-: MECHANICAL PROP. OF SOLIDS :-

ELASTICITY :-

∵ Property of matter by virtue of which it tends to regain its original shape and size after its deforming force are removed.

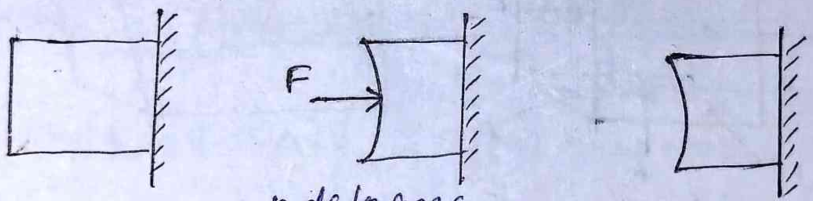
RIGID BODY :-

∵ seperation b/w two constituent particle do not change.
∵ never get deformed.

- elastic Body :- completely regains its shape.
- Partially elastic Body :- do not completely regains its shape

INELASTIC OR PLASTIC BODIES :-

no tendency to regain its shape.
W.D in deformation = completely dissipate during deformation.

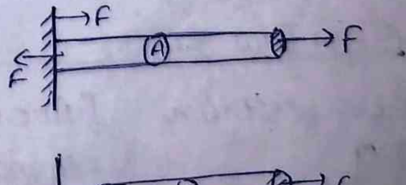


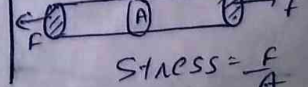
* deforms   * force removed

∴ STRESS DUE TO A FORCE :-

restoring forces per unit area of Body   stress = $\frac{F}{A}$

∴ Stress = $\frac{\text{deforming } F}{\text{Area (Normal to } F)}$



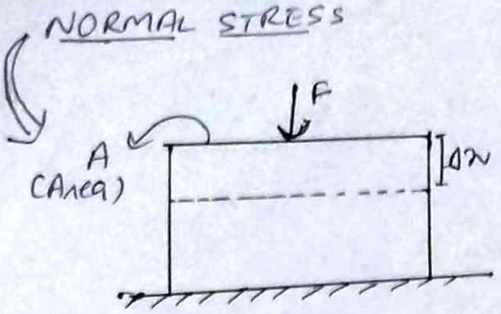


Stress = $\frac{F}{A}$

* Stress is same

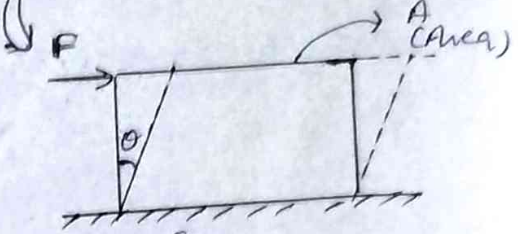
Types → Normal stress
→ shear stress

NORMAL STRESS



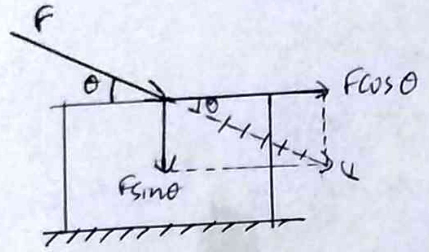
Stress = F/A

SHEAR STRESS



Stress = F/A

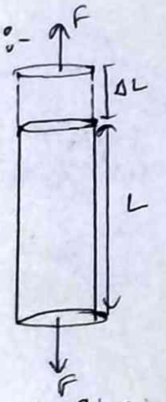
NOW;

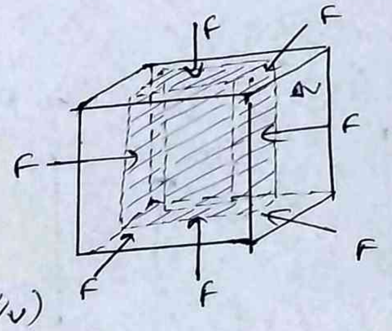


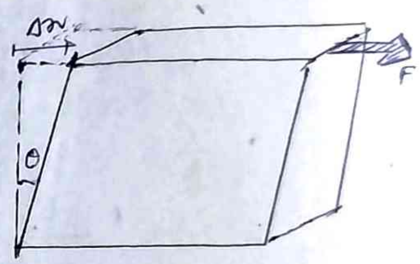
Normal Stress = $\frac{F \sin\theta}{A}$

Shear stress = $\frac{F \cos\theta}{A}$

STRAIN:-







($\Delta L/L$)
∵ longitudnal strain

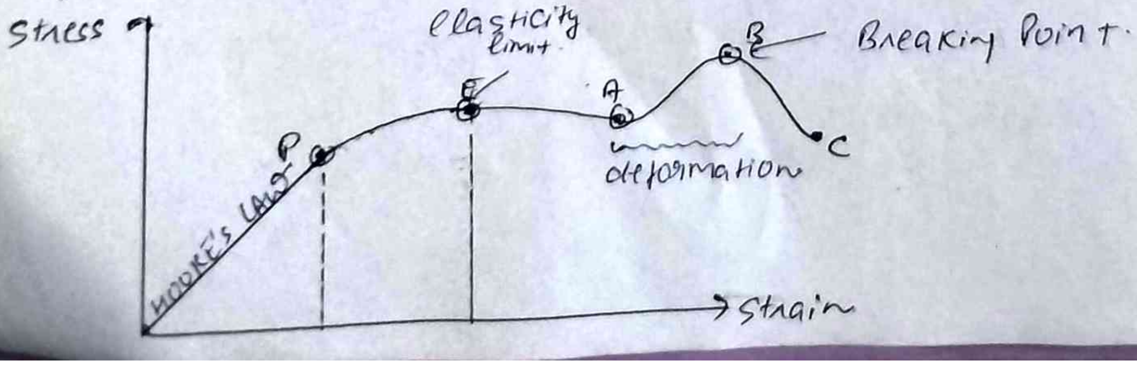
($\Delta V/V$)
∵ volume strain

∵ Shear strain = θ
(Tangential deformation)

The Relative change in dimension of Body which is subjected to stress is Called strain

* RELATION B/W STRESS & STRAIN :-

∵ Stress ∝ Strain [Hooke's law]



* Till P :- hooke's law
* P→E :- elasticity limit (till here it tends to regain its original shape)
* E→A :- The Body Break it elasticity limit & hence Permanent deformation happens.

It undergoes lot of strain for very less stress till A.

* After A :- It keep on elongating (on its own) and Breaks at Breaking limit B.

Now,

Stress ∝ Strain.

Stress = E(Strain) E :- modulus of elasticity

$E = \left(\frac{\text{Stress}}{\text{Strain}}\right)$

∵ It is a measure of material elastic prop.

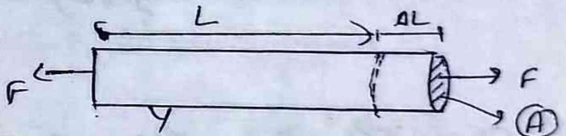
TYPES OF MODULUS :-

∵ YOUNG'S MODULUS :- (Y)

⇓

⇒ $\left(\frac{\text{longitudnal stress}}{\text{long. strain}}\right)$

> denoted by 'Y'

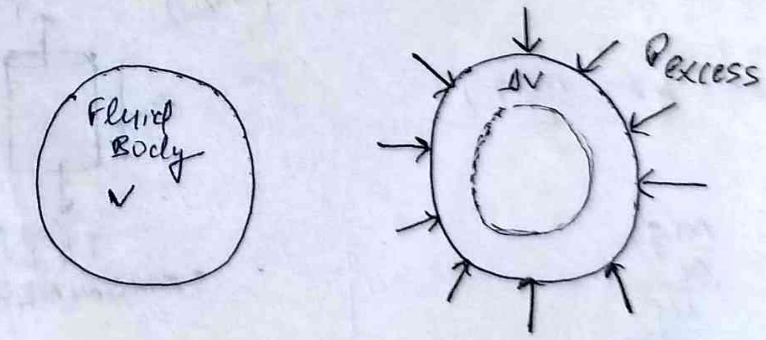


(Y) Young modulus = $\frac{\text{Stress}}{\text{Strain}} = \frac{(F/A)}{(\Delta L/L)}$

∵ BULK MODULUS :- (B)

⇓

⇒ $\left(\frac{\text{Volume stress}}{\text{Volume strain}}\right)$



Volume strain :- $\frac{\Delta V}{V}$

(B) Bulk modulus = $\frac{(P_{excess})}{(|\Delta V/V|)}$ → [F/A]

∵ SHEAR MODULUS :- (η)

⇓

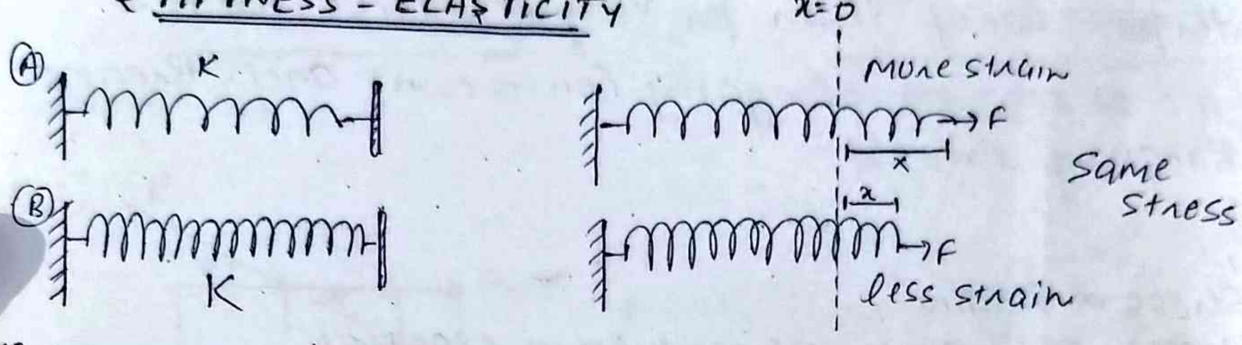
⇒ $\left(\frac{\text{Shear stress}}{\text{Shear strain}}\right)$

∵ COMPRESSIBILITY :- (C)

$$\text{Compressibility} = \frac{1}{\text{Bulk mod}} \Rightarrow \boxed{C = \frac{1}{B}}$$

FACTS

STIFFNESS = ELASTICITY



∵ More strain → less elastic
∵ less Strain → More Elastic

So, Metals are more elastic than Rubber.

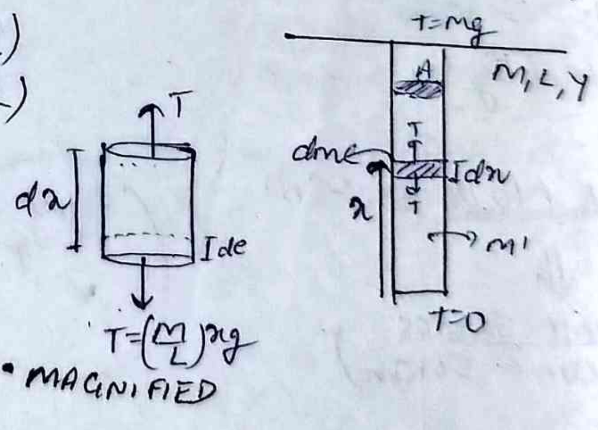
$$E_{solid} > E_{liq} > E_{gas}$$

as temperature (↑), Elasticity (↓)

* ELONGATION OF SUSPENDED ROD UNDER SELF WEIGHT

ellemental elongation; $Y = \dfrac{(T/A)}{(\Delta l/L)}$

(m')
mass $= \mu x = \dfrac{M}{L}(x)$

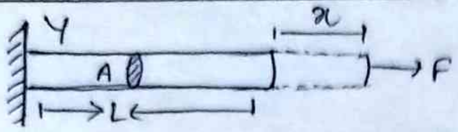


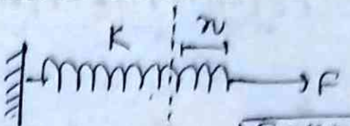
So,

$$Y = \frac{\frac{Mgx}{AL}}{\frac{de}{dx}}$$

$$\int de = \frac{mg}{YAL}\int_0^L x\,dx = \boxed{e = \frac{MgL}{2YA}}$$

∵ METAL WIRE OR RODS AS EQUIVALENT STRING :-





$\boxed{F = Kx}$ — ②

$Y = \dfrac{\text{stress}}{\text{strain}} = \dfrac{F/A}{x/L}$

$Y = \dfrac{F/A}{x/L} \Rightarrow F = \left(\dfrac{YA}{L}\right)x$ — ①

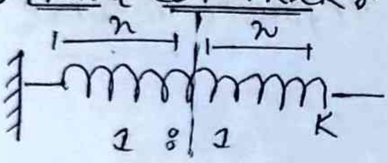
> from eq 1 and 2

$\therefore K = \dfrac{YA}{L}$

#

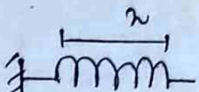
$$\boxed{\frac{1}{K_{eq}} = \frac{1}{K_1} + \frac{1}{K_2} \cdots}$$

∵ SPRING CUT TRICK :-

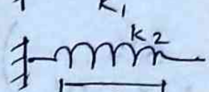


We know; $K = \dfrac{YA}{L}$

$\Rightarrow \underline{(K \propto 1/L)}$



$\Rightarrow \boxed{K_1 = 2K}$



$\boxed{K_2 = 2K}$

∵ Density of elastic Potential energy :-

↳ energy stored per unit volume

$U_e = \text{density(PE)} = \dfrac{PE}{V} = \dfrac{U}{AL} = \dfrac{1}{2}\left(\dfrac{F^2L}{2AY}\right) \times \dfrac{1}{AL} \Rightarrow \dfrac{1}{2} \times \left(\dfrac{F}{A}\right)^2 \times \dfrac{1}{Y}$

$\therefore U_e = \dfrac{1}{2} \times (\text{Stress})^2 \times \dfrac{\text{Strain}}{\text{Stress}} \Rightarrow \left(\dfrac{\text{Stress} \times \text{Strain}}{2}\right)$