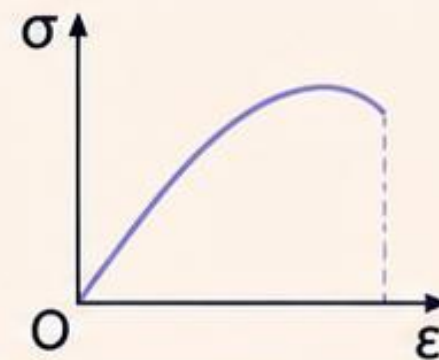


Chapter 8

Mechanical Properties of Solids

Stress • Strain • Elasticity



Pa

E

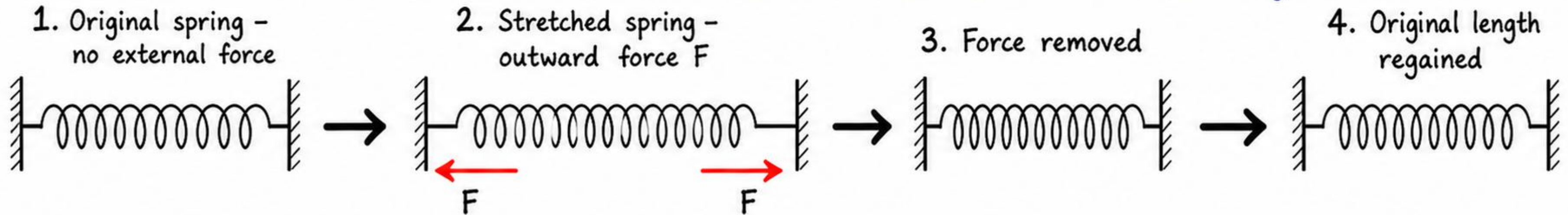
G

σ

+

DEFORMATION & ELASTICITY

- **RIGID BODY** – A perfectly rigid body is an idealisation.
Real solids can change shape or size when a force acts.
- **DEFORMATION** – Change in shape or size caused by an external force.
- **ELASTICITY** – Property by which a body tends to regain its original shape and size after the deforming force is removed.
- **ELASTIC DEFORMATION** – Reversible deformation; the original dimensions return after unloading.



Examples: spring and steel within the elastic limit.

Takeaway: Elasticity means recovery after the force is removed.

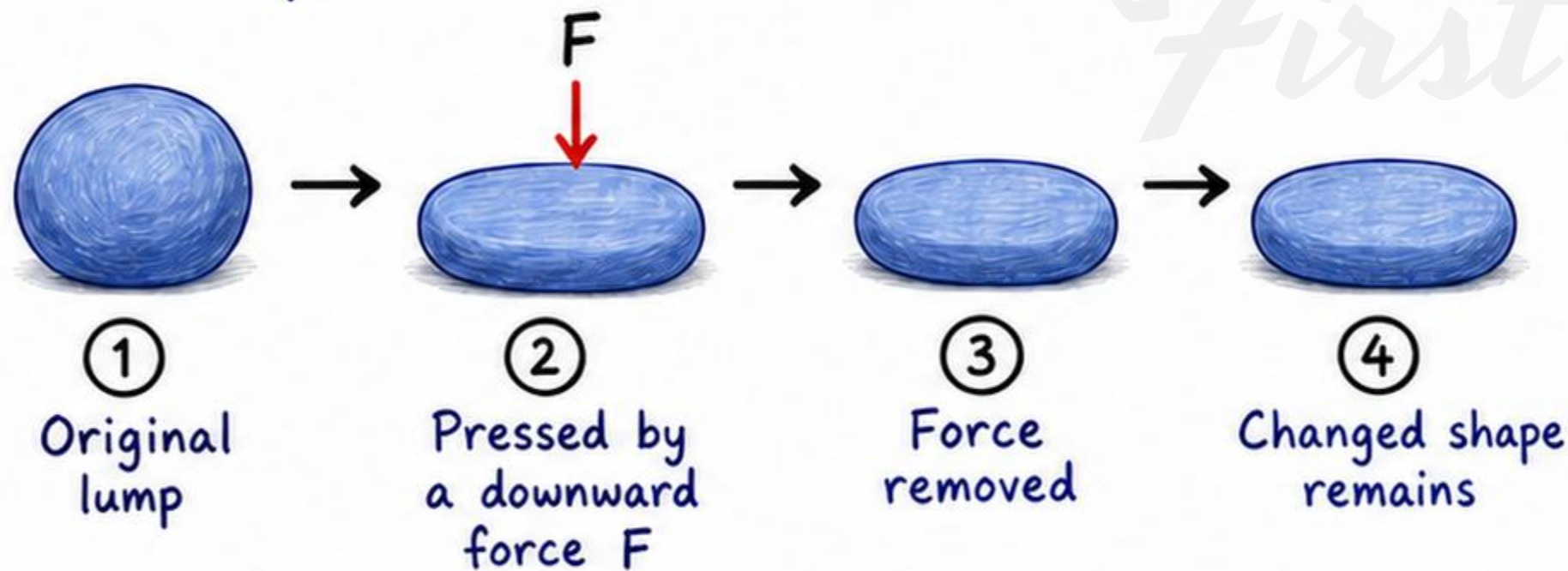
PLASTICITY & PERMANENT DEFORMATION

PLASTICITY

Property by which a body remains deformed after the force is removed.

PLASTIC DEFORMATION

Irreversible or permanent change in shape or size.



ELASTIC vs PLASTIC

	ELASTIC	PLASTIC
After unloading:	original shape returns	changed shape remains
Nature:	reversible	irreversible
Examples:	spring, steel within elastic limit	putty, mud

Real materials may show elastic behaviour for small deformation and plastic behaviour after the elastic limit.

Material behaviour depends on the material and the applied force.

STRESS & STRAIN: ESSENTIALS

- When an external force deforms a body, internal restoring forces develop.
- In static equilibrium, restoring force is equal in magnitude and opposite to the applied force.

STRESS — restoring force per unit area.

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

SI unit: $\text{N m}^{-2} = \text{pascal (Pa)}$

Dimensions: $[M L^{-1} T^{-2}]$

STRAIN — fractional change in a dimension.

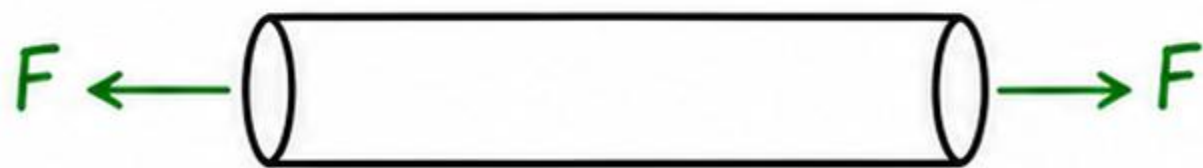
- It compares the change with the original dimension.
- Strain is dimensionless: no SI unit and no dimensions.

$$\text{strain} = \frac{\text{change}}{\text{original dimension}}$$

THREE TYPES OF STRESS

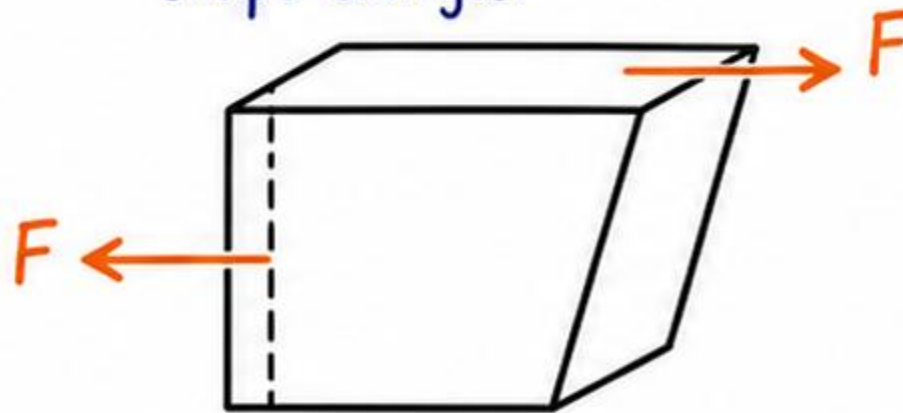
1. LONGITUDINAL

— normal force; length changes.



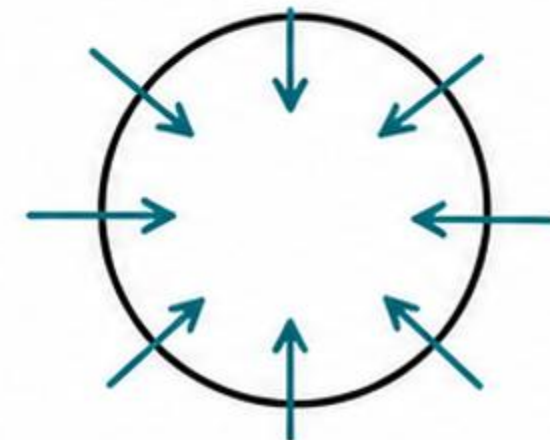
2. SHEARING

— tangential force; shape changes.



3. HYDRAULIC

— pressure normal to every surface point; volume changes.

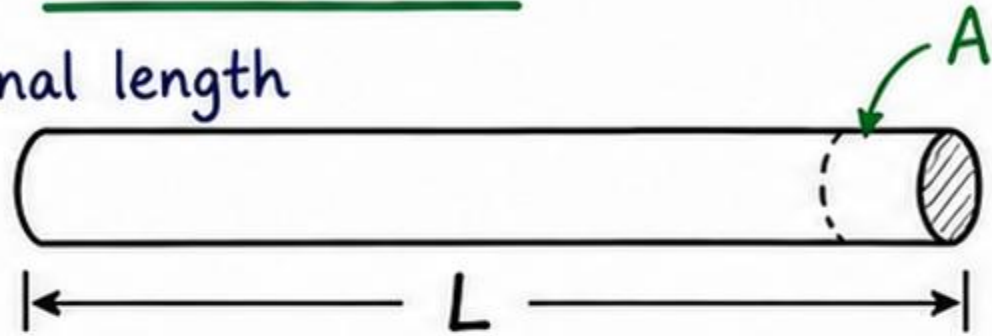


★ Stress is treated as a scalar quantity in this Class 11 chapter.

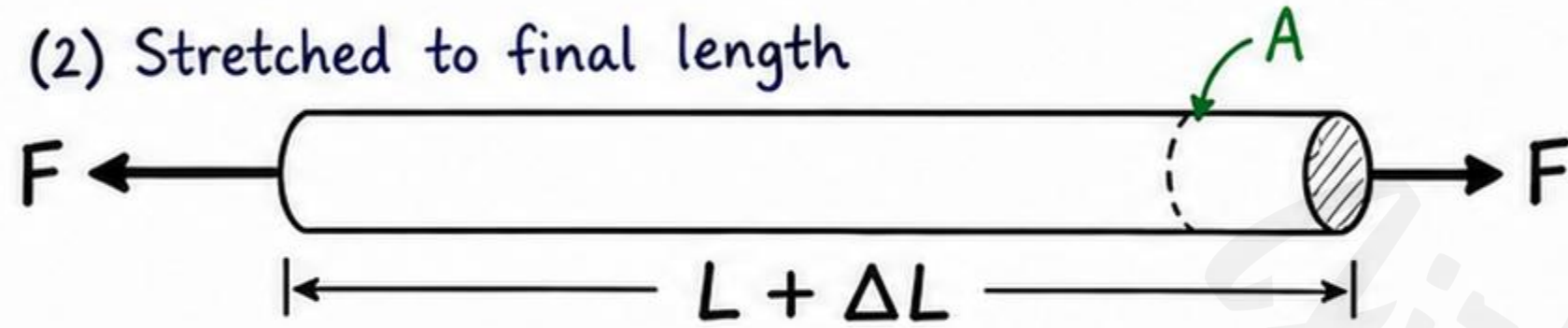
LONGITUDINAL STRESS & STRAIN

TENSILE

(1) Original length



(2) Stretched to final length



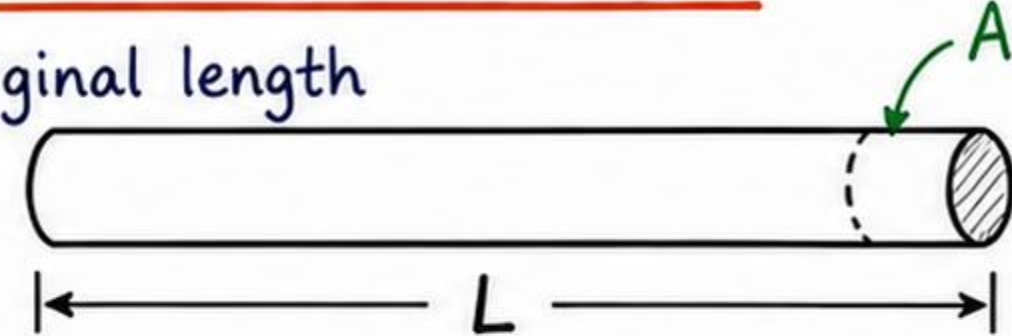
$$\sigma = \frac{F}{A} \quad \epsilon = \frac{\Delta L}{L}$$

- Force is normal to the cross-section.
- Length increases: $\Delta L > 0$.

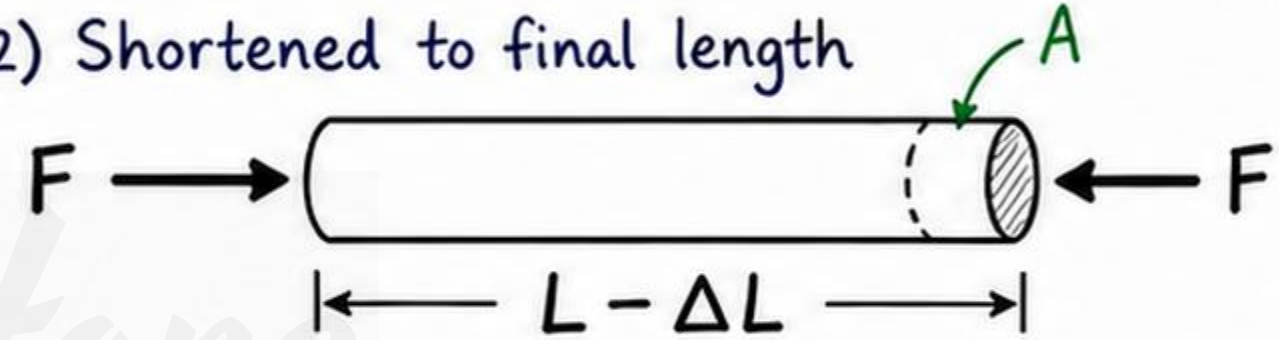
Example: a pulled wire

COMPRESSIVE

(1) Original length



(2) Shortened to final length

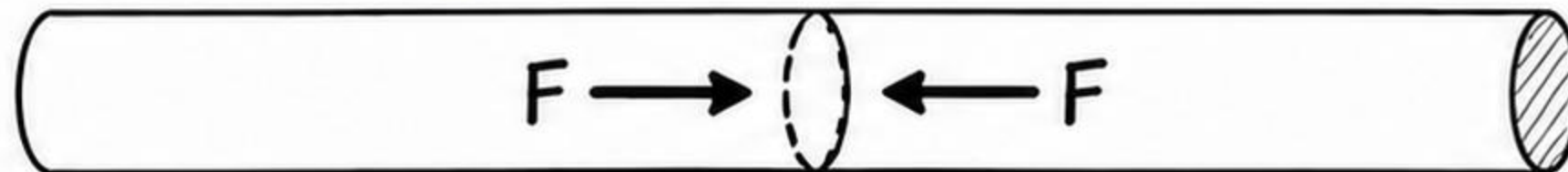


$$\sigma = \frac{F}{A} \quad \epsilon = \frac{\Delta L}{L}$$

- Force is normal to the cross-section.
- Length decreases: $\Delta L < 0$.

Example: a loaded pillar or thighbone

CUT-SECTION FACT: At any cut, the internal tension has magnitude F — not $2F$.



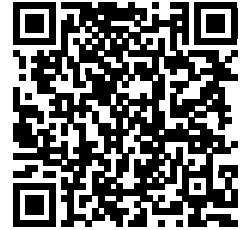


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