

Rigid body:

A rigid body is defined as a body on which the distance between two points never changes whatever be the force applied on it or we may say the body which does not deform under the influence of forces is known as a rigid body.

Deformable bodies:

When forces are applied to a body (solid, liquid or gas), internal forces are set up in the body and it deforms and/or moves. Such bodies are called as deformable bodies.

Stress

When a body is subjected to an external force, an internal resistance is developed in the body against deformation. The resistance per unit area is known as Stress.

$$\therefore \text{Stress} = \frac{\text{External load}}{\text{Cross-sectional area}}$$

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

It is expressed in N/m^2 .

Strain

When a body is subjected to an external force, some changes occur in the dimensions of the body. The ratio of change of dimension to the original dimension is known as strain.

$$\text{Strain} = \frac{\text{Change in length}}{\text{Original length}}$$

$$e = \frac{\delta l}{l}$$

It has no units.

Elasticity

The property of a material to regain its original shape and size after removal of an external force applied on the material is known as elasticity.

Modulus of elasticity

Within the elastic limit, the stress is directly proportional to strain. The ratio of stress to strain bears a constant, known as Young's modulus (or) modulus of elasticity. It is denoted by E.

$$\text{Young's modulus} = \frac{\text{Stress}}{\text{Strain}}$$

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

Hooke's law

When a member is subjected to an external force, within the elastic limit stress is directly proportional to strain.

i.e., Stress \propto Strain

$$\text{or } \frac{\text{Stress}}{\text{Strain}} = \text{a constant}$$

The constant is known as Modulus of elasticity (or) Young's modulus, expressed in N/mm^2 .

Importance of Hooke's law

- 1.The stress in a structural member is not allowed to exceed the limit of proportionality to avoid permanent deformation.
- 2.Only when the stress in a structure does not exceed the limit of proportionality, the structure will return to its un deformed shape on removal of the loading.

Strain energy

When an elastic material is subjected to deformation, an internal resistance is developed in the material of the body. The work done by the internal resistance is stored in the form of energy called as strain energy.

The unit of strain energy is Nm.

Factor of safety

The ratio of ultimate stress to the working stress is known as Factor of safety.

$$\text{i.e., Factor of safety} = \frac{\text{Ultimate stress}}{\text{Working stress}}$$

Proof Resilience

The maximum strain energy stored in a body within its elastic limit is known as Proof Resilience.

Modulus of Resilience

The Proof Resilience of a material per unit volume is known as modulus of Resilience.

$$\text{i.e., Modulus of Resilience} = \frac{\text{Proof Resilience}}{\text{Volume of the body}}$$