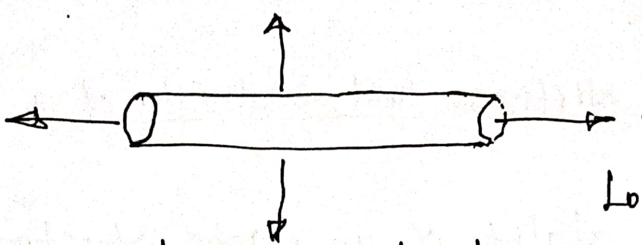
1-④

What is a bar?

A bar is a prismatic structural member subjected to axial or longitudinal loads.



Normal stress $\sigma = \frac{P}{A} = \frac{\text{axial force}}{\text{cross-sectional area}}$

Shear stress $\tau = \frac{V}{A} = \frac{\text{Shear force}}{\text{cross-sectional area}}$

unit of normal and shear stress

$= \frac{N}{mm^2}$ or $\frac{N}{m^2}$ or MegaPascals (MPa)

1 Pascal $= \frac{1 \text{ Newton}}{\text{meter}^2} = \frac{1 N}{m^2} = 1$ Pa

1 Mega Pascal $=$ 1 MPa $= 10^6$ Pascals.

1 Giga Pascal $=$ 1 GPa $= 10^9$ pascals.

1 Kg = 9.8 Newton or approximately 10 N.

Normal stress:
- tensile normal stress
- compressive normal stress

Axial loads or longitudinal loads act through the centroid of the cross-sectional area.

DAY 02

Axial bar, when subjected to axial forces undergoes change in length → Elongation or shortening of length.

Elongation of the bar due to tension. (stretching)
Shortening of the bar due to compression.

δ – change in length.

Strain ϵ (epsilon) (epsilon) $= \dfrac{\text{change in length } \delta}{\text{original length } L}$

Strain $\epsilon = \dfrac{mm}{mm}$ → dimensionless.

Strain ϵ
- normal strain ϵ
- shear strain γ (gamma)

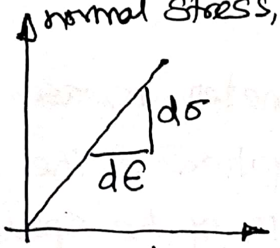
Shear strain is defined as angle of distortion, or change in the angle of 90° between two mutually perpendicular sides.

normal strain
- tensile strain → positive
- Compressive strain → negative

Shear strain
- increase in the angle of 90° (-ve)
- decrease in the angle of 90° (+ve)

Hooke's law in Tension/compression.

Within the linear elastic limit, stress is directly proportional to strain.



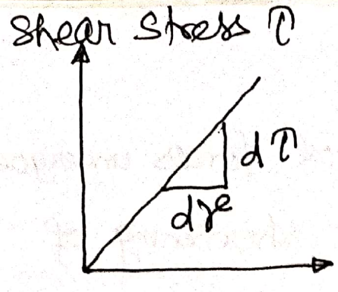
normal stress ∝ normal strain

$\sigma \propto \epsilon$

$\sigma = E\epsilon$

$E = \dfrac{\sigma}{\epsilon} = \dfrac{d\sigma}{d\epsilon}$

where E is the Young's modulus or Modulus of Elasticity or Elastic modulus.



Hooke's law in shear

Shear stress ∝ Shear strain

$\tau \propto \gamma$

$\tau = G\gamma$

$G = \frac{\tau}{\gamma} = \frac{d\tau}{d\gamma}$

G is the Rigidity modulus or shear modulus.

Young's modulus of steel = 210 GPa
Rigidity modulus of steel = 80 GPa

STRESS-STRAIN DIAGRAMS.

Mechanical properties of materials are determined by (1) static test — tensile test
compression test
Shear test

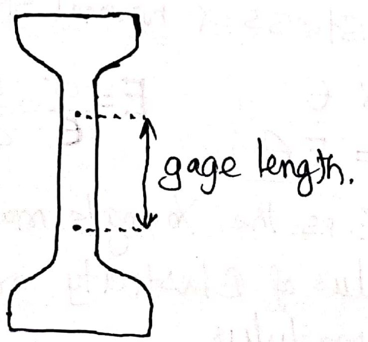
(2) Dynamic test — impact test
fatigue test

ASTM – American Society for Testing & Materials.
Universal Testing Machine - UTM

Tension test on mild steel or structural steel or low carbon steel.

Carbon content – less in steel – ductile steel → mild steel.
carbon content – more in steel – brittle steel → cast iron.

ASTM Specimen — dog-bone specimen.
diameter of 12.7 mm
gage length of 50.8 mm.



Extensometer measures the elongation in the gage length of the specimen.
Loading is gradually increased.
→ static test.