

# Elasticity

**B.V.Sreedhara Swamy**

**Department of Physics, National College, Jayanagar, Bengaluru.**

A body can exhibit two properties namely **rigidity** and **plasticity**

A rigid body is the one which oppose the **deformation** produced in it. The forces opposing it are called ***elastic forces***. They act to restore the body to its initial state once the deforming forces are **withdrawn**.



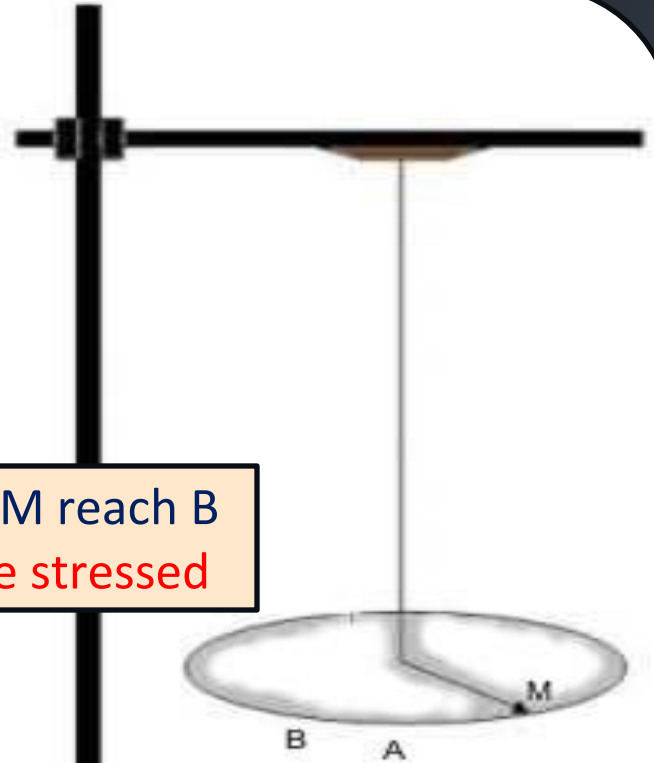
**Here the deformation is temporary. It exists as long as the deforming forces are acting. The moment these forces are withdrawn the body regain its initial state.**

**Stress:** It depends on the amount of deformation.

Greater the deformation larger is the stress.

Twisted so that M reach B  
- wire gets more stressed

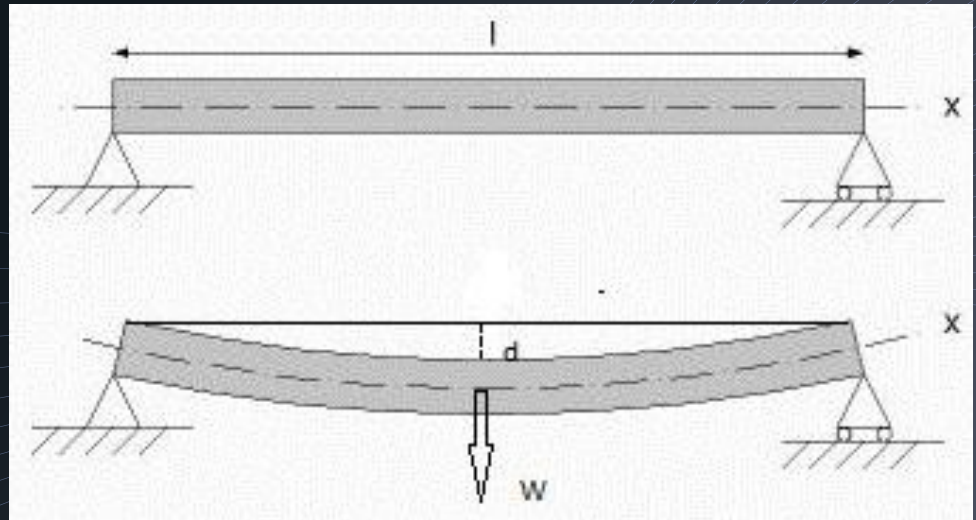
Twisted so that M reach A  
- wire gets stressed



**Strain** :The amount of deformation measures the strain acting on the deforming body. **Larger the deformation produced greater is the strain.**

No deformation – No Strain

Deformation – More Strain



Based on the kind of deformation we can have three kinds of strains.

***Longitudinal strain*** - Ratio of change in length to its original length

**Shear strain** - measuring change in SHAPE

***Volume strain*** - Ratio of change in volume to its original volume

Hooke's law:

Relation between stress and strain of a rigid body.

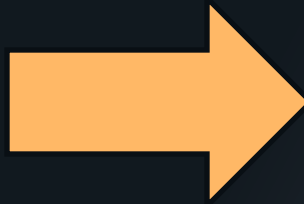
Statement

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

$\text{Stress} / \text{Strain} = \text{constant}$



Stress/ strain



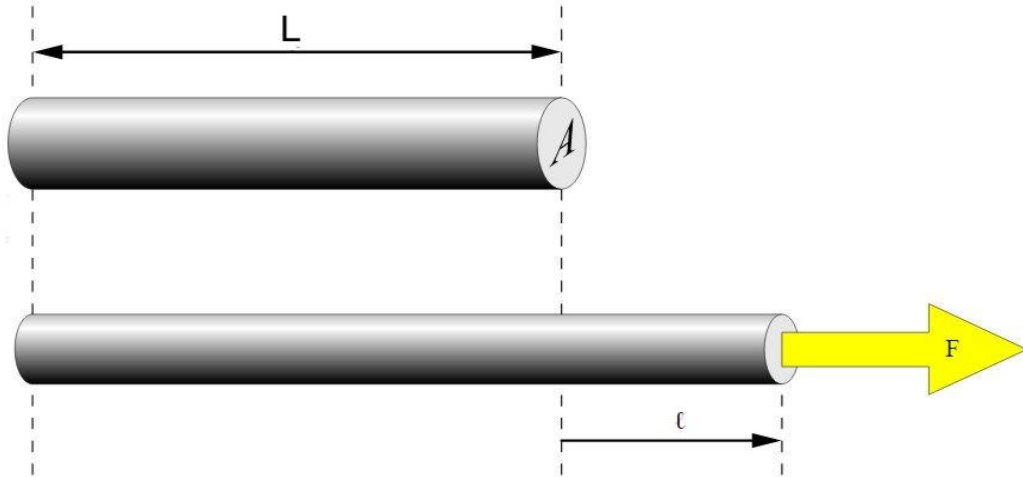
Elastic modulus

Elastic nature of  
the material.

Characteristic of  
the material.

# Three Elastic Moduli

**Young's modulus (Y):** Ratio of longitudinal stress to longitudinal strain.



$$\text{Stress} = F/A$$

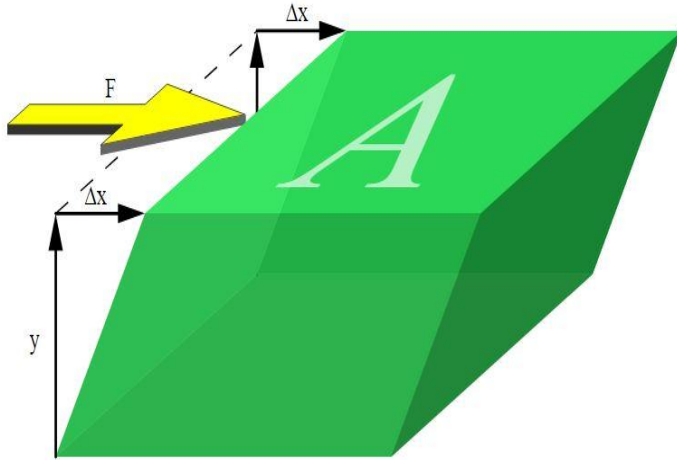
$$\text{Strain} = \ell/L$$

$$Y = FL/A\ell$$

Young's modulus

# Three Elastic Moduli

**Rigidity modulus( $n$ ):** Ratio of tangential stress shearing strain.

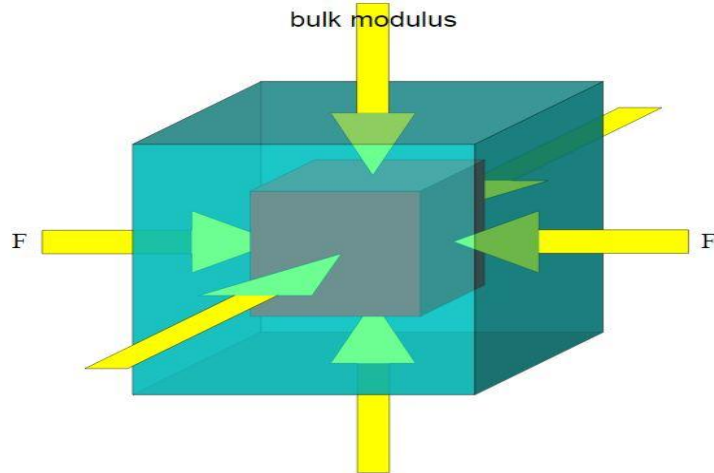


$$\begin{aligned}\text{Shearing strain} &= \delta x/y \\ &= \tan\theta \\ &= \theta\end{aligned}$$

$$\text{Rigidity modulus } \eta = F/A \theta$$

# Three Elastic Moduli

**Bulk modulus ( $k$ ):** Ratio of volume stress to the volume strain.



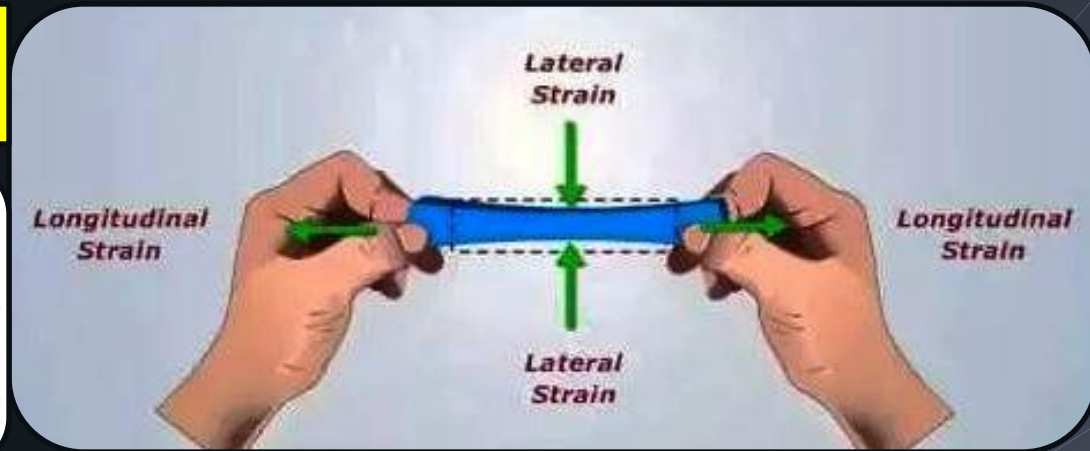
$$\text{Bulk strain} = \delta v/V$$

$$\text{Bulk stress} = F/A$$

$$\text{Bulk modulus} = FV/A\delta v$$

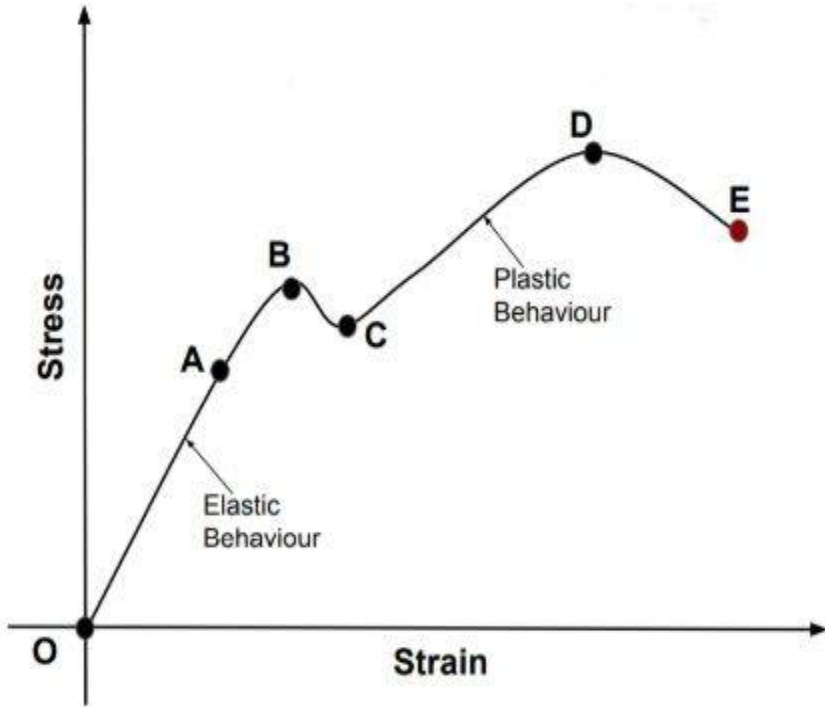
# Poisson's Ratio

$$\text{Poisson's ratio} = \frac{\text{Lateral strain}}{\text{Longitudinal strain}}$$



As the **lateral** strain is always less than **longitudinal** strain,  
above ratio is always less than 1  
Practical limits of above ratio is 0 - 0.5

# Stress strain diagram



OA region in which Hooke's law is applicable (ELASTIC REGION)

ABCDE region in which deviation from Hooke's law is observed (Plastic region)

B Upper yield point

C Lower yield point

D Maximum yield point

E breaking point

# Test your understanding

## 1. Identify the correct statement

Solids exhibit elasticity

Both solids and liquids exhibit elasticity

Matter in all its states of exhibit elasticity

# Test your understanding

## 2. Elastic forces occur due to

Gravitational force between atoms of the material  
Magnetic force between atoms of the material  
Electric force between atoms of the material



# Test your understanding

**3. Can we say that there is no stress in the plastic body**

Yes

No

Cant say

# Test your understanding

**4. Choose the correct statement related to stress from the following**

Stress is related to deforming forces

Stress is unrelated to deforming forces

Sometimes related, sometimes unrelated

# Test your understanding

**5. Choose the correct statement related to strain from the following**

Strain is related to the deformation

Strain is unrelated to the deformation

Not always related

# Test your understanding

## 6. Chose the correct statement

Longitudinal extension is always associated with lateral contraction

Longitudinal extension is always associated with lateral extension

Both of them are true

# Test your understanding

## 7. Identify the correct statement

Stress has no dimensions

Strain has dimensions

Stress has dimensions and strain has no dimensions

# Test your understanding

## 8. Among Steel and rubber

Rubber is more elastic than steel

Steel is more elastic than rubber

Both steel and rubber has same elasticity

# Test your understanding

9. Can Poisson's ratio be zero?

yes

No

Cant say

# Test your understanding

## 10. Mark the correct statement

A material exhibits both elastic and plastic properties independent of strain

A material exhibits elastic and plastic properties depending on the strain

None of the above