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Subject:- Fluid mechanics

department:- B-Tech (civil)

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(Q1)

Determine the presure at a point A in the figure if $h_1 = 0.2$ m and $h_2 = 0.3$ m. Use $\rho_{water} = 1000\ kg/m^3$.

Solution:-

$P_2 = P_1 + \rho_{Hg}\, g h_2$

But $P_1 = P_{atm}$ (open to atmosphere) $\Rightarrow P_1 = 0$ (gauge)

$\therefore P_2 = \rho_{Hg}\, g h_2$

$P_3 = P_A + \rho_{water}\, g (h_1 + h_2)$

We know that $P_2 = P_3$ {same horizontal level}

Thus

$\rho_{Hg}\, g h = P_A + \rho_{water}\, g (h_1 + h_2)$

$\therefore P_A = \rho_{Hg}\, g h_2 - \rho_{water}\, g (h_1 + h_2)$

$P_A = 13.54 \times 1000 \times 9.81 \times 0.3 - 1000 \times 9.81 \times (0.2 + 0.3)$

$P_A = 39,848 - 4905$

$P_A = 34.9\ kPa$

((Q2)) ~~Dif~~ Define different manometer and what hight would a barometer need to be measure atomospheric. Pressures?

★ Diffential Monometer-

In some case, the different b/w the pressures at two different points is ~~called~~ desired rather than the actual value of the pressure at each point.

a manometer to determine the pressures difference is called the differential manometer (see figure in next slide)

The liquid in manometer will rise or fall as the pressure at either and (or both ends of the tube changes.

* in the figure

$$P_1 = P_A + \rho_1 g a$$

$$P_2 = P_B + \rho_1 g(b-h) + \rho_{man} g h$$

But $P_1 = P_2$ (same horizontal level)

Thus $P_A + \rho_1 g a = P_B + \rho_1 g(b-h) + \rho_{man} g h$

Or $P_A - P_B = \rho_1 g(b-h) + \rho_{man} g h - \rho_1 g a$

$$P_A - P_B = \rho_1 g(b-a) + gh(\rho_{man} - \rho_1)$$

***What height would a barometer need to be to measure atmospheric pressure?**

Solution:-

P_{atm} 1 bar $= 1 \times 10^5$ Pa

$$P_{atm} = \rho g h$$

Water barometer: $h = \frac{P_{atm}}{\rho_{water} g} = \frac{1 \times 10^5}{1000 \times 9.81} = 10.2$ m of water

Mercury barometer: $h = \frac{P_{atm}}{\rho_{Hg} g} = \frac{1 \times 10^5}{13.6 \times 1000 \times 9.81} = 0.75$ m of mercury

(Q3)

Solution: Given

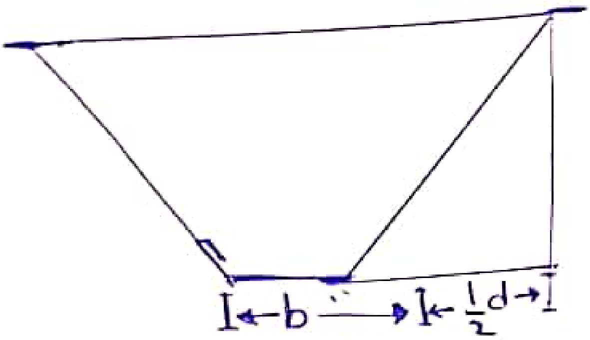

Fig (16.12)

Side Slope, $n = \frac{\text{Horizontal}}{\text{vertical}} = \frac{1}{2}$

Bed slope, $i = \frac{1}{1500}$

Area of Section $A = 40\,m^2$

Chezy's Constant, $C = 50$

For the most economical section, using equation (16.11)

$$\frac{b + 2nd}{2} = d\sqrt{n^2+1} \quad \text{or} \quad \frac{b + 2\times\frac{1}{2}\times d}{2} = d\sqrt{\left(\frac{1}{2}\right)^2+1}$$

Or $$\frac{b+d}{2} = d\sqrt{\frac{1}{4}+1} = 1.118\,d$$

Or $$b = 2\times 1.118\,d - d = 1.236\,d$$

But area of Trapezoidal section $A = \frac{b+(b+2nd)}{2}\times d = (b+nd)d$

$$= \left(1.236d + \frac{1}{2}d\right)d$$

$$= 1.736d^2 \qquad \left(\because b = 1.236\,d \text{ and } n = \frac{1}{2}\right)$$

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But $A = 40 m^2$

$\therefore$ $40 = 1.736 d^2$

$\therefore$ $d = \sqrt{\frac{40}{1.736}} = 4.80$ m. Ans

Subsitituting the value of in equation (i) we get.

$b = 1.236 \times 4.80 = 5.933$ m. Ans.

Discharge for most economical section. Hydraulic mean depth for most economical section is,

$m = \frac{d}{2} = \frac{4.80}{2} = 2.40 m$

$\therefore$ Discharge $Q = AC\sqrt{mi} = 40 \times 50 \times \sqrt{2.40 \times \frac{1}{1500}}$

$= 80 m^3/s$ Ans.

(Q4) What is Hydraulic Jump. Discuss typical for Location of hydraulic Jump.

* Hydraulic Jump:-

The Hydraulic Jump is defined as the rise of water level, which takes place due to transformation to unstable shooting flow (Super - Critical) to the stable streaming flow (sub-critical)

When Hydraulic jump occurs, a loss of energy due eddy formation and turbulence flow occurs.

* typical Location for Hydraulic jump:-

The most typical cases for the location of Hydraulic jump are.

(1) Below control structures like weir, sluice are used in the channel,

(2) When any obstruction is found in the channel.

(3) When a sharp change in the channel slope take place.

(4) At the toe of a spillway dam.