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ID 7862

SEC B

Hydraulic Eng

Qno # 1

Part -(A)

Given data

$Q = 7862 \text{ litre/sec} = 7.862 \text{ m}^3/\text{sec}$

$\text{Width} = 8m$

$\text{Mean velocity} = 7862 - 220 \text{ ft/sec} = 7642 \text{ ft/sec}$

$= 2396.338 \text{ m/sec}$

Solution :-

$$q = Q/b = \frac{7.862}{8} = 0.982 \text{ m}^3/\text{se}$$

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

$$y_c = \left[\frac{0.982^2}{9.81}\right]^{1/3} = \underline{0.461 \text{ m}}$$

As it is retangular Section,

$$Q = qb \quad — ① \quad , \quad Q = AV \quad — ②$$

Comparing

$$qb = AV$$

$$qb = b \times y \times V$$

$$q = yV$$

So

$$V_c = q/y_c = \left[\frac{0.982}{0.461}\right] = \underline{2.130 \ m/sec}$$

$\therefore$ $V > V_c$

Super Critical flow

$$Q = AV$$

$$Q = by \cdot V$$

$$y = \frac{Q}{b \cdot V} = \frac{7.862}{8 \times 2396.338} = \underline{0.00041 m}$$

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

$$y_2 = \frac{-0.00041}{2} + \sqrt{\frac{(0.0004)^2}{4} + \frac{2(0.0004)(2396.338)^2}{9.81}}$$

$$\boxed{y_2 = 21.64\,m}$$

$$\Delta y = y_2 - y_1 = 21.64 - 0.00041$$

$$\boxed{\Delta y = 21.63\,m}$$

Now for finding "V_2"

$$V_2 = y_1 V_1 / y_2$$

$$V_2 = \frac{0.00041(2396.338)}{21.64}$$

$$\boxed{V_2 = 0.044\ m/sec}$$

Now

$$\Delta E = E_1 - E_2$$

$$\Delta E = \left[y_1 + \frac{v_1^2}{2g}\right] - \left[y_2 + \frac{V_2^2}{2g}\right]$$

$$\Delta E = \left[0.0004 + \frac{(2396.338)^2}{2(9.81)}\right] - \left[210.64 + \frac{0.044}{2(9.81)}\right]$$

$$\Delta E = 292661.12 \text{ m}$$

So Power absorbed,

$$\Delta p = \rho g Q \left[E_1 - E_2\right]$$

$$\Delta p = 1000 \times 9.81 \times 7.862 \left[292661.12\right]$$

$$\boxed{\Delta p = 2.257 \times 10^{10} \text{ KW}}$$

Qno #1 part (b)

Given data

Width = 4m

$Q = 7862 \ ft^3/sec = 220.772 \ m^3/sec$

$y_1 = 2.9m$

$y_2 = 1.1m$

let:-

$E_1 = E_2$

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

As we know

$$V_2 = \frac{y_1 V_1}{y_2} = \frac{2.9}{1.1} V_1$$

$$\boxed{V_2 = 2.63\ v_1} \quad \text{— (2)}$$

Putting (2) in eq (1)

$$2.9 + \frac{v_1^2}{2 \times 9.81} = \frac{6.93\, v_1^2}{19.62} - \frac{v_1^2}{19.82}$$

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

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

$$\boxed{v_1 = 2.44\ m/sec} \quad \text{— (3)}$$

Now putting eq (3) in eq (1)

$$2.9 - 1.1 = \frac{v_1^2}{2g} - \frac{5.95}{2g}$$

$$1.8 = \frac{v_1^2 - 5.95}{2g}$$

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

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

To find type of flow

$$Fr = \frac{V_1}{\sqrt{g y_1}} \quad \text{(Upstream)}$$

$$Fr = \frac{2.44}{\sqrt{9.81(2.9)}} = 0.457 < 1$$

(Sub critical)

$$Fr = \frac{V_2}{\sqrt{g y_2}} \quad \text{(downstream)}$$

$$Fr = \frac{6.42}{\sqrt{9.81(1.1)}} = 1.95 > 1$$

(Super critical)

Q no # 2 part -(A)

Given data

$y = 1.8\,m$

$b = 66' = 20.12\,m$

$Q = 7862\ ft^3/sec = 220.77\ m^3/sec$

Solution

$Q = AV \quad \therefore \quad V = \dfrac{Q}{A} = \dfrac{Q}{b \times y}$

$V = \dfrac{220.77}{(20.12)(1.8)}$

$$\boxed{V = 6.095\ m/sec}$$

Now

$y_c = \left[\dfrac{q^2}{g}\right]^{1/3} \qquad \therefore \ q = \dfrac{Q}{b}$

$q = \dfrac{220.77}{20.12} = 10.97\ m^3/sec$

$$y_c = \left[\frac{(10.97)^2}{9.81}\right]^{\frac{1}{3}}$$

$$\boxed{y_c = 2.30 m}$$

As $V_c = \sqrt{g y_c} = \sqrt{9.81 \times 2.30}$

$$\boxed{V_c = 4.75 \ m/sec}$$

As we know

$$E_1 = E_2$$

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

$$1.8 + \frac{(6.095)^2}{2(9.81)} = \frac{4.75^2}{2 \times 9.81} + 2.30 + P$$

$$3.693 = \frac{4.75^2}{19.62} + 2.30 + P$$

$$P = \frac{3.693 \ (19.62}{4.75^2} - 2.30)$$

$$\boxed{P = 0.59\,kW}$$ Ans

Q no # 2 part (b)

Given data

$b = 2.8m$

$d = 1.5m$

$H_1 = 5m$

$H_2 = 5 + 1.5 = 6.5m$

$H = 5 + 0.6 = 5.6m$

$Cd = 0.7862$

Solution:- Discharge through Submerged

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

$$Q = 0.7862 \times 2.8 (6.5 - 5.6) \times \sqrt{2(9.81)(5.6)}$$

$$\boxed{Q = 20.76 \frac{m^3}{sec}}$$

Discharge of free Portion.

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

$$Q_2 = \frac{2}{3}(0.7862) \times (2.8)\left(\sqrt{2(9.81)}\right)\left[5.6^{3/2} - 5^{3/2}\right]$$

$$\boxed{Q_2 = 13.46 \ m^3/sec}$$

Now Total Discharge.

$$Q = Q_1 + Q_2$$

$$Q = 20.\cancel{78}6 + 13.46.$$

$$\boxed{Q = 34.22 \ m^3/se}$$

Qno # 3

Part - (A)

Given data

$$P_1 = R + 800 = 7862 + 800 = 8662 \; N/m^2$$

$$d_1 = R - 200 = 7862 - 200 = 7662 \; mm$$

$$A_1 = \frac{\pi}{4} d^2 = \frac{\pi}{4}(7.662m)^2 = 46.10 m^2$$

$$d_2 = R + 3000 = 7862 + 3000 = 10862 mm$$

$$= 10.862 m$$

$$A_2 = \frac{\pi}{4}(10.862)^2 = 92.66 m^2$$

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

Solution:-

$$V_1 = \frac{0.95}{46.10} \qquad \therefore V_1 = \frac{Q}{A_1}$$

$$\boxed{V_1 = 0.020 \, m/sec}$$

Now

$$V_2 = \frac{0.95}{92.66}$$

$$\boxed{V_2 = 0.0102 \, m/sec}$$

① Head losses due to enlargement.

$$h_e = \left[1 - \frac{A_1}{A_2}\right]^2 \frac{(V_1 - V_2)^2}{2g} = \left(1 - \frac{46.10}{92.66}\right)^2 \cdot \left[\frac{(0.020 - 0.0102)^2}{2 \times 9.21}\right]$$

$$\boxed{h_e = 1.23 \times 10^{-6}}$$

② Power loss due to enlargement.

$$P = \rho g Q h_e$$

$$P = 1000 \times 9.81 \times 0.95 \times 1.23 \times 10^{-6}$$

$$\boxed{P = 0.0115 \, W}$$

3) Pressure in the Smallest pipe

from Bernoullie equation

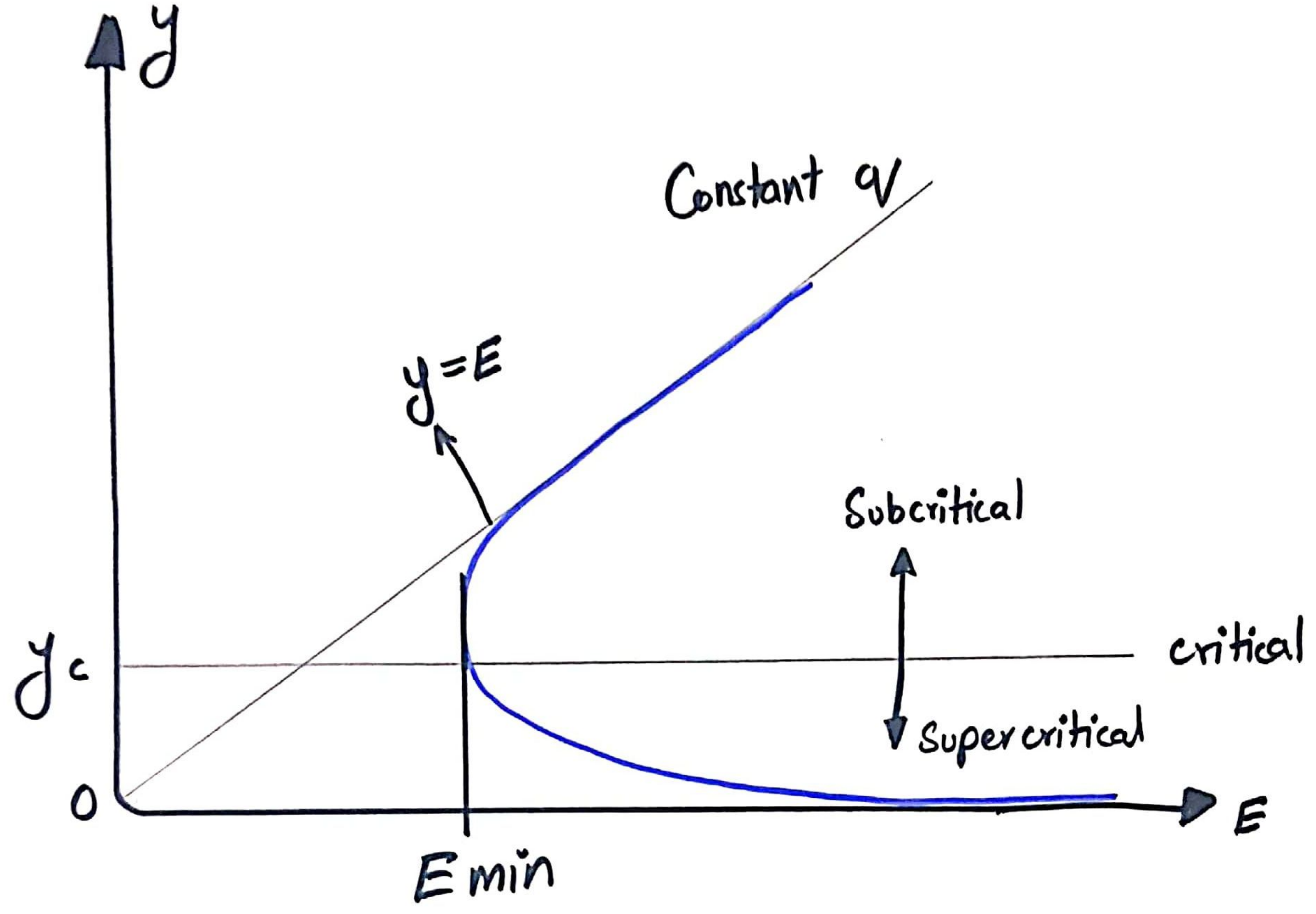
$$\frac{P_1}{\rho g} + \frac{V_1^2}{2g} = \frac{P_2}{\rho g} + \frac{V_2^2}{2g} + R_e$$

$$\frac{8662}{1000 \times 9.81} * \frac{(0.020)^2}{2 \times 9.81} = \frac{P_2}{1000 \times 9.81} + \frac{(0.0102)^2}{2g} + 1.23 \times 10^{-6}$$

$$0.8829 = \frac{P_2}{1000 \times 9.81} + \frac{(1.0404 \times 10^{-4})}{19.62} + 1.23 \times 10^{-6}$$

$$\boxed{P_2 = 8661.18 \ N/m^2}$$

Q no # 3 part -(b)



The above graph is plot between depth flow (y) and Specific energy (E). It is made from three degree polynomial equation. which shows us the different Specific energy for the depth flow which can be either

(i) Sub-critical.
(ii) Critical.
(iii) Super critical.

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

As we know

Total energy = P.E + K.E

$$T.E = mgh + \frac{1}{2}mv^2$$

As $m = \frac{w}{g}$, $w = mg$

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

Ignoring 'w'

$$T.E = h + \frac{1}{2g}v^2 \quad \therefore h = y$$

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

We know that

$$Q = VA$$

$$V = \frac{Q}{A} \quad \therefore \text{by squaring}$$

$$v^2 = \frac{Q^2}{A^2}$$

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

let Suppose channel is rectangular.

$$A = y \times b \quad - (x)$$

$$Q = q b \quad - (y)$$

putting (x) & (y) in eq (2)

$$E = y + \frac{q^2 \cancel{b^2}}{y^2 \cancel{b^2} 2g}$$

$$E = y + \frac{q^2}{2gy^2}$$

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

$$(E-y)\, y^2 = \text{Constant} \quad - (3)$$

As q & g are Constant.

Critical depth is flow depth Corresponding to min Specific energy.

$y > y_{cr}$ Sub-critical flow

$y = y_{cr}$ Critical flow

$y < y_{cr}$ Super-critical flow

END