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Subject: hydraulic Engineering.

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Assignment#01

Part 1:- Venturi Flume:-

A venturi flume is a critical-flow open flume with a constricted flow which causes a drop in they hydraulic grade line, creating a critical depth.

It is used in flow measurment of very large flow rates, usually given in millions of cubic units. A venturi meter would normally measure in millimaters, whereas a venturi flume measures in meter.

Measurement of discharge with venturi flumes requires two measurment. one upstream & one at the throat (narrowest cross-section), if the flow passes in a sub-critical state through the flume. If the flumes are designed so as to pass the flow from sub-critical to super-critical state while passing through the flume, a single measurement at the throat (which in this case becomes a critical section) is ~~str~~ sufficient ~~from~~ for computation of discharge. To ensure the occurance of critical depth at the throat, the flumes are usually designed in such way as to form a hydraulic jump on the downstream side of the structure. These flumes are called standing wave flumes.

* Part 2

$b = 3\,m$

$Q = 12\,m^3 s^{-1}$

a) Discharge per unit width:

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

Then, for rectangular channel.

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

Answer: critical depth = 1.18m

(b) For rectangular channel.

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

minimum specific energy = 1.77 m

(c) As $E > E_c$ there are two possible depths for given specific energy.

$E \equiv h + \frac{v^2}{2g}$ where $v = \frac{Q}{A} = \frac{q}{h}$ (for rectangular channel)

$\Rightarrow E \equiv h + q^2/2gh^2$

Substituting values in metre-second units.

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

For the subcritical (slow, deep) solution, the first term, associated with potential energy dominates, so rearrange as:

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

Assignment # 02.

Pb 01

Solution:. Check Froude number

$$Fr = \frac{v}{\sqrt{gy}} = \frac{6\,m/s}{\sqrt{9.81/s^2 \cdot 0.1m}} = 6.06 > 1$$

So the flow is supercritical

$$E = y + \frac{v^2}{2g} = 0.1m + \frac{(6\,m/s)^2}{2 \cdot 9.81\,m/s^2} = 1.935\,m$$

Solving for the alternate depth for an $E = 1.935m$ yield y_ah 1.93m

Pb 2

Solution:. $E_1 = y_1 + \frac{v_1^2}{2g} = 3m + \frac{(2\,m/s)^2}{2 \cdot 9.81\,m/s^2} = 3.20m$

$$E_2 = E_1 - \Delta z = 3.28m - 0.60m = 2.60m$$

Also

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

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 $y_2 = 3.17\,m$ & $\Delta y = y_2 - y_1 = 0.17m$ So water surface rises $0.07m$.

The maximum upsteps possible before affecting upstream water surface - $y_2 = y_1$

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

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

Assignment # 03.

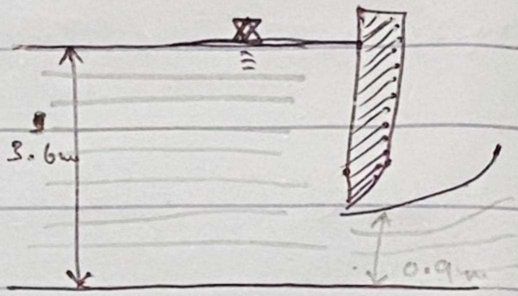
Given Data.

Depth of water at upstream side $y_1 = 3.6m$

Depth of water at downstream side $(y_2) = 0.9m$

width of sluice gate $(b) = 3.9m$.

Solution.



As we know that

Specific Energy on both bothstream are Same

So, $E_1 = E_2$

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

Also by discharge formula.

$$Q = A_1V_1 = A_2V_2$$

$$b_1y_1 \cdot V_1 = b_2y_2 \cdot V_2$$

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

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

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

$$= \frac{3.6}{0.9} \times V_1 \Rightarrow \boxed{V_2 = 4V_1} \quad \text{--- 2}$$

Puting the value of V_2 in eq (1)

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

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

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

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

$$\frac{v_1^2 - 16v_1^2}{2g} = -2.7$$

$$\cancel{-}\frac{15v_1^2}{2g} = \cancel{-}2.7$$

$$\sqrt{v_1^2} = \sqrt{\frac{2.7 \times 2(9.81)}{15}}$$

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

Putting the value of "v_1" in eq (2)

$$\Rightarrow v_2 = 4v_1$$
$$= 4(1.879)$$

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

Also $\Rightarrow Q_1 = A_1 v_1$

$$= by_1 \cdot v_1 \Rightarrow 3.9 \times 3.6 \times 1.879$$

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

$$\Rightarrow Q_2 = A_2 V_2$$
$$= by_2 \cdot v_2 \Rightarrow 3.9 \times 0.9 \times 7.516$$

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

$$\Rightarrow Q = Q_1 = Q_2 = 26.38 \text{ m/sec.}$$