MIND MAP

Elasticity

When a body is subjected to deforming forces, a restoring force is developed in the body. This restoring force per unit area is known as **Stress.**

$$\text{Stress} = \frac{\text{Restoring force}}{\text{Area of cross section}} = \frac{F}{A}$$

SI Unit : N/m^2 Dimension : $M^1 L^{-1} T^{-2}$

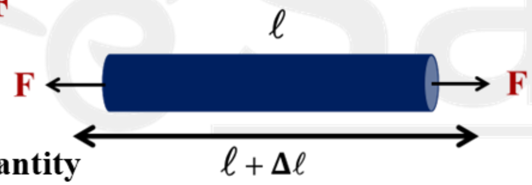
Longitudinal Stress (Normal Stress)

Longitudinal Stress (Tensile Stress)

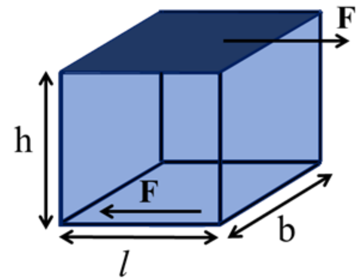
Longitudinal Stress (Compressive Stress)

$$\text{Longitudinal Strain} = \frac{\Delta \ell}{\ell}$$

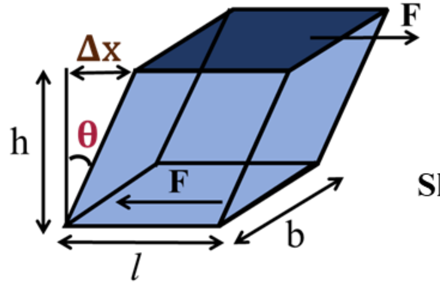
Unitless and dimensionless quantity



Tangential Stress or Shear Stress



$$\text{Shear Stress} = \frac{F}{\text{Area}} = \frac{F}{l \times b}$$



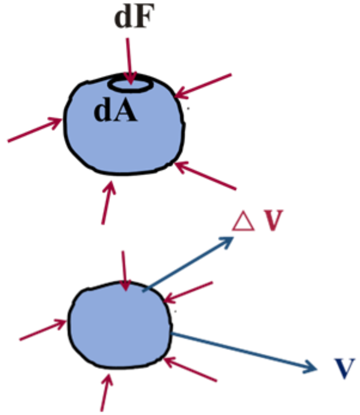
$$\text{Shear Strain} = \frac{\Delta x}{h} = \tan\theta \approx \theta \text{ (for small } \theta\text{)}$$

The property of body by virtue of which it tends to regain its original size & shape when the applied forces are removed, is known as **Elasticity** & the deformation caused is known as **Elastic deformation.**

If we apply a force to a lump or mud or putty, they have no cross tendency to regain their previous shape & they get permanently deformed. Such substances are caused Plastic & the property is called **Plasticity.**

Volumetric Stress

$$\text{Volumetric Stress} = \frac{dF}{dA}$$



$$\text{Volumetric Strain} = \frac{\triangle V}{V}$$

Hooke's Law

For small deformation, Stress and Strain are proportional to each other.

stress $\propto$ strain

stress $= k$ strain

MIND MAP

Elasticity

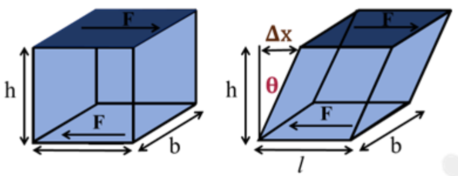
Young's Modulus

Young's Modulus is a property of material of the body.

$$Y = \frac{\text{Longitudinal stress}}{\text{Longitudinal strain}}$$

$$\boxed{Y = \frac{F}{A}\frac{\ell}{\Delta\ell}}$$

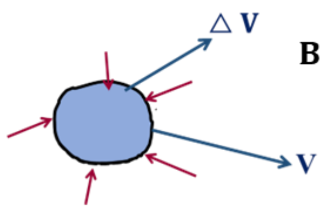
Shear Modulus / Modulus of rigidity / Torsional Modulus [G or η]



$$G = \frac{\text{Shear Stress}}{\text{Shear Strain}}$$

$$\boxed{G = \frac{F}{A\,\theta}}$$

Bulk Modulus (B)



$$B = \frac{\text{Volumetric stress}}{\text{Volumetric strain}}$$

$$\boxed{B = -\frac{\Delta P}{\frac{\Delta V}{V}}}$$

ΔP is excess (additional) pressure which caused ΔV.

Poisson's Ratio (σ)

σ deals with corresponding change in diameter with change in length

$$\sigma = -\frac{\Delta d/d}{\Delta \ell/\ell}$$

The stress at which material breaks is called **Breaking Stress.**

$$\boxed{B.S. = \frac{\text{Force}}{\text{Area}}}$$

property of a material

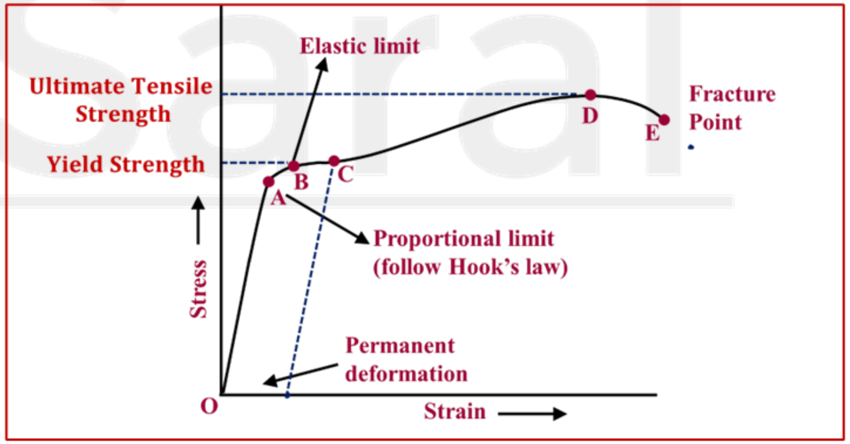
Force that a material can bear ∝ Area of cross-section

Elastic Potential Energy

$$U = \frac{1}{2}\frac{AY}{\ell}(\Delta\ell)^2$$

$$\text{Energy Density} = \frac{1}{2} \times \text{Stress} \times \text{Strain}$$

Stress-Strain Curve



- If the ultimate strength and fracture points D and E are close then the material is said to be Brittle.
- If they are far apart then the material is said to be Ductile.

$$\boxed{\text{Compressibility} = \frac{1}{\text{Bulk modulus}} = -\frac{\Delta V/V}{\Delta P}}$$