ELASTICITY

Lecture - I

(NEP Semester I - Chapter 5)

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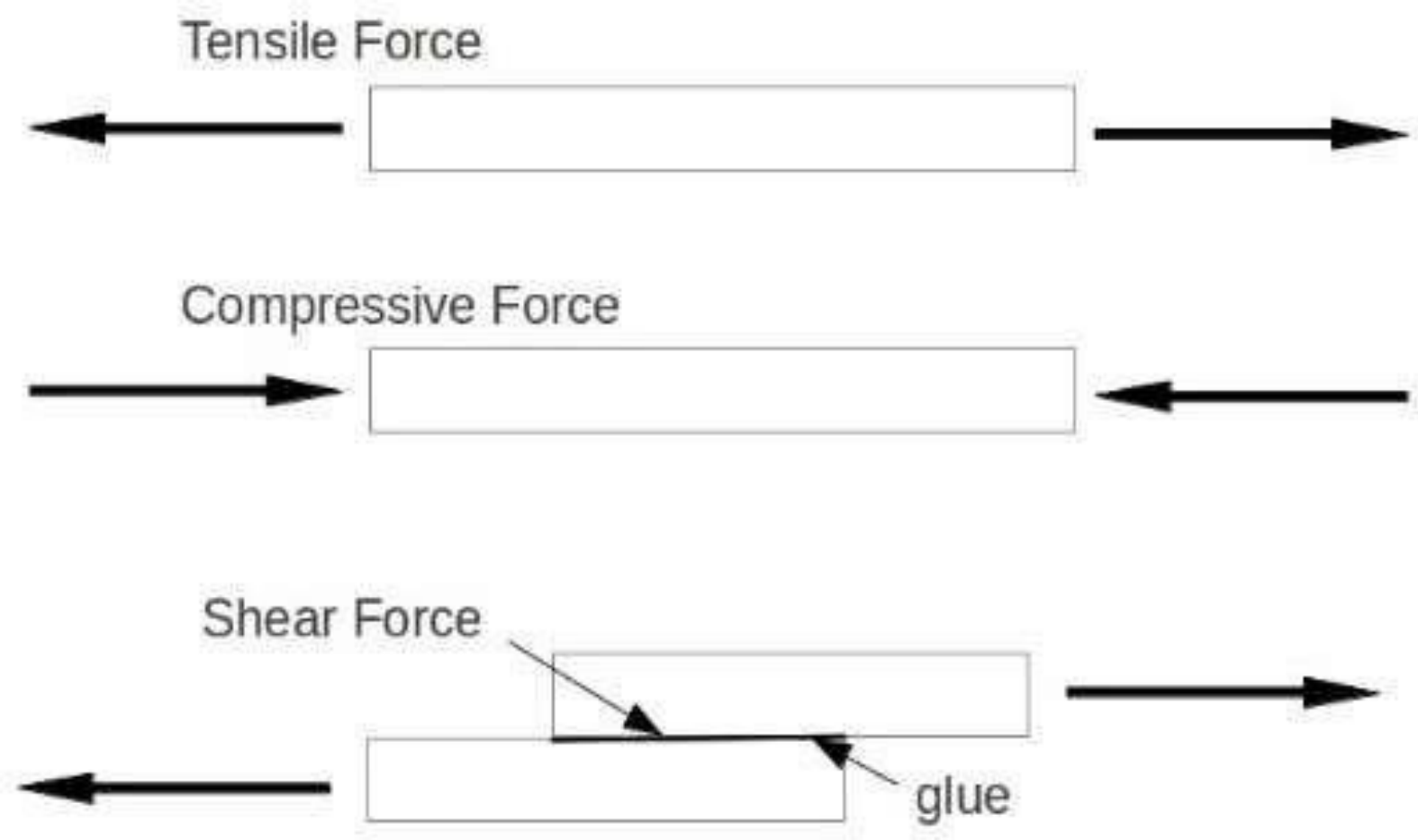
Elasticity

- The ability of an object or material to resume its normal shape after being stretched or compressed

Inelasticity ?

Stress, Strain and Modulus of Elasticity



Stress

- **Stress is "force per unit area" - the ratio of applied force F to cross section area - defined as "force per area".**

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

- *tensile stress* - stress that tends to stretch or lengthen the material - acts normal to the stressed area

- *compressive stress* - stress that tends to compress or shorten the material - acts normal to the stressed area

- *shearing stress* - stress that tends to shear the material - acts in plane to the stressed area at right-angles to compressive or tensile stress

- Tensile or compressive stress normal to the plane is usually denoted "**normal stress**" or "**direct stress**" and can be expressed as
- $\sigma = F_n / A \ (1)$
- *where*
- σ = *normal stress ((Pa) N/m²)*
- F_n = *normal component force (N)*
- A = *area (m²)*

Strain

- Strain is defined as "deformation of a solid due to stress" and can be expressed as

$$e = \frac{\Delta L}{L}$$

where

ΔL = *change of length*

(m) L = *initial length*

(m)

ε = *strain - unitless*

Modulus of Elasticity

E = Young's modulus (Modulus of Elasticity)
(N/m² (Pa)

Young's modulus can be used to predict the elongation or compression of an object.

$$E = \frac{\sigma}{e}$$

Elasticity Constant

$$\frac{F}{A} = E\frac{\Delta L}{L}$$

$$F = \left(\frac{AE}{L}\right)\Delta L$$

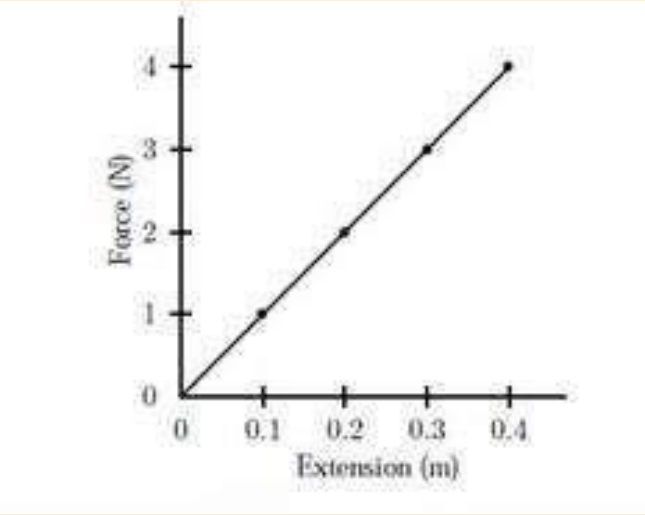
$$F = k\Delta L$$

$$\Delta x = \Delta L$$

$$k = \frac{AE}{L}$$

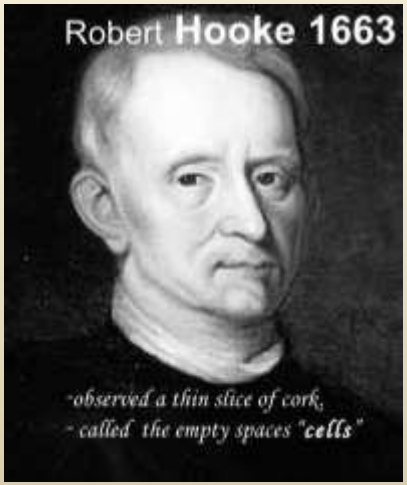
Material	Young's Modulus	
	10^{10} N/m^2	10^6 lb/in^2
Aluminum	7.0	10
Brass	9.1	13
Copper	11	16
Glass	5.5	7.8
Iron	9.1	13
Lead	1.6	2.3
Steel	20	29

Hooke's Law



Hooke's law is a principle of Physics that states that the force F needed to extend or compress a spring by some distance Δx is proportional to that distance.

$$F = k\Delta x$$



Where,

k is a constant factor characteristic of the spring

Δx is small compared to the total possible deformation of the spring.