# UTTAR PRADESH TEXTILE TECHNOLOGY INSTITUTE

## Department of Engineering

Semester : 4th

Subject: Engineering Mechanics

Faculty: Arpit Srivastava

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# Topic covered:

- Stress
- Strain
- Normal stress
- Stress-strain diagram for ductile material
- Stress- strain diagram for Brittle material
- Elastic constant and their relation

# Stress

When some external force or load is applied on a body, then the body offers resistance to these forces. to make the equilibrium condition this resistance force(which is developed in the material against the applied load).This internal resistance force per unit cross-sectional area is called stress. Unit of stress $N/mm^2$ or Pascal.

# Normal Stress or Direct stress

If the applying force is normal to the surface then the developed stress is known direct stress. Direct stress mainly depends upon the direction of force. Basically its of two types-

**Tensile Stress**

**Compressive stress**

The normal stress ($\sigma$) in a material is defined as $\sigma \equiv F/A$

where F is the force (either tension or compression) acting perpendicular to an imaginary plane surface passing through a piece of material and A is the cross section area.

# What is tensile stress?

When force is applied in such a way, due to this the length of the body increases, this force is called tensile force and stress developed by this force is known as tensile stress.

# What is **Compressive stress**?

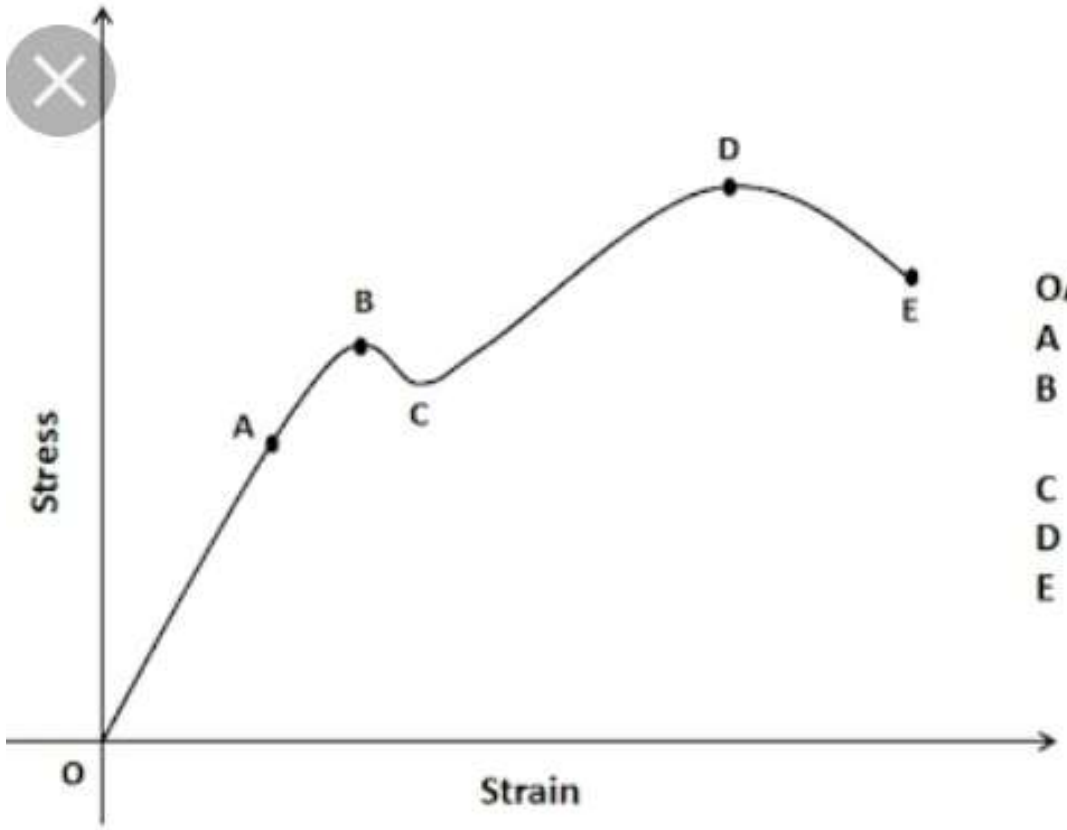
The force is applied in such a way, due to this length of the body decreases. This type of force is known as compressive force & the stress which is developed by using compressive force is known as compressive stress.

# Strain

After applying load on body, the body gets deformed. This deformation is measured in terms of a dimensionless quantity which is known as unit strain or called strain. This is of three types-

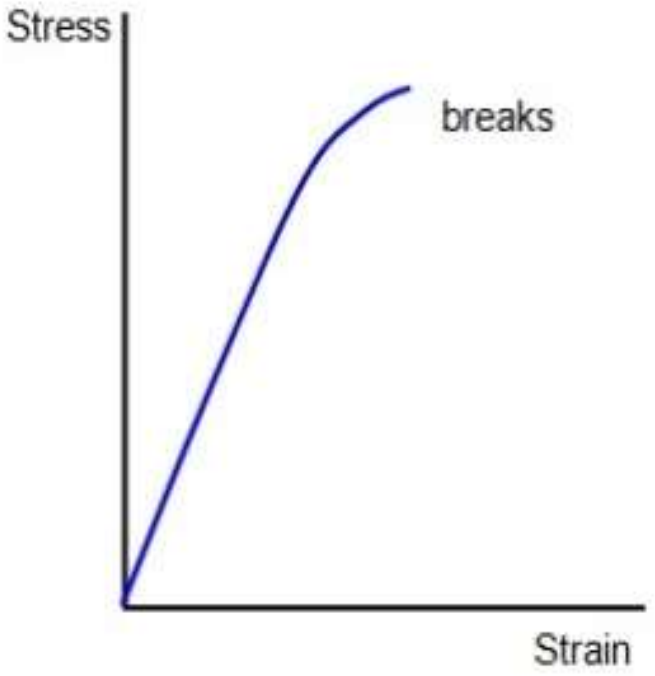
1. **Tensile strain**
2. **Compressive strain**
3. **Shear Strain**

# Stress-Strain Diagram of Ductile Material

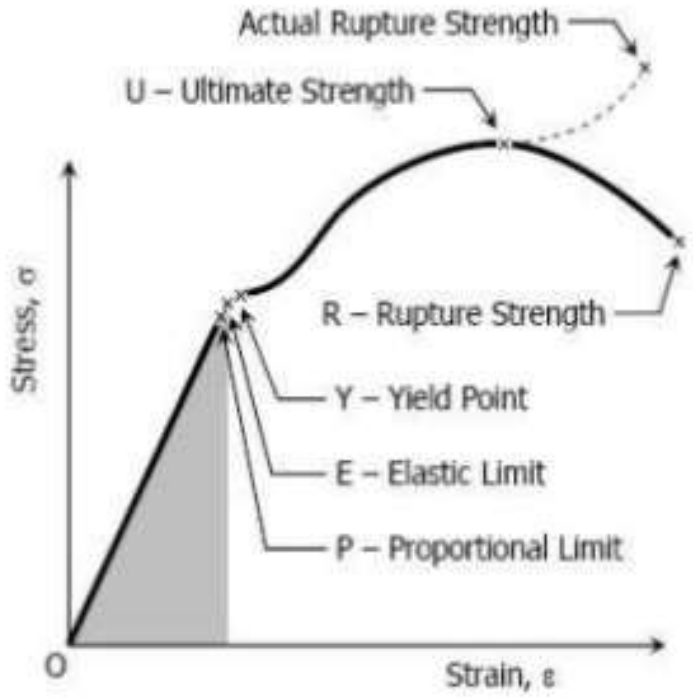



**OA** : Proportional limit
**A** : Elastic limit
**B** : Yield stress point/upper yield stress point
**C** : Lower yield stress point
**D** : Ultimate stress point
**E** : Breaking or rupture point

# Stress-Strain Curve




BRITTLE MATERIAL




DUCTILE MATERIAL

# Elastic constant

**1.Elasticity Modulus**

**2. Poisson's Ratio**

**3. Modulus of Rigidity**

**4. Bulk Modulus**

# Elastic constants

**Elastic constants:**

These are the relations which determine the deformations produced by a given stress system acting on a particular material. These factors are constant within elastic limit, and known as modulus of elasticity E, modulus of rigidity G, Bulk modulus K and Poisson's ratio μ.

# Elastic constants

**Poisson's Ratio**

The ratio lateral strain to longitudinal strain produced by a single stress is known as Poisson's ratio. Symbol used for poison's ratio is or 1/ m .

**Modulus of Rigidity**

For elastic materials it is found that shear stress is proportional to the shear strain within elastic limit. The ratio is called modulus rigidity. It is denoted by the symbol 'G' or 'C'. G= shear stress 2 N/mm shear strain | |

**Bulk modulus (K)**

It is defined as the ratio of uniform stress intensity to the volumetric strain. It is denoted by the symbol K.

$$K = \frac{StressIntensity}{volumetricstrain} = \frac{\sigma}{\varepsilon_v}$$

# Hook's Law

The property of material by virtue of which it returns to its original shape and size upon removal of load is known as elasticity. And according to Hooks law-

It states that within elastic limit stress is proportional to strain.

Mathematically E= Stress/Strain

Where E = Young's Modulus

Hooks law holds good equally for tension and compression.

# Relation between elastic constants

Relationship between modulus of elasticity (E) and bulk modulus (K):

$$E = 3K(1 - 2\mu)$$

Relationship between modulus of elasticity (E) and modulus of rigidity (G):

$$E = 2G(1 + 2\mu)$$

Relation among three elastic constants:

$$E = \frac{9KG}{G + 3K}$$