If the flumes are designed so as to pass the flow from sub to super critical state while passing through the flume, a single measurement at the throat is sufficent for computation of discharge. To ensure the occurrence of critical depth at the throat, the flumes are usually designd in such way as to from a hydraulic Jump on the downstream side of structure.

Q2:→ A 3-m wide channel carries a total discharge of 12 m^3/sec calculate.

a):→ The critical depth.

b):→ The minimum specific energy

c):→ The alternate depth where E = 4m.

Given Data

$b = 3m, \quad Q = 12 m^3/sec$

Sol

a) Discharge per unit width.

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

rectangular channel

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

critical depth = 1.18m

b):→

for rectangular channel

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

$$E_c = 1.77 m$$

minimum specific energy = 1.77m

c) :→ As $E > E_c$, there are two possible depth for a given specific energy.

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

(for rectangular channel)

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

Substituting values in meter-second units

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

for the subcritical (slow, deep) solution, the first term associated with potential energy

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

e.g $h = 4$ gives $h = 3.948m$

for the supercritical solution.

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

$$h = 0.4814 \, m$$

alternat depths are 3.95m and 0.481m

Assignment # 02

Q1:→ water flows at a depth of 10cm with a velocity of 6m/s in a rectangular Channel is the flow subcritical or supercritical what is the alternate depth?

Given Data

$d = 10cm$, $V = 6m/s$

$y_{alt} = ?$

~~Sol:→ By checking~~

Sol:→ By checking froud number:→

$$Fr = \frac{V}{\sqrt{gy}} \Rightarrow \frac{6}{\sqrt{9.81 \times 0.1}} = 6.06$$

$Fr\ 6.06 > 1$

Flow is supercritical

$$E = Y + \frac{V^2}{2g} = 0.1 + \frac{(6)^2}{2 \times 9.81} = 1.935m$$

For alternate depth $E = 1.935m$

$$Y_{at} = 1.93$$

Q2:→ water flow with a velocity of 2m/s and depth of 3m in rectangular channel what is the change in depth and in water surface elevation produced by a gradual upward change in bottom elevation (up step) of 60cm? what would be the depth and elevation changes if there were a gradual down step of 15cm? what is max size of upstep that could exist before upstream depth changes would result?

neglect head loses.

Given Data

$V_1 = 2 m/s$

$Y_1 = 3m$

$\Delta z = 6.0cm = 0.6m$

down step $= 15cm = 0.15m$

Sol:→

$$E_1 = Y_1 + \frac{V_1^2}{2g}$$

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

$$E_1 = 3.20m$$

Now

$E_2 = E_1 - \Delta z$

$E_2 = 3.2 - 0.6$

$E_2 = 2.60m$

Also

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

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

$y_2 = 2.24m$

$\Delta y = y_2 - y_1$

$\Delta y = 2.24 - 3$

$\Delta y = -0.76m$

So water surface drop $= 0.16m$

$\Rightarrow$ For a downward step of 15cm or 0.15m

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

$E_2 = 3.35m$

Now

$y_2 = 3.17m$

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

$$\Delta y = 0.17m$$

So water surface rises 0.07m

→ The max upstep possible before effecting upstream water surface level is for

$$y_2 = y_c$$

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

$$y_c = \sqrt[3]{\frac{6^2}{9.81}}$$

$$y_c = 1.54m$$

Assignment # 03

Q1:→ water passing from the slice 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.

Determine:

a):→ Discharge

b):→ Froud number upstream and downstream.

Given Data

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

$b = 3.9m$

Sol:→

$$E_1 = E_2$$

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

Now

$$Q = A_1V_1 = A_2V_2$$

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

$$y_1V_1 = y_2V_2$$

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

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

$$V_2 = 4V_1 \rightarrow ②$$

Put in equ①

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

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

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

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

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

$$\sqrt{V_1^2} = \sqrt{\frac{2.7 \times (2 \times 9.81)}{15}}$$

$V_1 = 1.879\,m/sec \rightarrow$ Put in equ②

$$V_2 = 4V_1$$

$$V_2 = 4(1.879) = 7.516\ m/sec$$

As

$$Q_1 = A_1V_1 = by_1V_1$$

$$= 3.9 \times 3.6 \times 1.879$$

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

$$Q_2 = A_2V_2 = by_2V_2$$

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

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

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

(1):→ Froud number → at upstream side.

$$fr_1 = \frac{V_1}{\sqrt{gy_1}} = \frac{1.879}{\sqrt{9.81 \times 3.6}}$$

$Fr_1 = 0.31$ → subcritical flow.

2): → Froud number at downstream side

$$Fr_2 = \frac{V_2}{\sqrt{g y_2}} = \frac{7.516}{\sqrt{9.81 \times 0.9}}$$

$Fr_2 = 2.52$ → super critical flow.