# Mechanical Properties of Solids

### *Introduction*

**Mechanical Properties of Solids** is the branch of physics that studies how solid materials respond when external forces are applied to them. It explains concepts such as **stress, strain, elasticity, and Young's modulus**. These properties help engineers and scientists select suitable materials for buildings, bridges, machines, and other structures.

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# Elasticity

### *Definition*

**Elasticity** is the property of a material by which it regains its original shape and size after the external force is removed.

Examples:

- Steel
- Rubber
- Spring

Materials that return completely to their original shape are called **elastic materials**.

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# Plasticity

### *Definition*

**Plasticity** is the property of a material by which it undergoes permanent deformation after the removal of the applied force.

Examples:

- Clay
- Putty
- Wax

Plastic materials do not regain their original shape.

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# Stress

### *Definition*

**Stress** is the internal restoring force acting per unit area of a material when an external force is applied.

Formula:

**Stress = Force / Area**

SI Unit: **Pascal (Pa)**

### *Types of Stress*

- Longitudinal Stress
- Shear Stress
- Bulk Stress

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## Strain

### *Definition*

**Strain** is the ratio of change in dimension to the original dimension of a body.

Formula:

**Strain = Change in Dimension / Original Dimension**

Strain has **no unit** because it is a ratio.

### *Types of Strain*

- Longitudinal Strain
- Shear Strain
- Volumetric Strain

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## Hooke's Law

### *Statement*

**Hooke's Law** states that **within the elastic limit**, stress is directly proportional to strain.

**Stress ∝ Strain**

or

**Stress = Elastic Modulus × Strain**

This law is valid only up to the elastic limit.

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# Elastic Moduli

### *Types of Elastic Modulus*

The three important elastic moduli are:

- **Young's Modulus (Y):** Measures the elasticity of a wire or rod under stretching or compression.
- **Bulk Modulus (K):** Measures resistance to change in volume.
- **Modulus of Rigidity (G):** Measures resistance to shear deformation.

These constants describe the stiffness of materials.

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# Poisson's Ratio

### *Definition*

**Poisson's Ratio** is the ratio of **lateral strain** to **longitudinal strain**.

It helps describe how a material deforms when stretched or compressed.

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# Stress-Strain Curve

### *Behavior of Materials*

The **stress-strain curve** shows how a material behaves under increasing load.

Important regions include:

- Elastic Limit
- Yield Point
- Ultimate Strength
- Breaking Point

The graph helps determine the strength and elasticity of materials.

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# Applications of Mechanical Properties of Solids

### *Importance*

These properties are used in:

- Construction of Buildings
- Bridges
- Machines
- Vehicles
- Engineering Design

- Manufacturing Industries

They help in choosing materials that are strong, flexible, and durable.

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## Key Points

- Elasticity is the ability to regain the original shape.
- Plasticity causes permanent deformation.
- Stress is force per unit area.
- Strain is the ratio of deformation.
- Hooke's Law states that stress is proportional to strain within the elastic limit.
- Young's, Bulk, and Rigidity Moduli measure different types of elasticity.
- The stress-strain curve describes the mechanical behavior of materials.

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## Chapter Summary

This chapter explains the mechanical properties of solids, including elasticity, plasticity, stress, strain, Hooke's Law, elastic moduli, Poisson's ratio, and the stress-strain curve. These concepts help understand how solid materials respond to external forces and are essential in engineering, construction, manufacturing, and material science.