Fluid Mechanics

Unit -1

① Density $= m/v$

② Specific wt or weight density $= \frac{\text{wt. of fluid}}{\text{volume of fluid}} = \frac{mg}{V}$

$w = \rho g$.

③ Specific volume :- $\frac{1}{\rho} = \frac{\text{volume of fluid}}{\text{mass of fluid}}$

④ Specific gravity :- $S = \frac{\text{wt. density of fluid}}{\text{wt. density of water}}$

wt. density of liquid $= S \times 9.81 \times 10^3\ N/m^3$

Prob (1.15)

Distance of water from plate $= 20$ cm,
velocity of water $= u = 120$ cm/sec.

$\mu = 8.5$ poise $= 0.85\ N\,s/m^2$

The velocity profile is given by a parabolic eqn

$$u = ay^2 + by + c \quad \text{—— (i)}$$

The values of constants a, b & c can be obtained from boundry conditions which are as follows.

(i) when $y = 0,\ u = 0$

(ii) when $y = 20$ cm $u = 120$ cm/sec

(iii) when $y = 20,\ \frac{du}{dy} = 0$

Putting boundry condition (a) in eqn (i) we get $c = 0$

Putting " —— (b) in —— we get.

$$120 = 400a + 20b \quad \text{—— (ii)}$$

Putting b.c (c) in eqn (i)

$$\frac{du}{dy} = 2ay + b$$

$$0 = 40a + b \text{ —(iii)} \rightarrow \therefore\ b = -40a.$$

Putting in eqn (ii)

$$120 = 400a - 800a \Rightarrow 120 = -400a$$

$$a = -0.3.$$

Putting in (iii) : $b = 12$

~~120 = 400x - 0.3 + 20b~~

Putting values of a, b, & c in (i) we get

$$u = -0.3y^2 + 12y$$

$$\frac{du}{dy} = -0.6y + 12$$

$$\left(\frac{du}{dy}\right)_{at\ y=0} = 12 \qquad \left(\frac{du}{dy}\right)_{at\ 20} = 0$$

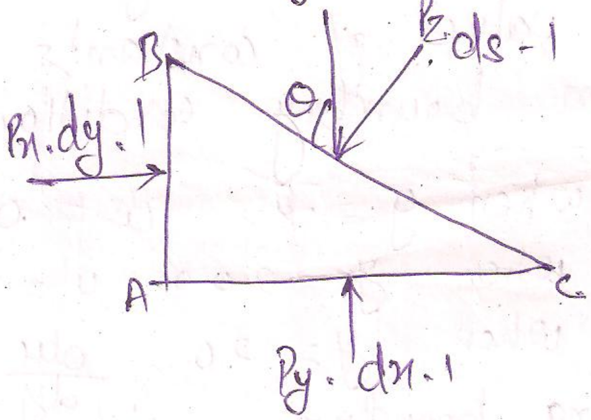
$$\left(\ '' \ \right)_{at\ y=10} = 6,$$

$\tau = \mu \frac{du}{dy}$ $\quad \tau$ can be calculated for above threes

* Pascal's Law :— It states that the pressure or intensity of pressure at a point in a static fluid is equal in all directions. let the element is very small dimensions dx, dy and dz.

let the width of the element is ~~very smal~~ ⊥ to the plane of paper is unity.

P_x, P_y & P_z are intensities of pressure at AB, AC & BC



Forces acting on the faces

Force on face AB

$$= P_x \cdot dy \cdot 1$$

Force on face AC

$$= P_y \cdot dx \cdot 1$$

~~Similarly~~ on BC $= P_z \cdot ds \cdot 1$

Weight of element $=$ mass $\times g =$ volume $\times \rho \times g$

$$= \frac{AB \times AC}{2} \times \rho \times g.$$

Resolving the forces in x- direction

$$P_x \cdot dy \cdot 1 - P_z (ds \times 1) \sin(90 - \theta) = 0$$

$$P_x \cdot dy \cdot 1 - P_z\, ds \cos\theta = 0$$

$$ds \cos\theta = AB = dy.$$

$$P_x \cdot dy = P_z\, dy \Rightarrow \therefore P_x = P_z.$$

Resolving in vertical direction

$$P_y \cdot dx \cdot 1 - P_z\, ds \cdot 1 \cos(90 - \theta) - \frac{dx \times dy}{2} \times \rho \times g = 0$$