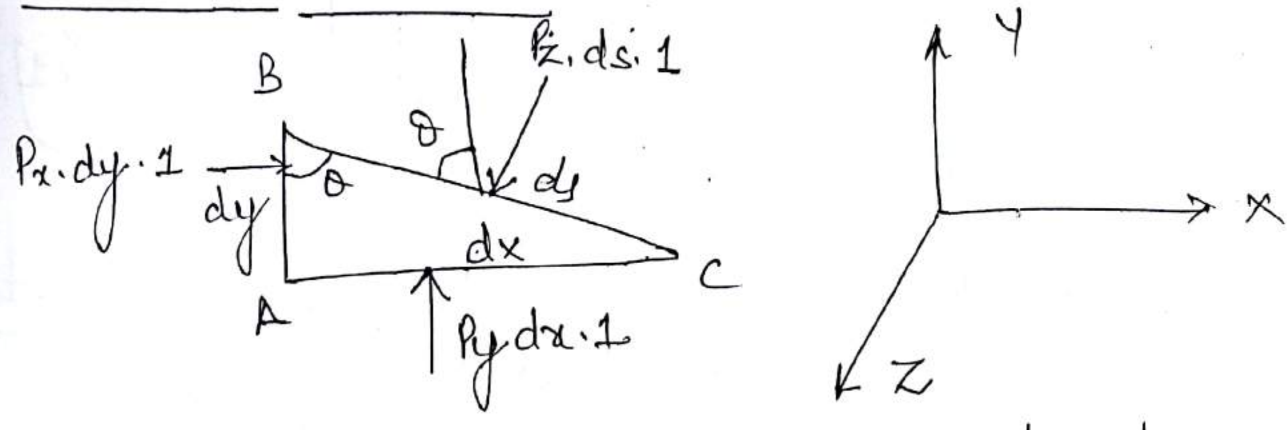
Pascal's Law:→



"It states that the pr. or pr. intensity at a point in a static fluid is equal in all directions."

The fluid element is of very small dimensions i.e. dx, dy and ds.

Let the width of the element perpendicular to the plane of paper is unity and P_x, P_y and P_z are the pr. intensity acting on the face AB, AC and ABC. Let ∠ABC = θ

then the force acting on the element are –

1. Pr forces normal to the surfaces
2. Weight of element in the vertical direction

Force on the face AB $= P_x \times$ Area of face
$= P_x \times dy . 1$

Similarly force on AC $= P_y \times dx \times 1$

" " BC $= P_z \times ds \times 1$

Weight of Element = Mass of element $\times g$ (2)

$= (\text{Volume} \times \rho) \times g = \left(\frac{1}{2} AB \times AC \times 1\right) \times \rho \times g$

Resolving the forces in x-direction —

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

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

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

$P_x \times dy \times 1 - P_z\, dy \times 1 = 0$

$\boxed{P_x = P_z}$ — (i)

Similarly resolving the forces in y-directions

$P_y \times dx \cancel{\times 1} - P_z \times ds \times 1 \cos(90 - \theta)$

$-$ weight of element $= 0$

$P_y \times dx - P_z\, ds \sin\theta - \frac{1}{2}\, dx \times dy \times \rho \times g = 0$

$P_y \times dx - P_z\, dx - 0 = 0$

since element is very small and hence is negligible

$\boxed{P_y = P_z}$ — (ii)

from eq — (i) and (ii)

$\boxed{P_x = P_y = P_z}$ — (iii)

P at any point same in all directions,

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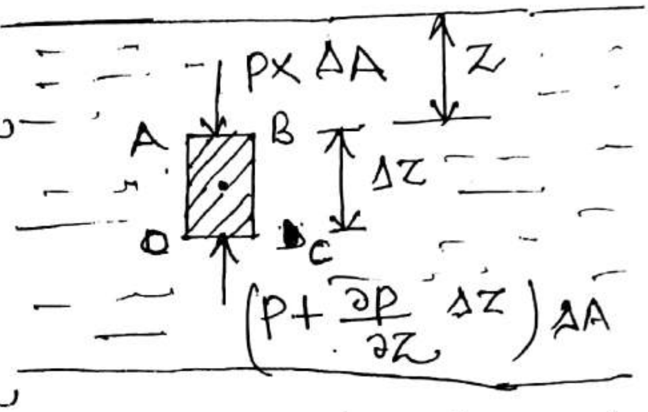
Applications :→

(1.) – Hydraulic Press
(2) – In Braking System.

Pressure Variation in A Fluid At Rest :→

Hydrostatic Law :→



Hydrostatic law states that the rate of increase of pressure in a vertically downword directions must be equal to the specific weight of the fluid at that point.

Consider a small fluid element –

Let ΔA = Cross sectional Area of element
ΔZ = Height of fluid element
P = Pr. on face AB
Z = Distance of fluid element from free surface.

The forces acting on the fluid element are :–

1. Pr. Force on AB = $P \times \Delta A \downarrow$
2. Pr. Force on CD = $\left(P + \frac{\partial P}{\partial Z}\Delta Z\right) \times \Delta A \uparrow$

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3. Weight of fluid element $= \rho \times g \times$ volume

$$= \rho \times g \times (\Delta A \times \Delta Z)$$

4. Pr. forces on surfaces BC and AD are equal and opposite.

For eq. of fluid element :→

$$p\Delta A - \left(p + \frac{\partial p}{\partial Z}\Delta Z\right)\Delta A + \rho g \times (\Delta Z \times \Delta A) = 0$$

$$-\frac{\partial p}{\partial Z}\Delta Z \Delta A + \rho \times g \times \Delta A \Delta Z = 0$$

OR $$\frac{\partial p}{\partial Z}\cancel{\Delta Z}\cancel{\Delta A} = \rho \times g \times \cancel{\Delta A} \times \cancel{\Delta Z}$$

$$\frac{\partial p}{\partial Z} = \rho \times g \quad \text{—— (I)}$$

By integrating the above eq ~

$$\int dp = \int \rho g z$$

$$\boxed{P = \rho g z} \quad \text{—— (II)}$$

$Z =$ Pressure head