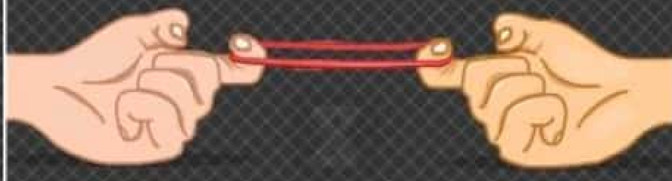


Elasticity

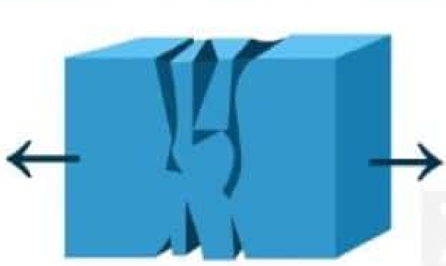
Part I

STRESS

The reaction force per unit area of the body due to the action of the applied force is called stress

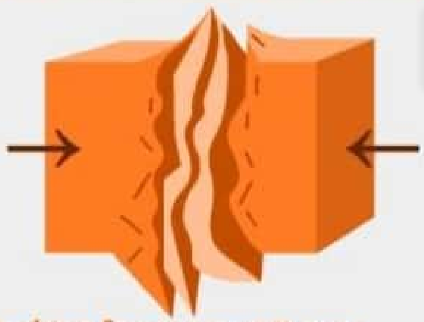
$$\text{Stress} = \frac{\text{Force}}{\text{Area}}\ N/m^2$$

TENSILE STRESS



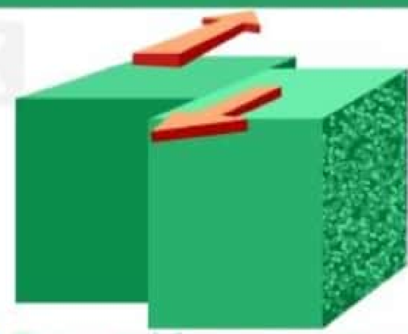
- Pulling force per unit area
- Increase in length or volume

COMPRESSIVE STRESS



- Pushing force per unit area
- Decrease in length or volume

TANGENTIAL STRESS



- Tangential force per unit area
- It causes shearing of bodies

STRAIN

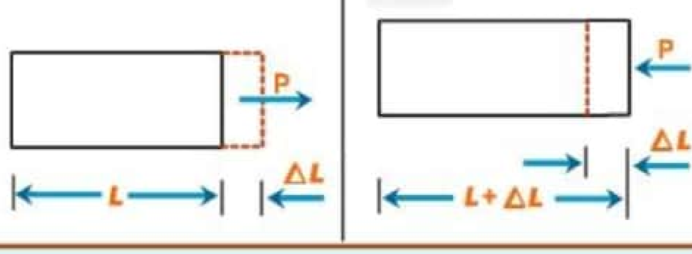
The ratio of the change in size or shape to the original size or shape of the body

$$\text{Strain} = \frac{\text{Change in size or shape}}{\text{Original size or shape}}$$

LINEAR STRAIN:

Change in length per unit length

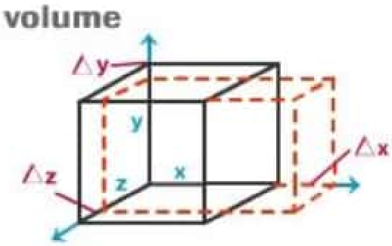
$$\text{Linear Strain} = \frac{\text{Change in length}}{\text{Original length}} = \frac{\Delta L}{L}$$



VOLUME STRAIN:

Change in volume per unit volume

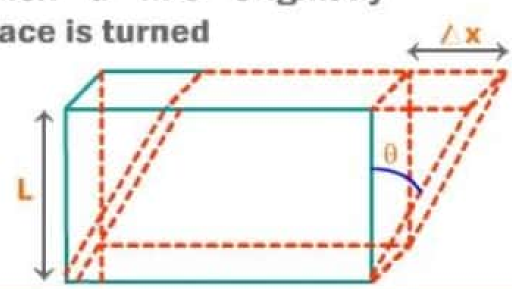
$$\text{Volume Strain} = \frac{\text{Change in volume}}{\text{Original volume}} = \frac{\Delta V}{V}$$



SHEAR STRAIN:

Angle through which a line originally normal to fixed surface is turned

$$\text{Shear Strain} = \frac{\text{Deformation}}{\text{Original Dimension}} = \frac{\Delta X}{L}$$



Part II

THERMAL STRESS

Thermal Stress = $Y \alpha \Delta t$

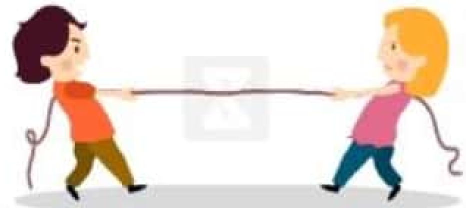
Y → Modulus of Elasticity

α → Coefficient of Linear Expansion

Δt → Change in Temperature

WORK DONE IN STRETCHING A WIRE

$$W = \frac{1}{2} F \times \Delta L = \frac{1}{2} \textit{ load} \times \textit{elongation}$$



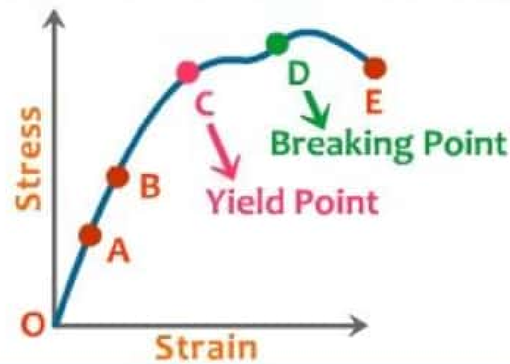
HOOKE'S LAW

$$\text{Modulus Of Elasticity} = \frac{\text{Stress}}{\text{Strain}}$$

Within the elastic limit, the stress developed in a body is proportional to the strain produced in it, thus the ratio of stress to strain is a constant.This constant is called the modulus of elasticity

STRESS STRAIN CURVE

If we increase the load gradually on a vertically suspended metal wire:



IN REGION OA
Strain is small (<2%)
Stress $\propto$ Strain → Hook's law is valid

IN REGION AB
Stress is not proportional to strain, but wire will still regain its original length after removal of stretching force

IN REGION BC
Wire yields → strain increases rapidly with small change in stress. This behavior is shown up to point C known as yield point

IN REGION CD
Point D corresponds to maximum stress, which is called point of breaking or tensile strength.

IN REGION DE
The wire literally flows. The maximum stress corresponding to D, after which wire begins to flow.

In this region, strain increase even if wire is unloaded and ruptures at E.

YOUNG'S MODULUS

Young's modulus is defined as the ratio of the linear stress to linear strain, provided the elastic limit is not exceeded.

$$Y = \frac{\text{Stress}}{\text{Strain}} = \frac{F}{A} \cdot \frac{L}{\triangle L}$$

BULK MODULUS

$$\beta = \frac{\text{Volume Stress}}{\text{Volume Strain}} = -\frac{V \triangle P}{\triangle V}$$

MODULUS OF RIGIDITY

$$\eta = \frac{\text{Tangential Stress}}{\text{Tangential Strain}} = -\frac{F/A}{\phi}$$

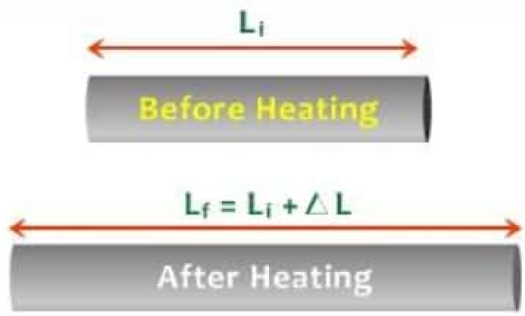
THERMAL EXPANSION

LINEAR EXPANSION

$$L_f = L_i (1 + \alpha \triangle T)$$

α = coefficient of linear expansion

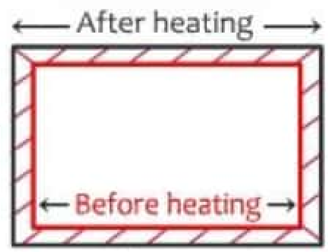
ΔT = Change in temperature



SUPERFICIAL OR AREAL EXPANSION

$$A_f = A_i (1 + \beta \triangle T)$$

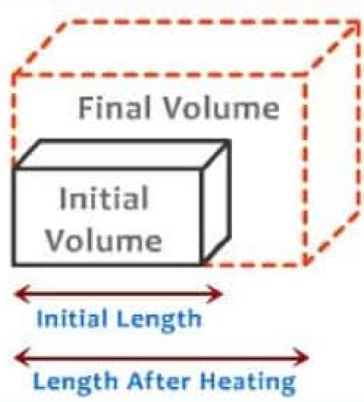
β = coefficient of Areal Expansion



VOLUME OR CUBICAL EXPANSION

$$V_f = V_i (1 + \gamma \triangle T)$$

γ = coefficient of Volume Expansion



$$\alpha : \beta : \gamma = 1 : 2 : 3$$