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Section A

Subject Hydroulic Engineering

Semester 6Th

Assignment 01, 02 & 03

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Assignment # 01.

Question 01.

Venture flume:- A venture flame is a critical 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 rate, usually given in millions of cubic units.

↳ A venturi meter would normally measure in millimeter, where as a venturi flume measure in meter.

↳ Measurement of discharge with venturi flume require the measurements one upstream and one at the throat. It the flow passes in subcritical state through the flume.

↳ If the flume are designed so as to pass the flume from sub critical to supercritical state while passing through at the flume.

Assignment 01.

Question 02

Given Data:-

Width of channel = b = 3m
Discharge given = Q = 12 m³/sec

Solution:-

a => Critical Depth

Discharge per unit width

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

$$q = 4\ m^2/sec$$

For Rectangular channel.

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

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

b => Minimum Specific Energy E_c = ?

For Rectangular channel

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

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

c ⇒ 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 $v = Q/A = q/h$

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

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

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

⇒ Iteration (From $h = 4$) gives $h = 3.948\ m$

So

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

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

So Alternate depth are 3.95m & 0.4814m

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Assignment 02

Question 01.

Solution:→

For Froud number

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

$$F_r = 6.06 > 1$$

So the flow is Super Critical.

Alternate Depth

As we know that

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

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

$$y_{alt} = 1.935\ m$$

Assignment 02

Question 02

Given Data:-

velocity $= v_1 = 2 m/s$

Depth $= y_1 = 3 m$

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

Down step $= 15 cm = 0.15 m$

Sol:- As we know that.

$$E_1 = y_1 + \frac{v_1^2}{2g}$$

$$E_1 = 3 + \frac{2^2}{2 \times 9.81}$$

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

Also

$$E_2 = E_1 - \Delta z$$

$$E_2 = 3.2 - 0.6$$

$$\boxed{E_2 = 2.60 m}$$

∴

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

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

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

$$\Delta y = y_2 - y_1$$

$$\Delta y = 2.24 - 3$$

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

water surface drop = 0.16 m

→ For down step of 15 cm or 0.15m

where

$$E_2 = E_1 - \Delta z$$

$$E_2 = 3.20 - (-0.15)$$

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

Now $y_2 = 3.17m$

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

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

So water surface rises 0.02m

→ Minimum up step possible before effecting upstream water surface

$$y_2 = y_c$$

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

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

$$\boxed{y_c = 1.54m}$$

Assignment 03

Question 01.

Given Data :-

Depth of water at upstream $y_1 = 3.6m$

" " " at downstream $y_2 = 0.9m$

width of sluice gate $= b = 3.9m$

Sol:-

As we know that

Specific energy on both side are same

So $E_1 = E_2$

Therefore

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

Also by Discharge formula

$$Q = A_1 V_1 = A_2 V_2$$

$$b_1 y_1 v_1 = b_2 y_2 v_2 \qquad b = b_1 = b_2$$

$$y_1 v_1 = y_2 v_2$$

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

$$v_2 = \frac{3.6}{0.9} \times v_1$$

$$\boxed{v_2 = 4 v_1} \quad \text{---} (2)$$

Putting the value of v_2 in eq (1)

$$y_1 = \frac{v_1^2}{2g} = y_2 + \frac{(4v_1)^2}{2g}$$

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

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

$$15v_1^2 = -2.7 \times 2g$$

$$\boxed{v_1 = 1.878 \, m/sec}$$

Now putting this value in eq (2)

$$v_2 = 4v_1$$

$$v_2 = 4(1.878)$$

$$\boxed{v_2 = 7.516 \, m/sec}$$

Also

$$Q_1 = A_1 v_1$$

$$Q_1 = b_1 y_1 v_1 = 3.9 \times 3.6 \times 1.879$$

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

$$Q_2 = A_2 v_2$$

$$Q_2 = b y_2 v_2 = 3.9 \times 0.9 \times 7.516$$

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

Froud Number at upstream Side:-

By formula

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

$$\boxed{Fr_1 = 0.31 < 1}$$

It is Sub Critical Flow

Froud Number at Downstream Side:-

$$Fr_2 = \frac{V_2}{\sqrt{gy_2}}$$

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

$$Fr_2 = 2.52$$

$$Fr_2 > 1$$

It is Super Critical Flow

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