NASRULLAH

7870

B

HYDRAULIC ENGG

6th

Q1 (A)

Given Data

Channel width $= b = 8m$

Discharge $= Q = 7870\, l/sec = 7.870\, m^3/sec$

Mean velocity $= V = 7870 - 220 = 7650\, ft/sec$

$$= \frac{7650}{3.28}$$

$$= 2332.31\, m/sec$$

Sol

1- Height of hydraulic jump.

$$Q = qb$$

$$= \frac{7.870}{8} = 0.983\, m^2/sec$$

$\Rightarrow$ critical Depth y_c

$$y_c = \left(\frac{q^2}{g}\right)^{1/3} = \left(\frac{(0.983)}{9.81}\right)^{1/3}$$

$$y_c = 0.461\, m$$

$\Rightarrow$ Critical velocity V_c

$$q = yV$$

$$V_c = q/y_c = \frac{0.983}{0.461}$$

$$V_c = 2.13\, m/sec$$

Depth of water on upstream side

$Q = AV$

$Q = byV$

$y = Q/V \times b$

$= \frac{7.870}{2332.3 \times 8}$

$y_1 = 0.00042m$

Now

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

$$= \frac{-0.00042}{2} + \sqrt{\frac{(0.00042)^2}{4} + \frac{2(0.00042)(2332.3)^2}{9.81}}$$

$y_2 = 21.58m$

Difference in Depth

$\Delta y = y_2 - y_1$

$= 21.58 - 0.00042$

$= 21.58$

$\Rightarrow \Delta E = E_1 - E_2$

As we know that

$Q_1 = Q_2$

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$$A_1V_1 = A_2V_2$$

$$\cancel{b}y_1v_1 = \cancel{b}y_2v_2$$

$$v_2 = \frac{y_1v_1}{y_2}$$

$$v_2 = \frac{(0.00042)(2332.3)}{21.58}$$

$$V_2 = 0.045\ m/s$$

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

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

$$= \left(0.00042 + \frac{(2332.3)^2}{2(9.81)}\right) - \left(21.58 + \frac{(0.045)^2}{2(9.81)}\right)$$

$$= 277248.893 - 21.58$$

$$E_1 - E_2 = 299\ 227.313$$

2) power absorbed

$$\Delta p = \rho g Q (E_1 - E_2)$$

$$(1000)(9.81)(7.870)(299227.313)$$

$$= 2.3101 \times 10^{10}\ W$$

$$\boxed{\Delta p = 23101754.93\ KW}$$

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Q1 (b)

Given Data

$b = 4m$

$Q = 7870 ft^3/sec = \frac{7870}{(3.28)^3} = 223.02 m^3/sec$

$y_1 = 2.9m$

$y_2 = 1.1m$

Let Specific Energy at upstream & Downstream side

$$E_1 = E_2$$

$$y_1 + \frac{V_1^2}{2g} = y_2 + \frac{V_2^2}{2g} \rightarrow ①$$

As we know that

$$Q = A_1 V_1 = A_2 V_2$$

$$b y_1 V = b y_2 V_2$$

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

$$V_2 = \frac{2.9}{1.1} V$$

$$V_2 = 2.634 V_1 \quad — ②$$

put the value of equ ② in eq ①

$$2.9 + \frac{V_1^2}{2 \times 9.81} = 1.1 + \frac{(2.634 V_1)^2}{2 \times 9.81}$$

$$2.9 - 1.1 = \frac{6.938 V_1^2}{19.62} - \frac{V_1^2}{19.62}$$

$$1.8 = \frac{6.938 V_1^2 - V_1^2}{19.62}$$

$$1.8 \times 19.62 = 5.938 V_1^2$$

$$V_1^2 = \sqrt{\frac{1.8 \times 19.62}{5.938}}$$

$$V_1 = 2.44 \, m/sec$$

Now put the value of "V_1" in eq ①

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

$$2.9 + \frac{2.44^2}{2g} = 1.1 + \frac{V_2^2}{2g}$$

$$2.9 - 1.1 = \frac{V_2^2}{2g} - \frac{5.95}{2g}$$

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

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

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

$$V_2 = 6.42 m/Sec$$

Using Froud No to Determine type of Flow.

Up Stream side:-

$$Fr_1 = \frac{V_1}{\sqrt{gy_1}} = \frac{2.44}{\sqrt{9.81 \times 2.9}} = 0.457 < 1$$

(Subcritical flow)

Downstream side:-

$$Fr_2 = \frac{V_2}{\sqrt{gy_2}} = \frac{6.42}{\sqrt{9.81 \times 1.1}} = 1.95 > 1$$

(Supercritical flow)

Q2 (A)

Given Data:

Channel Depth, $y = 1.8m$

Channel width, $b = 66ft = 20.1m$

Discharge, $Q = \frac{7870 ft^2}{(3.28m)^3} = 223.02 m^2/sec$

Required?

weir weight $= P = ?$

Sol

$Q = AV$

$V = Q/A$

$V_1 = Q/by$

$= \frac{223.02}{20.1 \times 1.8}$

$V_1 = 6.164 m/sec$

3 critical Depth y_c:

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

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

$$y_c = \left(\frac{(223.02)^2}{(20.1)^2 (9.81)}\right)^{1/3}$$

$$y_c = 2.723m$$

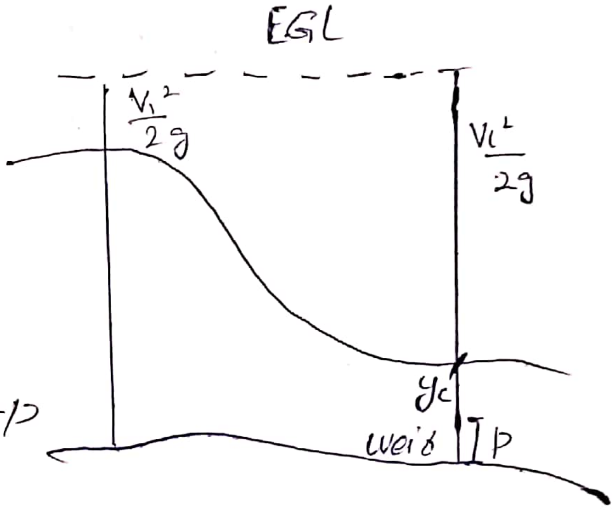
Also $v = \sqrt{gy}$

$$V_c = \sqrt{g y_c}$$

$$\sqrt{9.81(2.323)}$$

$$V_c = 4.77\ m/sec$$

From Fig



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

$$\frac{(6.164)^2}{2(9.81)} + 1.8 = \frac{(4.77)^2}{2(9.81)} + 2.323 + P$$

$$3.736 = 3.482 + P$$

$$P = 3.736 - 3.482$$

$$P = 0.2533\ m$$

Thus the height of weir is 0.2533 from Channel bed.

Q2 (13)

Given Data :

$b = 2.8m$

$a = 1.5m$

$H_1 = 5m$

$H_2 = 1.5 + 5m = 6.5m$

$H = 5 + 0.6 = 5.6m$

$Cd = 0.7870$

Sol

Discharge through submerge portion

$Q_1 = Cd \times b \times (H_2 - H) \times \sqrt{2gH}$

$= 0.7870 \times 2.8 \times (6.5 - 5.6) \times \sqrt{2(9.81)(5.6)}$

$= 20.788 \, m^2/sec$

Discharge through Free portion

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

$= 2/3 \times 0.7870 \times 2.8 \sqrt{2(9.81)} \left[(5.6)^{3/2} - (5)^{3/2} \right]$

$= 13.48 \, m^3/sec$

Total Discharge

$Q = Q + Q_2$

$Q = 20.788 + 13.48$

$\boxed{Q = 34.268 \, m^3/sec}$

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Q3 (A) Given Data

$d_1 = R - 200$
$= 7870 - 200 = 7670mm = 7.670m$
$d_2 = R + 3000 = 10870mm = 10.870m.$

Flow rate $= Q = 0.95 m^3/sec$
pressure in Layer pipe $= R + 800$
$= 7870 + 800$
$= 8670$

Sol

1) Head loss due to sudden enlargment

$d_1 = 7.670mm$

$A_1 = \frac{\pi}{4} d^2 = \frac{\pi}{4}(7.670)^2$

$A_1 = 46.20$

$d_2 = 10.870$

$A_2 = \frac{\pi}{4} d^2 = \frac{\pi}{4}(10.870)^2$

$A_2 = 92.80 m^2$

$\Rightarrow$ As $Q = AV$
$V = Q/V$

$V_1 = Q/A_1 = \frac{0.95}{46.20}$

$V_1 = 0.020 m/sec$

Similarly $V_2 = Q/A_2 = \frac{0.95}{92.00} = 0.010 m/sec$

Scanned with CamScanner

By Formula

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

$$\left(1 - \frac{46.20}{92.80}\right)^2 \left(\frac{0.020 - 0.010}{2(9.81)}\right)^2$$

$$0.2521 \times 5.096 \times 10^{-6}$$

$$h_e = 1.284 \times 10^{-6}$$

2) Power lost due to Sudden enlargment

$$P = \rho g Q h_e$$

$$= 1000 \times 9.81 \times 0.95 \times 1.284 \times 10^{-6}$$

$$P = 0.0119\,m$$

pressure in smaller pipe

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

$$\frac{P_1}{1000 \times 9.81} + \frac{(0.020)^2}{2(9.81)} = \frac{8670}{1000 \times 9.81} + \frac{(0.01)^2}{2(9.81)} + 1.284 \times 10^{-6}$$

$$\frac{P_1}{9810} + 2.038 \times 10^{-5} = 0.8837$$

$$P_1 = 0.8836 \times 9810$$

$$P_1 = 8668.897\ N/m^2$$

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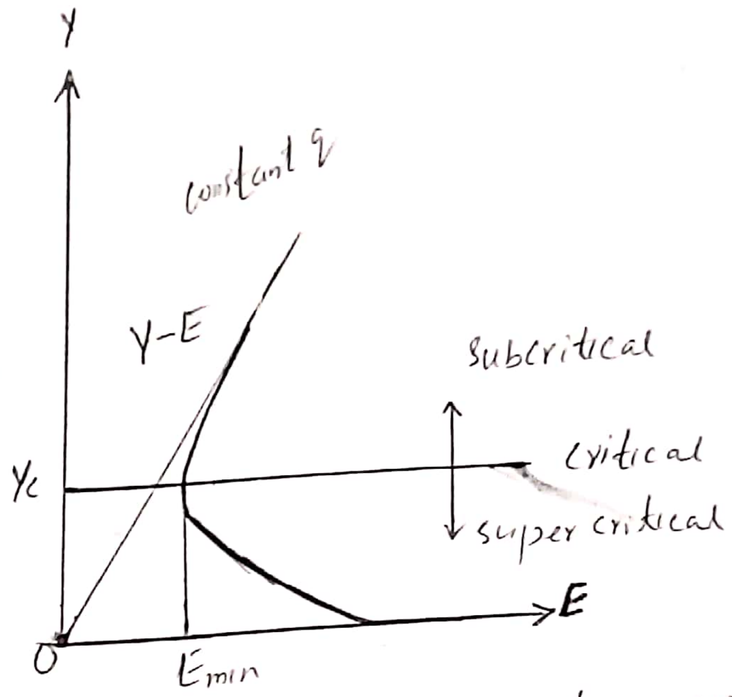
Q3
(B)



What does blue curve indicates. How it is obtained.

Explain the above figure from each and every point.

Ans The above graph is plot between Depth Flow (Y) and specific Energy (E) it is made from Three Degree polynomial equation which show us the different specific energy for the Depth Flow which may be either.

(i) Sub critical
(ii) critical
(iii) Supercritical.

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

HOW is This Acheid?

total Energy = potential Energy + kinetic

$$T.E = mgh + \frac{1}{2} mv^2 \qquad \because w = mg, \quad m = w/g$$

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

ignoring "w" weight of water

$$T.E = y + \frac{v^2}{2g} \quad \text{—— (1)}$$

As we know that

$$Q = VA$$

$$V = Q/A$$

Squring b.HS

$$V^2 = Q^2/A^2$$

put v^2 in eq (1)

$$E = y + \frac{Q^2}{A^2 2g} \quad \text{—— (2)}$$

let's Suppose the channel is Retengular

$$A = y \times b \quad \text{— (x)}$$

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

puting value of (x) & (y) in (2)

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

$$E = y + \frac{q^2}{y^2 2g} \quad \text{— (puting y)}$$

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

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

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

As "q" and "g" are constant

* Critical Depth is the flow depth corresponding to minimum specific energy.

$y > y_c \rightarrow$ Subcritical Flow

$y = y_c \rightarrow$ Critical Flow

$y < y_c \rightarrow$ Super critical flow.