Mid Term Exam

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Section = A

Subject = Hydraulics Engineering

Date 20/04/2020

QNO1 ⇒ A ⇒ Let Suppose a rectangular Channel, discharge R 7877 litre/sec of water into a 8m wide apron with zero slop, Mean velocity is R-220 Ft/sec

Calculate

(1) Height of hydralic Jump (in unit of Meter)

(2) Power absorbed due to hydralic Jump (in unit of KW)

(1) Height of hydralic Jumpe

As "q" is discharge per unit width

Discharge = 7877 lit/sec = $7.877 \, m^3/sec$

width of apron = 8m

Mean velocity = 7877 − 220 = 7657 ft/sec

$$= \frac{7657}{3.28} = 2334.45 \, m/sec$$

$q = Q/b$

$$q = \frac{7.877}{8} = \boxed{0.985 \, m^2/sec}$$

⇒ As Critical depth (y_c) is

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

$$y_c = \left(\frac{0.985^2}{9.81}\right)^{1/3} = 0.462\,m$$

$$\boxed{y_c = 0.462\,m}$$

⇒ Critical velocity

As $q = vy$

$v = q/y$

$v_c = q/y_c$

$$v_c = \frac{0.985}{0.462}$$

$$\boxed{V_c = 2.132\ m/sec}$$

As $v_1 > v_c$
Super-critic Flow

⇒ Water Depth on upstream side is ⇒ of hydrolic Jump

$Q = Av$

$Q = (by).v$

$$y = \frac{Q}{v.b}$$

$$y_1 = \frac{Q}{v_1.b} = \frac{7.877}{2.132 \times 8}$$

$$\boxed{y_1 = 0.462}$$

By Using Formula

$$y_2 = \frac{-y_1}{2} + \sqrt{\frac{y_1^2}{4} + \frac{2y_1 v_1^2}{g}}$$

$$y_2 = -\frac{0.462}{2} + \sqrt{\frac{(0.462)^2}{4} + \frac{2(0.462)(2.132)^2}{9.81}}$$

$$y_2 = -0.234 + \sqrt{0.053 + 0.428}$$

$\boxed{\cancel{y_2 = 0.4625}}$ $\boxed{y_2 = 0.6534}$

⇒ Difference in depth ⇒

$$\Delta y = y_2 - y_1$$

$\cancel{\Delta y = 0.4625 - 0.462} =$

$$\Delta y = 0.6534 - 0.462$$

$$\boxed{\Delta y = 0.1914}$$

⇒ As we know that

$$\Delta E = E_1 - E_2$$

Also, $Q_1 = Q_2$

$$A_1 v_1 = A_2 v_2$$

$$\cancel{b_1} y_1 v_1 = \cancel{b_2} y_2 v_2$$

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

$$V_2 = \frac{0.462 \times 2334.45}{0.6534}$$

$$\boxed{V_2 = 1650.62}$$

$\Rightarrow$ $\Delta E = E_1 - E_2$

$$\Delta E = \left(y_1 + \frac{V_1^2}{2g}\right) - \left(y_2 + \frac{V_2^2}{2g}\right)$$

$$E_1 - E_2 = 0.462 + \frac{(2334.45)^2}{2 \times 9.81} - 0.6534 + \frac{(1650.62)^2}{2 \times 9.81}$$

$$E_1 - E_2 = 267305.08 - 133580.97$$

$$\boxed{E_1 - E_2 = 133724.11\,m}$$

$\Rightarrow$ <u>Power Dissipation in hydralic Jump</u>

$$\Delta P = \gamma g Q (E_1 - E_2)$$

$$\Delta P = (1000)(9.81)(7.877)(133724.11)\,w$$

$$\boxed{\Delta P = 1033308004}$$

QNo1 Part B

Given Data

Channel width $(b) = 4m$

Discharge $= 7877\ ft^3/sec$

Height of upstream side $= 2.9m$

Height of downstream side $= 1.1m$

$\Rightarrow$ First we have to find downstream velocity

As Specific Energy is $E_1 = E_2$

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

Also from Discharge

$$Q = AV$$

$$\Rightarrow A_1 v_1 = A_2 v_2$$

$$\cancel{b_1} y_1 v_1 = \cancel{b_2} v_2 y_2$$

$$y_1 v_1 = y_2 v_2$$

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

$$v_2 = \frac{(2.9) v_1}{1.1} \quad \boxed{v_2 = 2.63 v_1} \rightarrow (2) \text{ put in eq } (1)$$

$$2.9 + \frac{v_1^2}{2g} = 1.1 + \frac{(2.63 v_1)^2}{2g}$$

$$\Rightarrow 2.9 + \frac{v_1^2}{2g} = 1.1 + \frac{6.91 v_1^2}{2g}$$

$$\Rightarrow \frac{v_1^2}{2g} - \frac{6.91 v_1^2}{2g} = 1.1 - 2.9$$

$$\Rightarrow -\frac{5.91 v_1^2}{19.62} = -1.8$$

$$\Rightarrow 5.91 v_1^2 = 1.8 \times 2 \times 9.81$$

$$\sqrt{v_1^2} = \sqrt{\frac{1.8 \times 2 \times 981}{5.91}}$$

$$\boxed{v_1 = 2.44 \, m/sec}$$

$\Rightarrow$ Put in eq 2

$$v_2 = 2.63 \, v_1$$

$$v_2 = (2.44) \, 2.63$$

$$\boxed{v_2 = 6.41 \, m/sec}$$

Type of Flow using Froud Number

(1) On upstream Side ⇒

$$Fr_1 = \frac{V_1}{\sqrt{g y_1}}$$

$$Fr_1 = \frac{2.44}{\sqrt{9.81 \times 2.91}} = 0.45$$

$0.45 < 1$, It's mean Sub-critical flow)

(2) On Down Stream side

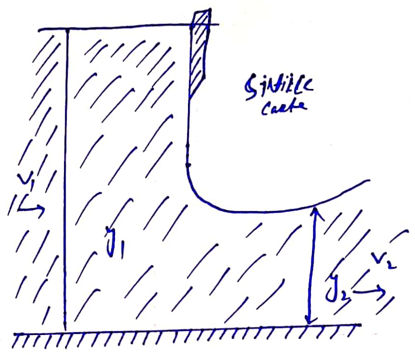
$$Fr_2 = \frac{V_2}{\sqrt{g y_2}}$$

$$Fr_2 = \frac{6.41}{9.81 \times 1.1} = 1.95$$

$1.95 > 1$

It's meam Super critical flow

Diagramatically



Q No 2 A ⇒ What is the minimum height (In unit of meter) of broad Crested weir if it is to function Critical depth on the Crese. If water flows along a rectangular Channel at a depth of 1.8m with a discharge of Q = 7877 Ft^3/sec the channel width is 66Ft.

Given Data

depth of Channel = 1.8m

Discharge = 7877 ft^3/sec = 223.23 m^3/sec

Width of Channel = 66ft = 20.121m

P = weir height =

(8) (9)

Sol

As $Q = AV$

$V = Q/A = \frac{Q_1}{b \times y}$

$V_1 = \frac{223.23}{20.1 \times 1.8} = \boxed{6.17\ m/sec}$

⇒ Critical Depth

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

As $q = Q/b$

$q = \frac{223.23}{20.12} = \boxed{11.09}$

⇒ $y_c = \left(\frac{(11.09)^2}{9.81}\right)^{1/3}$

$\boxed{y_c = 2.323\ m}$

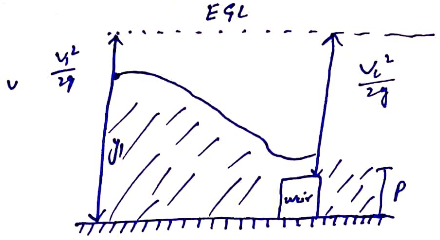
Also

$V = \sqrt{g y_c}$

$V_c = \sqrt{9.81 \times 2.323}$

$\boxed{V_c = 4.774\ m/sec}$

(10)



<u>From figure</u>

$$\frac{v_1^2}{2g} + y_1 = \frac{v_c^2}{2g} + y_c + P$$

$$\frac{(6.17)^2}{2\times 9.81} + 1.8 = \frac{(4.774)^2}{2\times 9.81} + 2.323 + P$$

$$1.940 + 1.8 = 1.162 + 2.323 + P$$

$$3.74 = 3.485 + P$$

$$\boxed{P = 0.255 m}$$

So the weir should have height of 0.255m measured from the channel bed.

QNo 2: B ⇒ An orific in one side of large tank is rectangular in Shape 2.8m broad and 1.5m deep. The water level on one side of the orifice is 5 meters above it's top edge. The water on the other side of the orific is 0.6m below it's top edge Caculate the discharge through the orific if Coefficient of discharge is Cd : 0.R

Give data

Breadth = 2.8m

Depth = 1.5m

Water level on one side (above its top edge) H_1 = 5m

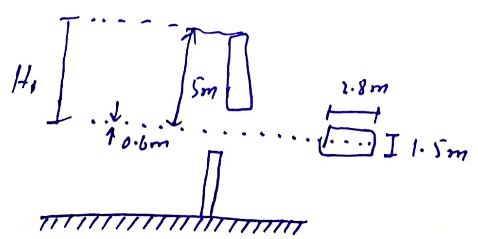
Water Level on other side = 5m + 1.5 = H_2 = 6.5m

Cd = 0.7877

H = 5.6m

Discharge = ?

Solution



As by using Formula

⇒ Discharge through Submerged Portion

$$Q_1 = Cd \times b \times (H_2 - H_1) \times \sqrt{2gh}$$

$$Q_1 = 0.7877 \times 2.8(6.5 - 5.6) \times \sqrt{2(9.81)(5.6)}$$

$$Q_1 = 8.257 \times 2.8(6.5 - 5.6)$$

$$\boxed{Q_1 = 20.807\ m^3/sec}$$

⇒ Discharge through Free portion

$$Q_2 = \frac{2}{3} cd \times b \sqrt{2g} \times H^{3/2} - H_1^{3/2}]$$

$$Q_2 = \frac{2}{3}(0.7877) \times 2.8) \sqrt{2 \times 9.81} \times 5.6^{3/2} - 5.0^{3/2}$$

$$Q_2 = 0.5251 \times 12.40 \times 13.25 - 11.18$$

$$\boxed{Q_2 = 13.48}$$

Total Discharge

$$Q_T = Q_1 + Q_2$$

$$Q_T = 20.807 + 13.48$$

$$\boxed{Q_T = 34.287\ m^3/sec}$$

QNO3 A ⇒ The diameter of a water pipe as Suddenly enlarged from R-200mm to R+3000mm, the rate of flow through is $0.95 m^3/sec$ and the pressure in the large pipe is R+800 N/m^2

Calculate

(1) The loss of head due to sudden enlargedment

(2) The power lost due to sudden enlargement

(3) The pressure in the smaller pipe (if the pipe is horizontal)

Given data

$d_1 = R - 200mm$

$d_1 = 7877 - 200 = 7677 mm$

$d_2 = R + 3000mm$

$d_2 = 7877 + 3000 = 10877 mm$

Flow rate $= 0.95 m^3/sec$

Pressure in larger pipe $= R + 800 N/m^3$

$= 7877 + 800 = 8677 N/m^3$

Solution

(1) The loss of head due to sudden enlargment:

$\Rightarrow d_1 = 7677m$

$A_1 = \frac{\pi}{4}(7677)^2 = \boxed{46.265 m^2}$

$\Rightarrow d_2 = 10877 mm = \boxed{10.877 m}$

$A_2 = \frac{\pi}{4}(10.877)^2 = \boxed{92.873}$

As we know that

$Q = AV$

$V_1 = Q/A$

$V_1 = \frac{0.95}{46.256} = \boxed{0.0205 m/sec}$

$\Rightarrow V_2 = \frac{Q}{A_2}$

$V_2 = \frac{0.95}{92.873} = \boxed{0.0102 m/sec}$

⇒ **By Formula of Sudden Enlargement**

$$he = \left(1 - \frac{A_1}{A_2}\right)^2 \times \frac{(0.0205 - 0.0102)^2}{2 \times 9.81}$$

$$he = \left(\frac{1 - 46.265}{92.873}\right)^2 \times \frac{(0.0205 - 0.0102)^2}{2 \times 9.81}$$

$$he = 1 \cancel{- 0.248}$$

$$\cancel{he = 0.4}$$

$$he = (1 - 0.498)^2 \times (5.204 \times 10^{-4})$$

$$he = 0.252 \times (5.204 \times 10^{-4})$$

$$\boxed{he = 1.311 \times 10^{-4} m}$$

(B) **Power lost due to Sudden Enlargement**

⇒ $P = \rho g Q \, he$

$$P = (1000)(9.81)(0.95)(1.311 \times 10^{-4})$$

$$\boxed{P = 1.222}$$

(c) **Pressure in the Smaller pipe:**

By Using Bornoulli's Equation

$$\frac{P_1}{\rho g} + \frac{V_1^2}{2g} = \frac{P_2}{\rho g} + \frac{V_2^2}{2g} + h_e$$

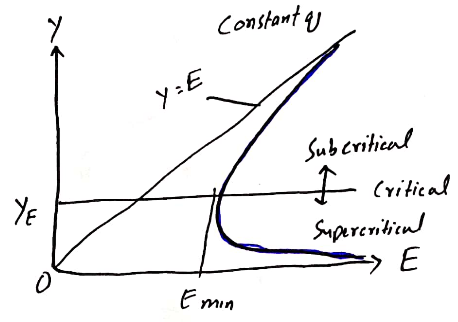
$$\Rightarrow \frac{P_1}{(1000)(9.81)} + \frac{(0.0205)^2}{2 \times 9.81} = \frac{8677}{1000 \times 9.81} + \frac{(0.0102)^2}{2 \times 9.81} + 1.311 \times 10^{-4}$$

$$\frac{P_1}{9810} + 0.0000203 = 0.8845 + 5.303 \times 10^{-6} + 1.311 \times 10^{-4}$$

$$\frac{P_1}{9810} = 0.8846$$

$$\boxed{P_1 = 8677 \ N/m^2}$$

QNO3 B



What does this blue curve indicates. How it is obtained. Explain the above figure from each and every point of view.

Ans

First we define Specific Energy as " Specific Energy is a parameter that can be used to crarify the meaning of Super Critical, Sub critical and Critical flow in an open channel.

Critical depth

Critical depth is the depth corresponding to minimum specific energy

↳ $y > y_c$, $E > E_{min}$ (Sub critical flow)
↳ $y = y_c$, $E = E_{min}$ (Critical flow)
↳ $y < y_c$, $E < E_{min}$ (Super critical flow)

In the three degree polynomial equallion it can be use to prepare a plot of Specific Energy 'E'