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Assignment#01

Question#01

Venture flume:-

The term flume is usually applied to devices in which the flow is accelarated due to a stream lined lateral contraction in channel sides and the combination of the lateral contraction, together with a stream lined hump in the inert 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.

↳ To ensure the occurance of critical depth at the throat, the flumes are usually designed in such away that it form a hydraulic jump on the down stream side of the structure and these are called standing wave flumes.

↳ Venture flumes are used in open channels for the ~~movemen~~ measurment of very large flow rates, usually given in millions of cubic units
For measurment of discharge with venture flumes, two measurments are required, one one upstream and other ~~on~~ at the throat., if the flow passes in a subcritical state through the flumes.

Question #02

Given data:

width of the channel = $b = 3m$

Discharge = $Q = 12\ m^3/sec$

Required,

a) critical depth = $y_c = ?$

b) minimum specific energy = $E_{min} = ?$

c) The alternate depths when $E = 4m$.

Solution:

a) For critical depth,

As we know

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

we also know that for rectangular channel,

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

$$\Rightarrow \boxed{y_c = 1.177 \ m}$$

b) For E_{min}

we know that

$$Q = A.V \quad — (i)$$

also $Q = q.b \ -(ii)$ $\because q = \frac{Q}{b}$

So

$$A.V = q.b$$

$$\cancel{b}.y.V = q.\cancel{b}$$

$$y.V = q$$

$$V = \frac{q}{y}$$

$$\Rightarrow \quad V = \frac{q}{y_c}$$

$$V = \frac{4}{1.177}$$

$$\Rightarrow \boxed{V = 3.398 \ m/sec}$$

~~th~~

we know that

$\because y = y_c \ , \ V = V_c$

$$E_{min} = y_c + \frac{(V_c)^2}{2g}$$

$$= 1.177 + \frac{(3.398)^2}{2 \times 9.81}$$

$$\Rightarrow \boxed{E_{min} = 1.766 \ m}$$

c)

As

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

$$\Rightarrow E = y + \frac{Q^2/A^2}{2g}$$

$\because Q = A \cdot V$

$\Rightarrow V = \frac{Q}{A}$

$$E = y + \frac{Q^2}{2g \cdot A^2}$$

$\because A = B \cdot y$

$$E = y + \frac{Q^2}{2g \cdot B^2 \cdot y^2}$$

$\because q = \frac{Q}{b}$

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

$\Rightarrow$

$$4 = y + \frac{4^2}{2 \times 9.81 \times y^2}$$

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

$$\Rightarrow \quad y = 4 - \frac{0.8155}{y^2}$$

By iteration,

when $y = 4$

$\Rightarrow y = 3.948\,m \approx 3.95\,m$

$\Rightarrow$ From the Super critical Solution, the 2nd term associated with K.E dominates

So, by re arranging

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

$$\Rightarrow$$

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

$$\Rightarrow y^2 = \frac{0.8155}{4-y}$$

$$\sqrt{y^2} = \sqrt{\frac{0.8155}{4-y}}$$

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

From iteration, at $y = 4$

$$\Rightarrow y = 0.4814 \text{ m}$$

Hence the alternate depths are

$y = 3.95$ m & $y = 0.481$ m

 7799

Assignment#02

Q #01:

Given data:

$y = d = 10cm = 0.1m$ ∴ $1m = 100cm$

$V = 6 \; m/sec$

Required:

$E = ?$

Solution:

By using Froud number

$$Fr = \frac{V}{\sqrt{gy}}$$

$$= \frac{6}{\sqrt{9.81 \times 0.1}}$$

$$Fr = 6.058$$

As $Fr > 1$

So the flow is Super critical

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

$\Rightarrow \boxed{E = 1.935m}$

which yields $\boxed{y = 1.935m}$

Q#2

Given data

$V = 2 m/sec$

$y = 3m$

Change in bottom deviation = 60cm = 0.6m

Gradual downward Step = 15cm = 0.15m

Solution,

As

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

$$\Rightarrow E_1 = y_1 + \frac{V_1^2}{2g} = 3 + \frac{2^2}{2 \times 9.81} = 3.20 m$$

Now For downward Step

$$E_2 = E_1 - \Delta Z$$

$$E_2 = 3.20 - 0.60$$

$$\Rightarrow E_2 = 2.60 m$$

So

$$E_2 = y_2 + \frac{V_2^2}{2g}$$

$$= y_2 + \frac{Q^2/A^2}{2g}$$

$$= y_2 + \frac{Q^2}{2g \cdot B^2 . y^2}$$

$\Rightarrow E = y_2 + \dfrac{q^2}{2g \times y^2}$; $q = \dfrac{Q}{b}$

$2.60 = y_2 + \dfrac{6^2}{2 \times 9.81 \times 3^2}$; $q = \dfrac{AV}{b}$

$q = \dfrac{\cancel{b} \cdot y \cdot V}{\cancel{b}}$

$\Rightarrow q = V \cdot y$

$q = 2 \cdot 3 = 6$

$\Rightarrow \boxed{y_2 = 2.34\,m}$

$\Delta y = y_2 - y_1 = 2.34 - 3$

$\Delta y = 0.76\,m$

So change in upset $= 0.76 - 0.6 = 0.16\,m$

For downward step

$E_2 = E_1 - \Delta Z = 3.2 - (0.15)$

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

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

$\Rightarrow y_2 = 3.17\,m$

So $\Delta y = \cancel{3.17}\ y_2 - y_1 = 3.17 - 3 = 0.17\,m$

Also the water in down step

$= 0.15 - 0.17$

$= -0.02$

Hence water rises to 0.02m

Now the maximum upstep possible before affecting upstream water lesser is for

$$y_2 > y_c$$

Hence,

$$y_c = \left(\frac{q^2}{g}\right)^{1/3} = \left(\frac{6^2}{9.81}\right)^{1/3}$$

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

Assignment#03

Question:

Given data:

water depth on upstream side (y_1) = 3.6m

water depth at downstream side (y_2) = 0.9m

width of Sluice gate (b) = 3.9m

Solution:

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 by discharge formula

$$Q = A_1 V_1 = A_2 V_2$$

$$\cancel{b_1} \cdot y_1 \cdot V_1 = \cancel{b_2} \cdot y_2 \cdot V_2 \qquad \because b = b_1 = b_2$$

$$y_1 \cdot V_1 = y_2 \cdot V_2$$

$$V_2 = \frac{y_1}{y_2} \times V_1 = \frac{3.6}{0.9} \times V_1$$

$$\Rightarrow V_2 = 4.V_1 \quad -(2)$$

(i) $\Rightarrow$

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

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

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

$$\Rightarrow + \frac{15 v_1^2}{2g} = +2.7$$

$$v_1^2 = \frac{2.7 \times 2 \times 9.81}{15} = 3.532$$

$$\Rightarrow \boxed{v_1 = 1.879 \text{ m/sec}}$$

(ii) $\Rightarrow$

$$V_2 = 4 V_1 = 4 \times 1.879 = 7.516 \text{ m/sec}$$

also

$$Q_1 = A_1 V_1$$

$$= b y_1 . V_1 = 3.9 \times 3.6 \times 1.879$$

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

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

So by Froud number, for upstream side

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

$Fr_1 = 0.316 < 1 \rightarrow$ flow is Subcritical

For down stream side

$$Fr_2 = \frac{V_2}{\sqrt{gy_2}} = \frac{7.516}{\sqrt{9.81 \times 0.9}}$$

$Fr_2 = 2.529 > 1$

So the flow is super critical