Since $ds \sin\theta = AE = dx$. ①

Element is very small. wt can negligible.

$P_y \cdot dy \cdot 1 = P_z \, dx \Rightarrow P_y = P_z$

$\therefore P_x = P_y = P_z$

$\therefore$ Intensity of pressure is equal in all dirn.

* **Hydrostatic law :-** The pressure at a point in a fluid at rest is obtained by H.L.

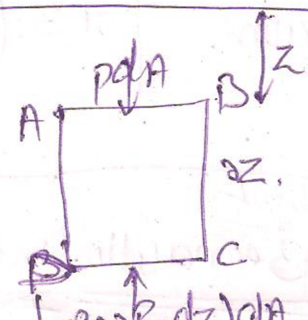
It states that the rate of increase of pressure in a vertically downward dirn is equal to the specific weight of element.

dA = cross sectional area of ele

dz = Height of element.

z = distance of fluid element from free surface.

P = pressure at face AB



1. Pressure force on AB = $p \times dA$ and acting ⊥ to face AB in vertically down dirn
2. Pressure force on CD = $(p+\frac{\partial p}{\partial z} \cdot dz)dA$ and acting ⊥ to CD in vertically upward dirn
3. Weight of element = volume $\times \rho \times g$ = $dA \, dz \times \rho \times g$.
4. Force at AD & BC are equal & opp

For equilibrium

$$pdA - \left(p+\frac{\partial p}{\partial z} \cdot dz\right) dA + dA\,dz \times \rho \times g = 0$$

$$\cancel{pdA} - \cancel{pdA} - \frac{\partial p}{\partial z} \cdot dz\,dA = -dA\,dz \times \rho \times g$$

$$\boxed{\frac{\partial p}{\partial z} = \rho \times g = w}$$

$\therefore$ Rate of increase of pressure in vertically downward dirn is equal to weight density

$$\int \partial p = \int \rho g \, \partial z$$

$$p = \rho g z$$

$$\boxed{z = \frac{p}{\rho \times g}}$$

* for vertical plane :—

Total Pressure Force $= \rho g A \bar{h}$

centre of pressure $= h^* = \frac{I_G}{A\bar{h}} + \bar{h}$

Moment of inertia of some important plane surfaces.

Plane	C.G from base	Area	M.O.I from C.G & ∥ to base	M.O.I from base
Rectangle	$x = d/2$	bd	$\frac{bd^3}{12}$	$\frac{bd^3}{3}$
Triangle	$x = \frac{h}{3}$	$\frac{bh}{2}$	$\frac{bh^3}{36}$	$\frac{bh^3}{12}$
circle	$x = d/2$	$\frac{\pi}{4}d^2$	$\frac{\pi d^4}{64}$	—
Trapezium.	$x = \left(\frac{2a+b}{a+b}\right)\frac{h}{3}$	$(a+b)\frac{h}{2}$	$\left(\frac{a^2+b^2+4ab}{a+b}\right)h^3$	—

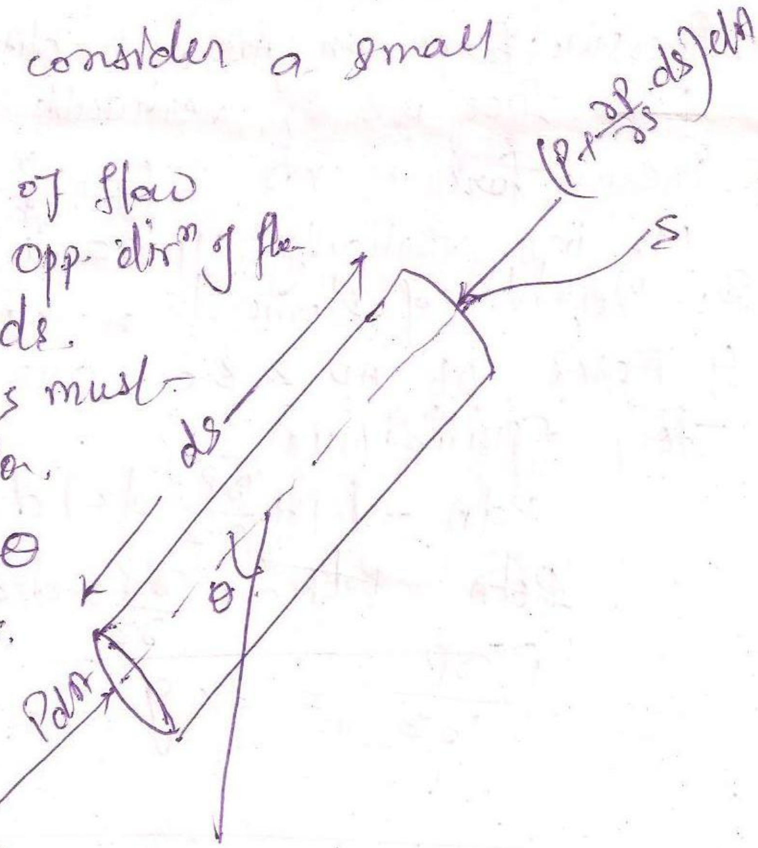
Unit-3.

* Bernaulli's Equation :— consider a small element of

(i) Pressure force $p\,dA$ in dirⁿ of flow

(ii) Pressure force $\left(p+\frac{\partial p}{\partial s}ds\right)dA$ opp. dirⁿ of flow

(iii) weight of element $= \rho\, dA\, ds$.



The resultant force in dirⁿ of s must be equal to mass × acceleration.

$$p\,dA - \left(p + \frac{\partial p}{\partial s}ds\right)dA - \rho g\, dA\, ds\cos\theta = \rho\, dA\, ds \times a_s.$$

$$a_s = \frac{\partial v}{\partial t} = \frac{\partial v}{\partial s}\cdot\frac{ds}{dt} + \frac{\partial v}{\partial t}$$

$$= \frac{v\,\partial v}{\partial s}$$

For steady flow $\frac{\partial v}{\partial t} = 0$

$$\cancel{p\,dA} - \cancel{p\,dA} - \frac{\partial p}{\partial s}\,ds\,dA - \rho g\, dA\, ds\cos\theta = \rho\, dA\, ds\cdot\frac{v\,\partial v}{\partial s}$$

$$\frac{\partial p}{\rho\,\partial s} + g\cos\theta + \frac{v\,\partial v}{\partial s} = 0 \qquad \cos\theta = \frac{dz}{ds}$$

$$\frac{\partial p}{\rho\,\partial s} + g\cdot\frac{dz}{ds} + \frac{v\,\partial v}{\partial s} = 0$$

$$\frac{\partial p}{\rho} + g\,dz + v\,\partial v = 0 \qquad \text{Euler's equation}$$