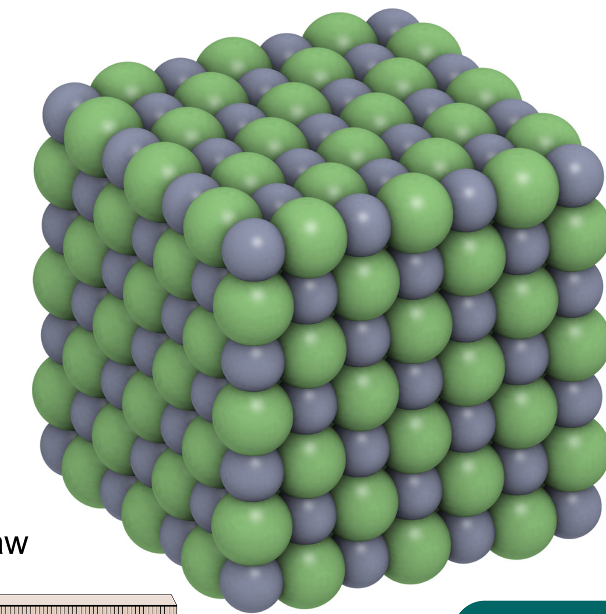
MECHANICAL PROPRTIES OF SOLIDS

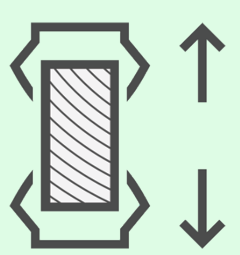


STRESS & ITS TYPES

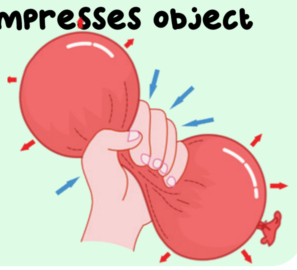
(1) Stress is restoring force per unit area
(2) $\sigma = \frac{F}{A}$
(3) It is neither scalar nor vector.
(4) It's unit is N/m^2

NORMAL STRESS

(1) Tensile stress is produced when axial force acts per unit area.
(2) This stress results in Elongation:

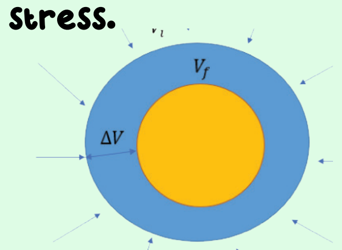


(1) Compressive stress is produced when force compresses object per unit area.
(2) This stress results in compression



VOLUMETRIC STRESS

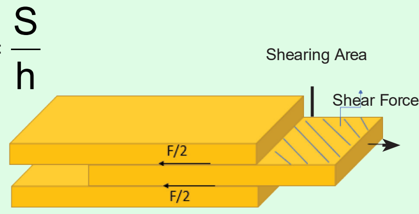
- When object is immersed inside the liquid, the hydrostatic pressure decreases the volume of an object, that results the volumetric stress.



SHEAR STRESS

(1) Shear stress is produced when force acts tangentially to a surface area.
(2) Deforming force acts tangentially to the surface

$\tan\theta = \frac{S}{h}$

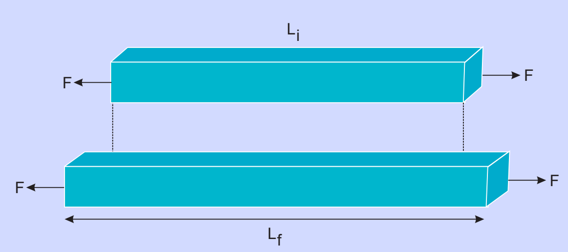


STRAIN & ITS TYPES

(1) Ratio of change in configuration to original configuration of body.
(2) It is a unit less quantity
(3) Strain = $\frac{\Delta \text{ configuration}}{\text{original configuration}}$

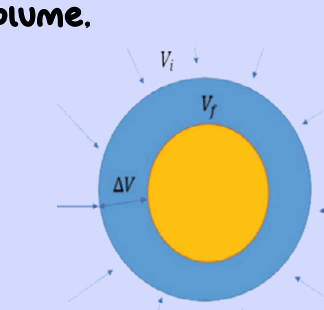
LINEAR STRAIN

(1) Linear strain is the ratio of change in length to original length.
(2) $\Sigma = \frac{\Delta \ell}{\ell}$



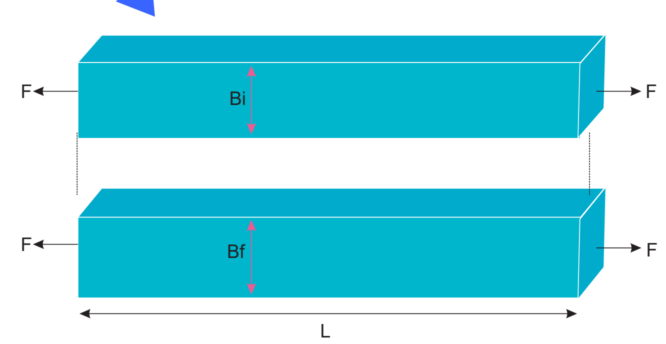
VOLUMETRIC STRAIN

(i) Ratio of change in volume to original volume.
(ii) $\Sigma = \frac{\Delta V}{V}$



LATERAL STRAIN

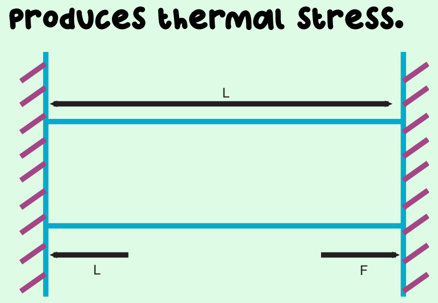
(1) Lateral strain is ratio of change in breadth/ diameter to original breadth/ diameter.
(2) $\Sigma = \frac{\Delta(\text{Breadth / Diameter})}{\text{Breadth / Diameter}}$
(3) Change occurs in the direction perpendicular to the applied force.



THERMAL STRESS

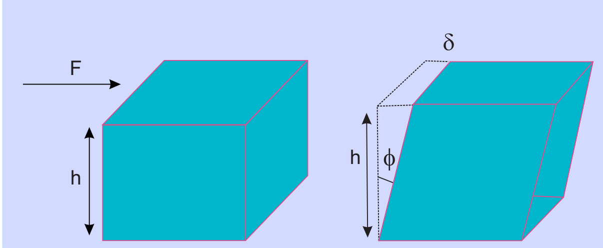
(1) Difference in temperature of a rod results the change in configuration of it. This produces thermal stress.

$\frac{F}{A} = Y \propto \Delta T$

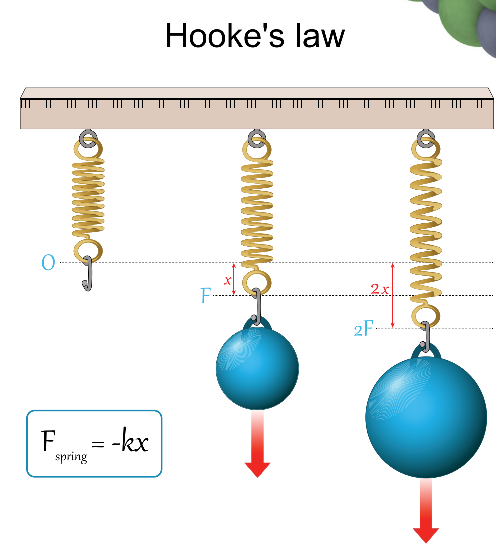


SHEAR STRAIN

(1) Angular deformation caused by shearing force is shearing strain.
(2) $\tan\theta = S / h$
(3) For small change $\theta = S / h$



Hooke's law

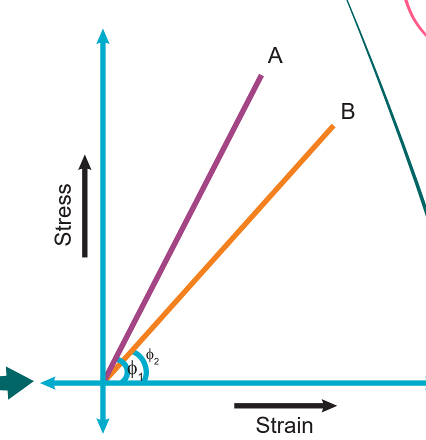


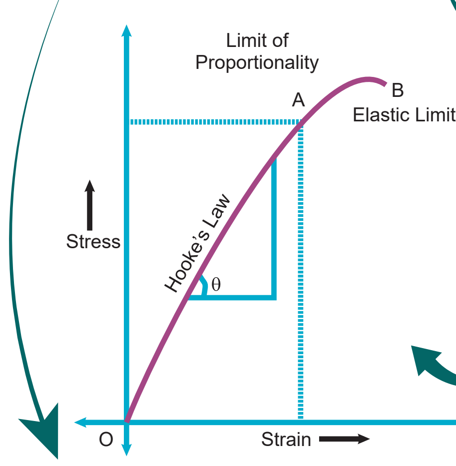
HOOKE'S LAW

- When load is applied to bodies up to certain proportionality limit, stress is directly proportional to strain.
- $\sigma \propto \Sigma$
- $\sigma \propto Y\Sigma$
- $y = \frac{\sigma}{\Sigma}$, where Y is the proportionality constant named as Young's modules

STRESS-STRAIN GRAPH

Slope of stress strain curve will be Young's modulus

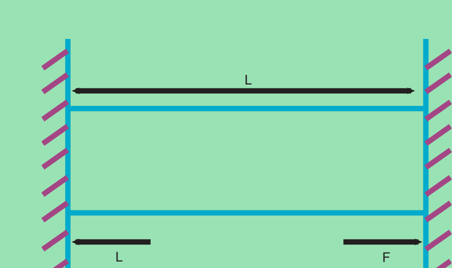




STRESS-STRAIN CURVE

THERMAL STRESS

(i) energy stored due to elastic deformation.
(ii) Strain energy density is energy per unit volume.
(iii) Strain energy per unit volume = $\frac{1}{2} \times \sigma \times \Sigma$
(iv) Strain energy per unit volume = $\frac{1}{2} \times \frac{(\sigma)^2}{y}$



POISSON'S RATIO

Ratio of lateral to longitudinal strain is Poisson's ratio

$\sigma = \frac{-\Sigma \text{lateral}}{\Sigma \text{longitudinal}} (-1 \le \sigma \le 0.5)$

Relation between Y, B, η and Σ
(1) Y = 3B (1 - 2σ).
(2) Y = 2η (1 + σ)
(3) $\sigma = \frac{3B - 2\eta}{2\eta + 6B}$

TYPES OF ELASTIC CONSTANTS

YOUNG'S MODULES = $\frac{\sigma}{\Sigma}$

- Property of material, that tells how easily it can be stretched.
- σ, E are normal stress and strains respectively

SHEAR MODULUS

- Ratio of shear stress by shear strain.
- Unit is Pascal (Pa)

BULK MODULUS = $\frac{-\Delta P}{\Delta V / V}$

- Measure of ability of material to withstands the change in volume.
- Negative sign indicates decrease in volume

ISOTHERMAL BULK MODULUS
B = P

ADIABATIC BULK MODULUS
(1) B = YP.
(2) Y = Adiabatic constant

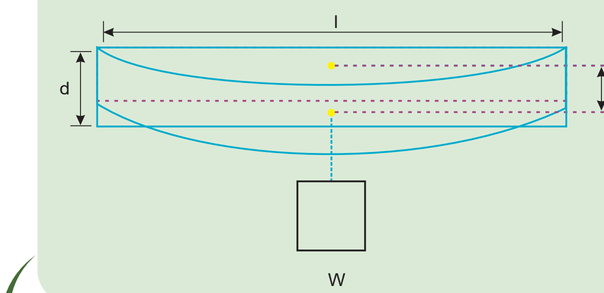
COMPRESSIBILITY = $\frac{1}{B}$

- Reciprocal of Bulk modulus
- Value depends on particle shape, density and chemical composition.

APPLICATIONS OF ELASTIC BEHAVIOUR OF SOLIDS

When weight is suspended in beam, it strouse buckling

$S = \frac{\omega \ell^3}{4 bd^3 y}$



- Extension is measured in ropes of cranes while load is suspended on it

$\sigma = \frac{mg}{A}$

σ = stress produced in rope

I - SHAPED BEAMS

- I - shape of beams makes them excellent for unidirectional bending.
- Use of rectangular shaped beams is not possible in railway tracks as of improper load distribution