Name:-

Osama Asghar Khan

ID #

7820

Section:-

A

Subject:-

Hydraulic Engineering

Assignment # 01

Question No.1.. What is venture flume? Explain

Answer:

VENTURE FLUME:
The term flume is applied to the devices in which the flow is locally accelerated due to

→ A streamlined lateral contraction in the channel sides.

→ The combination of the lateral contraction, together with a streamlined hump in the invert (channel bed).

→ 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.

→ Venture flumes are used in open-channels for the measurement of very large flow rates, usually given in millions of cubic units..

Question NO. 2

~~Solution~~

Given Data:-

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

Solution:-

(a) Discharge per unit width:

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

then rectangular channel

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

$\boxed{\text{Critical depth} = 1.18\ m}$

(b) For rectangular channel:-

$$E_c = \frac{3}{2} h_c \Rightarrow \frac{3}{2} \times 1.17$$

$$E_c = 1.766\ m$$

minimum specific energy = 1.77

1c) As $E > E_c$, there are two possible depth for a given specific energy

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

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

Substituting values in meter-second ~~with~~ 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 $h = 3.948$ m

For the supercritical solution

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

$$h = 0.4814 \text{ m}$$

alternate depths are 3.95m & 0.481m.

Assignment # 02

Question No. 1

Given Data:

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

$y_{alt} = ?$

Solution:

By checking Froud number:

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

$$\boxed{F_r = 6.81 > 1}$$

Flow is super critical

$$E = y + \frac{V^2}{2g} = 0.1 + \frac{6}{2 \times 9.81}$$

$E = 1.935$ m

For alternate depth $E = 1.935$ m

$$\boxed{y_{at} = 1.93}$$

Question No.2

Data:-

$V_1 = 2 m/s$

$y_1 = 3 m$

$\Delta z = 60 cm = 0.6 m$

downstep = 15 cm = 0.15 m

Solution:-

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

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

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

Now,

$$E_2 = E_1 - \Delta z$$

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

Also,

$$E_2 = y_2 + \frac{q^2}{2gy_2^2}$$

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

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

$$\Delta y = y_2 - y_1$$
$$= 2.24 - 3$$
$$\boxed{\Delta y = -0.76\,m}$$

So water surface drop = 0.16 m

=) For a downward slop of 15 cm or 0.15 m we have,

$$E_2 = E_1 - \Delta z = 3.20 - (-0.15)$$
$$\boxed{E_2 = 3.35\,m}$$

Now $y_2 = 3.17\,m$

$$\Delta y = y_2 - y_1 = 3.17 - 3$$
$$\Delta y = 0.17\,m$$

So water surface rises 0.02 m

=) The max upstep possible before effecting upstream water surface level is for.

$$y_2 = y_c$$
$$y_1 = \sqrt[3]{\frac{q^2}{g}}$$
$$= \sqrt[3]{\frac{6^2}{9.18}}$$
$$\boxed{y_1 = 1.54\,m}$$

Assignment # 03

Problem:-

A water passing from the slice gate in Dam having a depth of water at upstream side is 3.6m, after passing through slice gate the back water curve shows that depth of water at downstream side is 0.9m. The width of slice gate is 3.4m.

Determine:-

a) Discharge Q

b) Froud Number upstream & down stream

Given Data:

$y_1 = 3.6m$, $y_2 = 0.9m$, $b = 3.4m$

Solution:

$$E_1 = E_2$$

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

Now,

$$Q = A_1 V_1 = A_2 V_2$$

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

$$y_1 V_1 = y_2 V_2$$

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

$$= \frac{3.6}{0.4} \times V_1$$

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

Put in eq (1)

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

$$3.6 + \frac{V_1^2}{2g} = 0.4 + \frac{(4V_1)^2}{2g}$$

$$\frac{(V_1)^2}{2g} - \frac{16 V_1^2}{2g} = 0.4 - 3.6$$

$$\frac{V_1^2 - 16 V_1^2}{2g} = 0.4 - 3.6$$

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

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

$$\sqrt{V_2^2} = \sqrt{\frac{2.7 \times (2 \times 9.81)}{15}}$$

$V_2 = 1.879$ m/sec

Put in eq (2) we will get

$V_2 = 4 V_1$

$V_2 = 4(1.874) = \boxed{7.516 \text{ m/sec}}$

As,

$Q_1 = A_1 V_1 = b y_1 V_1$

$= 3.9 \times 3.6 \times 1.879$

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

$Q_2 = A_2 V_2 = b y_2 V_2$

$= 3.9 \times 0.4 \times 7.516$

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

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

(i) Froud Number at upstream side

$$Fr_1 = \frac{V_1}{\sqrt{g y_1}} = \frac{1.879}{\sqrt{9.81 \times 3.6}}$$

$\boxed{Fr_1 = 0.31}$ Subcritical flow

(2) Froud Number at downstream side

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

$$\boxed{Fr_2 = 2.52}$$

Supercritical flow