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BE (C) Sec B

Semester 6th

Hydraulic Engineering

Assignments 1, 2, 3

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Assignment # 02

Question no 1:-

Venture flume:-

A venturi 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 measurment of very large flow rates, usually givens in millions of cubic units. A venturi meter would normally measure in millimeters, whereas a venturi flume measure in metres.

(i): Parshall flame:-

The parshall flame is an open channel flow metering device that was developed to measure the flow of surface waters and irrigation flows. The parshall flume is a fixed hydraulic structure. It is used to measure volumetric flow rate in industrial discharges, municipal sewer lines, and influent/effluent flows in wastewater treatment plants.

(ii) : **Cutthroat Flume:-**

The cutthroat flume is a class of flow measurement flume developed during 1966/1967 that is used to measure the flow of surface waters, sewage flows, and industrial discharges. Like other flumes, the cutthroat flume is a fixed hydraulic structure.

(iii) : **Montana Flume:-**

A montana flume is a popular modification of the standard Parshall flume. The montana flumes removes the throat and discharge sections of the Parshall flume, resulting a flume that is lighter in weight, shorter in length and less costly to manufacture.

Question no 2:-

A 3m wide channel carries a total discharge of 12 m³/sec. calculate
(a) The critical depth
(b) The minimum specific energy
(c) The alternate depths when. E = 4 m.

Solution:-

(a) Discharge per unit

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

Then for a 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 = 1.18 m

(b) For a rectangular channel

$$E_c = \frac{3}{2} h_c = \frac{3}{2} \times 1.177 = 1.776 m$$

minimum specific energy = 1.77 m

(c) As $E < E_c$, there are two possible depths 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 time

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

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

$$h = y \frac{0.8155}{h^2}$$

$$y = 3.45 \text{ ft.}$$

Assignment # 02

Problem 4.22:-

Water flows a depth of 10 cm with a velocity of 6 m/s in a rectangular channel is the flow subcritical or supercritical. What is the alternate depth.

Solution:-

Check Froude number

$$Fr = \frac{V}{\sqrt{gy}} = \frac{6 \text{ m/s}}{\sqrt{9.81/s^2 \; 0.1m}} = 1.95 \text{ m}$$

so the flow is supercritical

$$E = y + \frac{V^2}{2g} = 0.1m + \frac{(6m/s)^2}{2 \cdot 981 \text{ m/s}} = 1.935 \text{ m}$$

Solving for alternate depth for an $E = 1.935$ m yields $y_{alt} = 1.93$ m

Problem 4.36 :-

water flows with velocity of 2 m/s ....?

Solution:-

$$E = y_1 + \frac{V_1^2}{2g} = 3m + \frac{2 m/s^2}{2 \cdot 9.81 m/s^2}$$

$$= 3.20 \text{ m}$$

$$E_2 = E_1 - D_2 = 3.20 m - 0.60 m = 2.60 m$$

Also

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

so $y_2 = 2.24$ m $\Delta y = y_2 - y_1 = 0.76$ m

so water surface drops 0.16 m for a downward step of 15 cm we have

$$E_2 = E_1 - D_2 = 3.20 m - (-0.15 m)$$

$$= 3.35 \text{ m}$$

giving $y_2 = 3.17$ m and

$\Delta y = y_2 - y_1 = 0.17$ m and

water surface varies

0.02 m -

The maximum upstep possible before affecting upstream water surface level is for

$$y_2 = y_c$$

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

Assignment # 03

Problem 01 :-

A water passing from the slice gate in Dam .....?

Given data:-

$y_1 = 3.6\,m$

$y_2 = 0.9\,m$

$b = 3.9\,m$

Solution:-

As we know that

$$E_1 = E_2$$

$$y_1 + \frac{v_1^2}{2g} = y_2 + \frac{V_2^2}{2g} \rightarrow (1)$$

Also

$$Q = A_1 V_1 = A_2 V_2$$

$$b_1 y_1 = b_2 y_2 - V_2 \qquad (b = b1 = b2)$$

$$b y_1 v_1 = b y_2 v_2$$

$$y_1 v_1 = y_2 v_2$$

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

$$V_2 = \frac{3.6 \times}{0.9} V_1 = 4 V_1 \rightarrow (2)$$

putting eq (1)

$$y_1 + \frac{v_1^2}{2g} = y_2 + \frac{V_2^2}{2g} = 3.6 + \frac{v_1^2}{2g}$$

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

$\boxed{V_1 = 1.879 \text{ m/sec}}$ put in eq (2) we get

$V_2 = 4V_1$

$Q_1 = A_1 V_1 = b y_1 . V_1$

$= 3.9 \times 3.6 \times 1.879$

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

$\Rightarrow Q_2 = A_2 V_2 = b y_2 . V_2$

$= 3.9 \times 0.9 \times 7.516$

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

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

(1) Froud Number → At upstream side

$$Fr_1 = \frac{V_1}{\sqrt{g y_1}} = \frac{1.879}{\sqrt{9.81 \times 3.6}} = 0.31$$

subcritical flow = 0.31

(2) Froud Number → At down stream side

$$Fr_2 = \frac{V_2}{\sqrt{g y_2}} = \frac{7.156}{\sqrt{9.81 \times 0.9}} = 2.52$$

Super critical flow = 2.52