Mechanical Properties Of Solids

Stress And Strain

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

$$\text{Strain} = \frac{\text{Change in configuration}}{\text{Original configuration}}$$

Young's Modulus

$$Y = \frac{\text{Normal Stress}}{\text{Longitudinal Strain}}$$

Bulk Modulus

$$B = \frac{\text{Normal Stress}}{\text{Volumetric Strain}}$$

$$\text{Compressibility, } K = \frac{1}{B}$$

Modulus Of Rigidity

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

Poisson's Ratio

$$\sigma = \frac{\text{Shearing Stress}}{\text{Longitudinal Strain}}$$

Relatioln Between Y, B, G and σ

- $Y = 3B(1 - 2\sigma)$
- $Y = 2G(1 + \sigma)$
- $\sigma = \frac{3D - 2G}{2G + 6B}$
- $\frac{9}{Y} = \frac{1}{B} + \frac{3}{G}$

Hooke's Law

Stress α Strain

or Stress = E x Strain

(E = modulus of elasticity)

Elasticity And Plasticity

Elasticity: Ability of a body to regain its original shape, on removing deforming force.

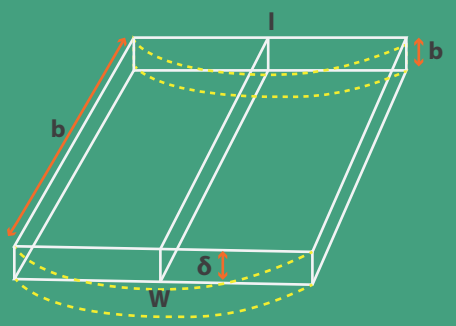
Plasticity: The inability of a body to regain its original size and shape on the removal of the deforming force.

Application Of Elasticity

Designing beams for bridges:

The depression in rectangular beam,

$$\delta = \frac{Wl^3}{4YBd^3}$$



Elastic Potential Energy

$$U = \frac{1}{2} F \times \Delta L$$

$$= \frac{1}{2} \text{ Stress x Strain x Volume}$$

P.E. stored per unit volume of stretched wire,

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

$$= \frac{1}{2} \times Y \times (\text{Strain})^2$$