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ID : 7845

SUBBMITTED TO : Engr. FAWAD AHMAD

SUBJECT : HYDRULIC ENGINEERING

MODULE : "6th"

SECTION : B

DATE : 22, APRIL, 2020.

QNo.1 PART (A).

Given data:

Channel width = $b = 8m$

Discharge = $Q = 7845$ ltr/sec $= 7.845\ m^3/sec$

Mean velocity $= V = R - 220$ ft/sec $= 7845 - 220$

$= 7625/3.28$

$= 2324.695122\ m$

As we know that.

$Q = qb$

$q = Q/b = 7.845/8 = 0.980625$

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

$$= \left(\frac{(0.98065)^2}{9.81}\right)^{1/3}$$

$$\Rightarrow y_c = 0.46109$$

As it is rectangular Section.

$$Q = qb \longrightarrow (1)$$

$$Q = AV \longrightarrow (2)$$

Equating (1) & (2)

$$qb = AV$$

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

$$q = yV$$

$$V_c = \frac{q}{y_c} = \frac{0.98065}{0.46109}$$

$$V_c = 2.126808215$$

$\therefore$ $V > V_c$ (Super critical flow)

weight of hydraulic Jump in the upstream Side.

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As

$$Q = AV$$

$$Q = byV$$

$$y_1 = \frac{Q}{bV_1}$$

$$y_1 = \frac{7.845}{8 \times 2324.695122}$$

$$y_1 = 0.00042$$

$$y_2 = \frac{-y_1}{2} + \sqrt{\frac{(y_1)^2}{4} + \frac{2 y_1 V_1^2}{g}}$$

$$y_2 = \frac{-0.00042}{2} + \sqrt{\frac{(0.00042)^2}{4} + \frac{2(0.00042)(2324.695122)^2}{9.81}}$$

$$y_2 = 21.511$$

$$\Rightarrow \Delta y = y_2 - y_1$$

$$\Delta y = 21.511 - 0.00042$$

$$\Delta y = 21.51058$$

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

As we know that

$$Q_1 = Q_2$$

$$A_1 V_1 = A_2 V_2 \qquad \therefore b_1 = b_2 = b$$

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

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$$V_2 = \frac{y_1 v_1}{y_2}$$

$$V_2 = \frac{(0.00042)(2324.695122)}{21.511}$$

$$V_2 = 0.4538 \text{ m/sec}$$

$$\Delta E = E_1 - E_2 = \left(y_1 + \frac{v_1^2}{2g}\right) - \left(y_2 + \frac{v_2^2}{2g}\right)$$

$$= \left(0.00042 + \frac{(2324.695122)^2}{2(9.81)}\right) - \left(21.511 + \frac{(0.4538)^2}{2(9.81)}\right)$$

$$\Delta E = 275422.2817$$

⇒ Power Absorbed:-

$$\Delta P = \rho g Q \Delta E$$

$$\Delta P = 1000 \times 9.81 \times 7.845 \times 275422.2817$$

$$\Delta P = 21196347.32 \text{ KN}.$$

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QNo.1 Part "B"

Given data:

$B = 4m$

$Q = 7845\ ft^3/sec$

$Q = 7845/(3.28)^3 = 222.3163\ m^3/sec$

$y_1 = 2.9m$

$y_2 = 1.1\ m$

Let Specific energy at upstream and ~~downward~~ downstream side

$E_1 = E_2$

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

As we know that.

$Q = A_1V_1 = A_2V_2$

$= \cancel{b}y_1V_1 = \cancel{b}y_2V_2 \qquad \therefore b = b_1 = b_2$

$$V_2 = \frac{y_1V_1}{y_2} = \frac{(2.9)V_1}{1.1} = 2.634V_1 \rightarrow (2)$$

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Put value of eq (2) in (1)

$$2.9 + \frac{v_1^2}{2(9.81)} = 1.1 + \frac{(2.634v_1)^2}{2(9.81)}$$

$$2.9 - 1.1 = \frac{6.938v_1^2}{19.62} - \frac{v_1^2}{19.62}$$

$$1.8 = \frac{6.938v_1^2 - v_1^2}{19.62}$$

$$1.8 \times 19.62 = 5.938v_1^2$$

$$v_1^2 = \sqrt{\frac{1.8 \times 19.62}{5.938}}$$

$$v_1 = 2.44 \text{ m/sec}$$

Now Put the value of "v_1" in equation 1

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

$$2.9 + \frac{2.44}{2g} = 1.1 + \frac{v_2^2}{2g}$$

$$2.9 - 1.1 = \frac{v_2^2}{2g} - \frac{5.95}{2g}$$

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$$1.8 = \frac{V_2^2 - 5.95}{2g}$$

$$1.8 \times 2 \times 9.81 = V_2^2 - 5.95$$

$$\sqrt{V_2^2} = \sqrt{41.266}$$

$$V_2 = 6.42 \text{ m/sec}$$

Using Froud No to determine type of flow

<u>UPStream Side</u> :

$$Fr_1 = \frac{V_1}{\sqrt{g y_1}} = \frac{2.44}{\sqrt{9.81 \times 2.9}}$$

$$Fr_1 = 0.457$$ (Subcritical flow)

<u>Downstream Side</u> :

$$Fr_2 = \frac{V_2}{\sqrt{9.81 \times 1.1}} = 1.95 > 1$$

(Super critical flow)

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QNo. 2

Part (A).

Given data:

$Y_1 = 1.8\,m$

$b = 66' = 66/3.28 = 20.12\,m.$

$Q = \frac{7845}{(3.28)^3} = 222.316\ m^3/sec$

Required Data:

Minimum height (P) of weir

$Q = AV$

$V = \frac{Q}{A} = \frac{Q}{by} = \frac{222.31}{(20.12)(1.8)}$

$V = 6.138\ m/sec$

As we know that

$y_c = \left(\frac{q^2}{g}\right)^{1/3} = \left(\frac{(11.04)^2}{9.81}\right)^{1/3}$ $\therefore q = \frac{Q}{b} = \frac{222.31}{20.12} = 11.04$

$y_c = 2.316\ m$

Also $V = \sqrt{gy} = \sqrt{gy_c}$

$V = \sqrt{9.81 \times 2.316}$

$V_c = 4.766\ m/Sec$

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Now According to Specific Energ.

$E_1 = E_2$

$$y_1 = \frac{V_1^2}{2g} = \frac{V_c^2}{2g} + y_c + P$$

$$1.8 + \frac{(6.138)^2}{2(9.81)} = \frac{(4.766)^2}{2(9.81)} + 2.316 + P$$

$$3.720 = 1.157 + 2.316 + P$$

$$3.720 = 3.473 + P$$

$$P = 3.720 - 3.473$$

$$P = 0.247.$$

Q 2 **Part B**

Given data:

$b = 2.8\,m$

$d = 1.5\,m$

$H_1 \; 5\,m$

$H_2 = 5 + 1.5 = 6.5\,m$

$H = 5 + 0.6 = 5.6\,m$

$Cd = 0.7845$

(10)

Required Data:

$Q = ?$

Discharged throug Submerged Portion

$Q_1 = cd \times b \times (H_2 - H) \times \sqrt{2gh}$

$Q_1 = 0.7845 \times 2.8 \times (6.5 - 5.6) \times \sqrt{2(9.81)(5.6)}$

$Q_1 = 20.72 \ m^3/sec$

Discharge of Free Portion

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

$Q_2 = 2/3(0.7845) \times 2.8 \sqrt{2 \times 9.81} \left[5.6^{3/2} - 5^{3/2} \right]$

$Q_2 = 13.437$

Total Discharge

$Q = Q_1 + Q_2$

$Q = 20.72 + 13.437$

$Q = 34.157 \ m^3/sec.$

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Q No 3 (A)

Given Data

$$P_1 = R + 800 = 7845 + 800 = 8645 \, N/m^2$$

$$d_1 = R - 200 = 7845 - 200 = 7645mm = 7.645m$$

$$A_1 = \frac{\pi}{4} d_1^2 = \frac{\pi}{4}(7.645)^2 = 45.90 \, m^2$$

$$d_2 = R + 3000 = 7845 + 3000 = 10845mm = 10.845m$$

$$A_2 = \frac{\pi}{4}(10.845)^2 = 92.37 \, m^2$$

$$Q = 0.95 \, m^3/sec$$

$$Q = AV$$

$$V_1 = \frac{Q}{A} = \frac{0.95}{45.90} = 0.0206 \, m/sec$$

$$V_2 = \frac{0.95}{92.37} = 0.0102 \, m/sec$$

(i) Head loss due to sudden enlargement

$$h_e = \left(1 - \frac{A_1}{A_2}\right)^2 \left(\frac{V_1 - V_2}{2g}\right)^2$$

$$= \left(1 - \frac{45.90}{92.37}\right)^2 \left(\frac{0.0206 - 0.0102}{2 \times 9.81}\right)^2$$

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$h_e = 1.020 \times 10^{-4}$

(2) Power lost due to sudden enlargment

$P = \rho g Q h_e$

$P = 1000 \times 9.81 \times 0.95 \times 1.02 \times 10^{-4}$

$P = 0.94\ W$

(3) pressure in the smallest pipe Apply Bernoullie eqn:

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

$$\frac{8645}{1000 \times 9.81} + \frac{0.0206^2}{2(9.81)} = \frac{P_2}{1000 \times 9.81} + \frac{0.010^2}{2 \times 9.81} + 1.02 \times 10^{-4}$$

$$\frac{P_2}{1000 \times 9.81} = 0.88126 - 1.0709 \times 10^{-4}$$

$$P_2 = 0.88115 \times 9810$$

$$P_2 = 8645.16\ N/m^2$$

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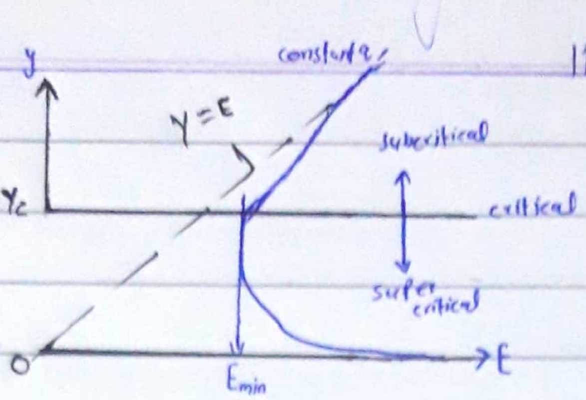
QNo# 3

Part (B)



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

ANS: The above graph is plot between depth flow (y) & Specific Energy (E) polynomical equation which Shows us the different Specific Energy for the depth flow which may be either

i) Sub Critical
ii) Critical
iii) Super critical

Specific energy is used to clarify the meaning of the above terms (in an open channel.

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How is this Acheived?

Total Energy = potential Energy + Kinetic

$$TE = mgh + \frac{1}{2} mv^2 \qquad W = mg \qquad m = w/g$$

$$= Wh + \frac{1}{2} \frac{w}{g} v^2$$

ignoring "W" weight of water

$$TE = h + \frac{v^2}{2g} \Rightarrow \boxed{TE = y + \frac{v^2}{2g}} \text{ —(i)}$$

As we Know that

$$Q = VA \qquad V = Q/A \quad \text{Squaring b s}$$

$$v^2 = Q^2/A^2 \quad \text{put } v^2 \text{ in eq (i)}$$

Let's Suppose the channel is Rectangular

$$A = y \times b \text{ —(x)}$$

$$Q = q\, b \rightarrow \text{(y)}$$

putting value of (x) and y in 2

$$E = y + \frac{Q^2}{y^2 b^2 2g} \quad \text{(putting x)}$$

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$$E = y + \frac{q^2}{y^2 2g} \Rightarrow y^2(E-y) = \frac{q^2}{2g}$$

$$(E-y)\,y^2 = \text{Constant}$$

As "q" and "g" are Constant

* Critical depth is the flow depth Corresponding to minimum Specific Energy.

$y > y_c \Rightarrow$ Sub Critical flow

$y = y_c \Rightarrow$ Critical flow

$y < y_c \Rightarrow$ Super Critical flow

THE END