Subject: Fluid Mechanics and Hydraulic machine

Chapter : 3.Static Forces on Surface and Buoyancy

*Fluid Static

Rest ⇒ No Relative motion

$\tau = \mu \frac{\partial u}{\partial y}$ → Change in velocity

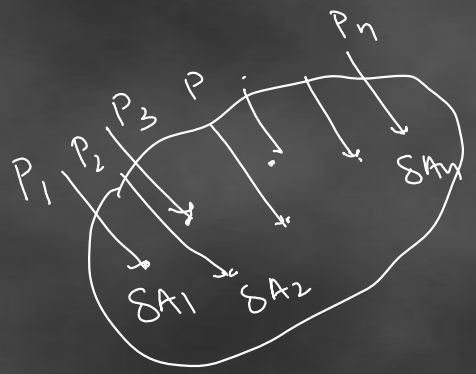
$\tau = \mu \, 0 \Rightarrow \tau = 0$

Fore

1) Pressure
2) gravity

→ Static

Action of Fluid Pressure on Surface



Plane Surface

$\underline{R} = \Sigma(P\delta A)$

Total pressure

Centre of Pressure

$R = P_1 \delta A_1 + \cdots + P_n \delta A_n$

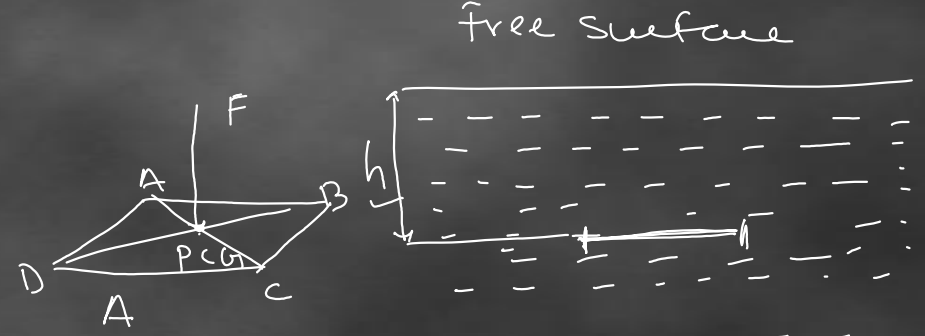
Cour

Total Pressure : total pressure can be defined as the force exerted by static fluid on a plane or curved surface when fluid comes contact with surface and this force is always normal to surface

Centre of Pressure : it is the point of application of the total pressure force on the surface

Case - I Horizontal Plane
II Vertical
III Inclined Surface
} → Total Pressure
Centre of Pressure

⇒ Case-I Horizontal Plane



let A = area
h = depth
ρ = density

$F = P \times A$

$= \rho g h A$

$= W A h$

$P = \rho g h$

$W = \rho g$ Specific Weight of fluid

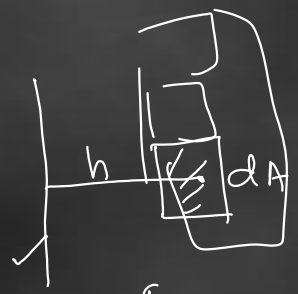
Case - II Vertical Plane

let A = area

G = C.G

h = Distance of elementary area from F.S.

$\bar{h}$ = Distance of CG from free surface



First moment $= \int h dA$

Second $= \int h^2 dA$

$\int h dA = h_1 dA_1 + \dots + h_n dA_n = A\bar{h}$

Pressure on the strip

$P = \rho g h$

Total Pressure force

$dF = P \times dA$

$= \rho g h \, dA$ where

$dA = b \times dh$

$dF = \rho g h \, b \, dh$

Total force on curved surface

$F = \int dF$

$= \int \rho g h b \, dh$

$= \rho g \int h \, dA$

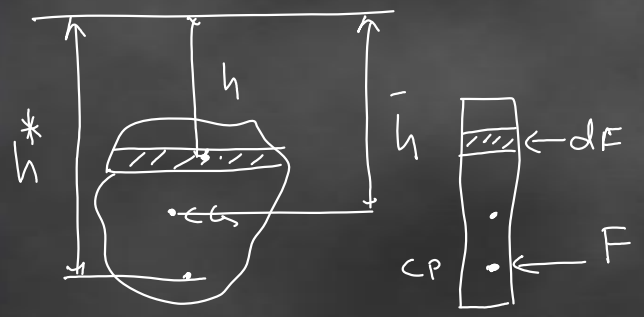
$F = \rho g A \bar{h}$

$F = w A \bar{h}$

$h^*, h, \bar{h}$

CP ↑ ↓

STRIP C.G



The moment of force about Free surface = Sum of moments of the Components about Free surface

Force acting on STRIP

$dF = P \times dA$

$= \rho g h dA$

Moment of force acting on STRIP about Free surface

$= h \times dF$

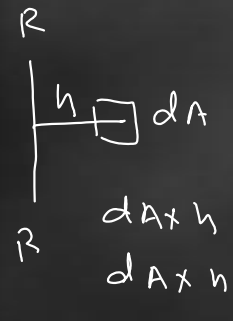
$= h \times \rho g h dA$

$= \rho g h^2 dA$

Total moment $= \int \rho g h^2 dA$

$= \rho g \int h^2 dA$

$= \rho g I_0$



$dA \times h$

$dA \times h^2 = I_0$

Total moment $= F \times h^*$

$F \times h^* = \rho g I_0$

$h^* = \frac{\rho g I_0}{F}$

$$h^* = \frac{\rho g I_0}{F}$$

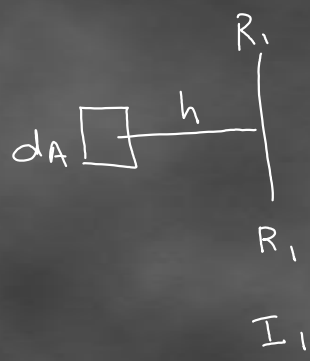
$$= \frac{\rho g I_0}{\rho g A \bar{h}}$$

$$h^* = \frac{I_0}{A\bar{h}} = \text{free surface}$$

$$I_0 = I_G + A\bar{h}^2$$

$$h^* = \frac{I_G + A\bar{h}^2}{A\bar{h}}$$

$$\boxed{h^* = \frac{I_G}{A\bar{h}} + \bar{h}}$$



$$I_2 = I_1 + A h^2$$

$$I_0 = I_G + A\bar{h}^2$$