# SNS COLLEGE OF TECHNOLOGY

**Coimbatore-35**

**An Autonomous Institution**

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Approved by AICTE, New Delhi & Affiliated to Anna University, Chennai

## DEPARTMENT OF AEROSPACE ENGINEERING

## 19ASB201 Aero Mechanics of Solids

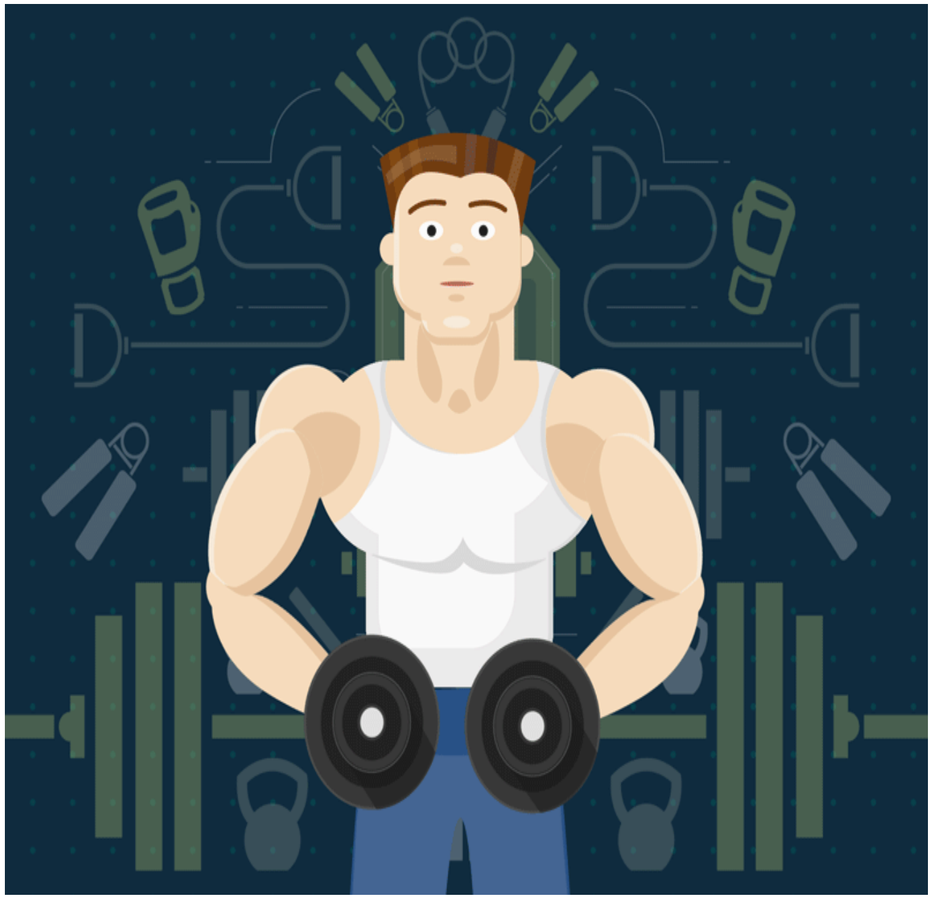
II YEAR III SEM

UNIT 1 – STRESS STRAIN DEFORMATION OF SOLIDS

TOPIC 1 – Rigid and Deformable bodies - Strength, Stiffness and Stability

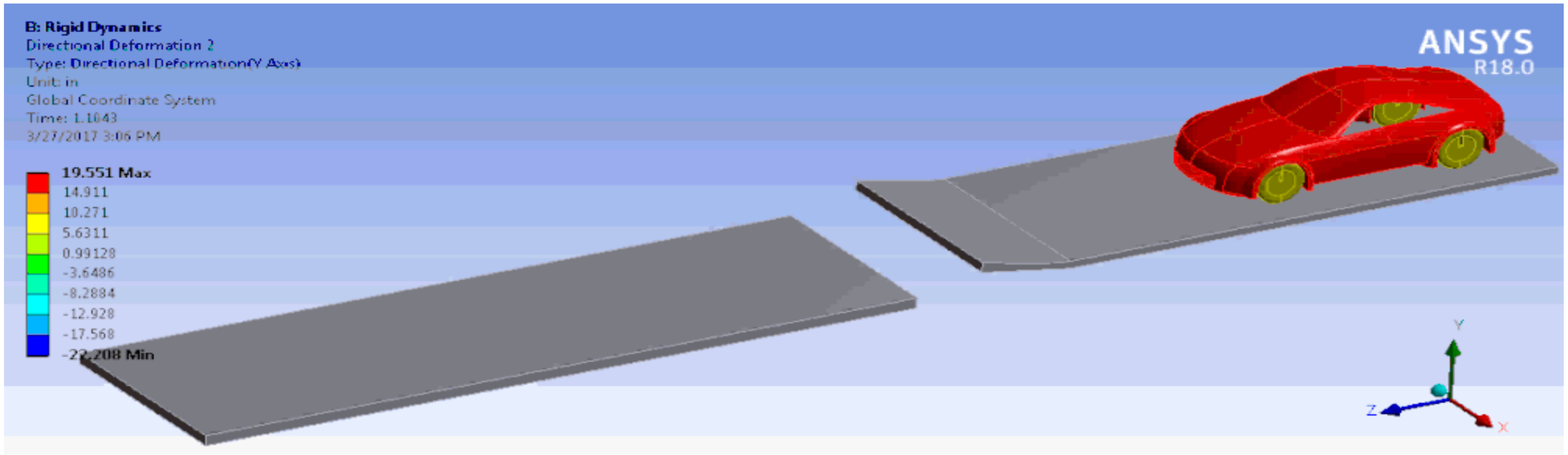
# STRENGTH OF MATERIALS

- **Aero Mechanics of Solids** also called **Mechanics of materials**, is a subject which deals with the behavior of solid objects subject to stresses and strains.
- The study of strength of materials often refers to various methods of calculating the stresses and strains in structural members, such as beams, columns, and shafts.



# 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.
- Practically, there is no rigid body.



# DEFORMABLE BODY

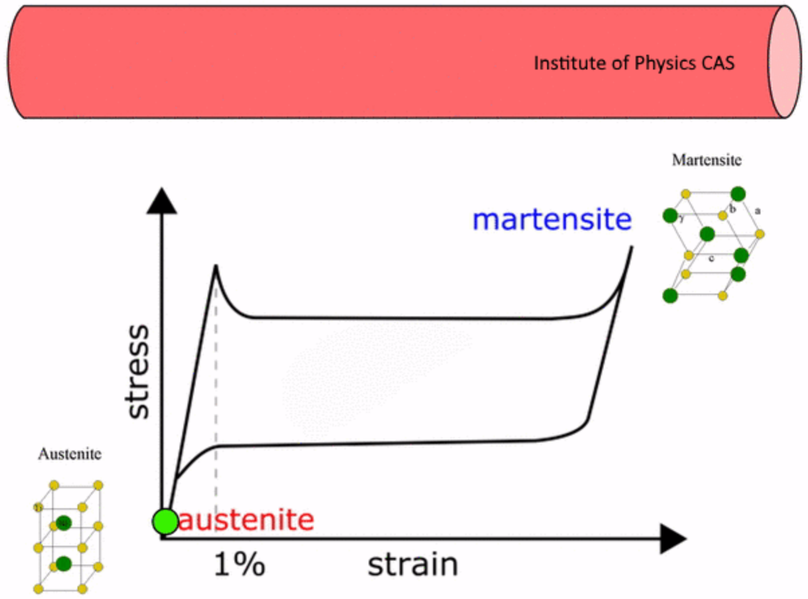
A deformable body is defined as a body on which the distance between two points changes under action of some forces when applied on it.

The study of the property of this body is called **Elasticity**

# ELASTICITY

- The property of a body by virtue of which it tends to regain its original shape and size when deforming force is removed .
- All solids show the property of elasticity.

# STRESS ($\sigma$)




**Stress** is the applied force or system of forces that tend to deform a body.

# STRESS...

$$Stress = \frac{External\ deforming\ force}{Area} = \frac{F}{A}$$

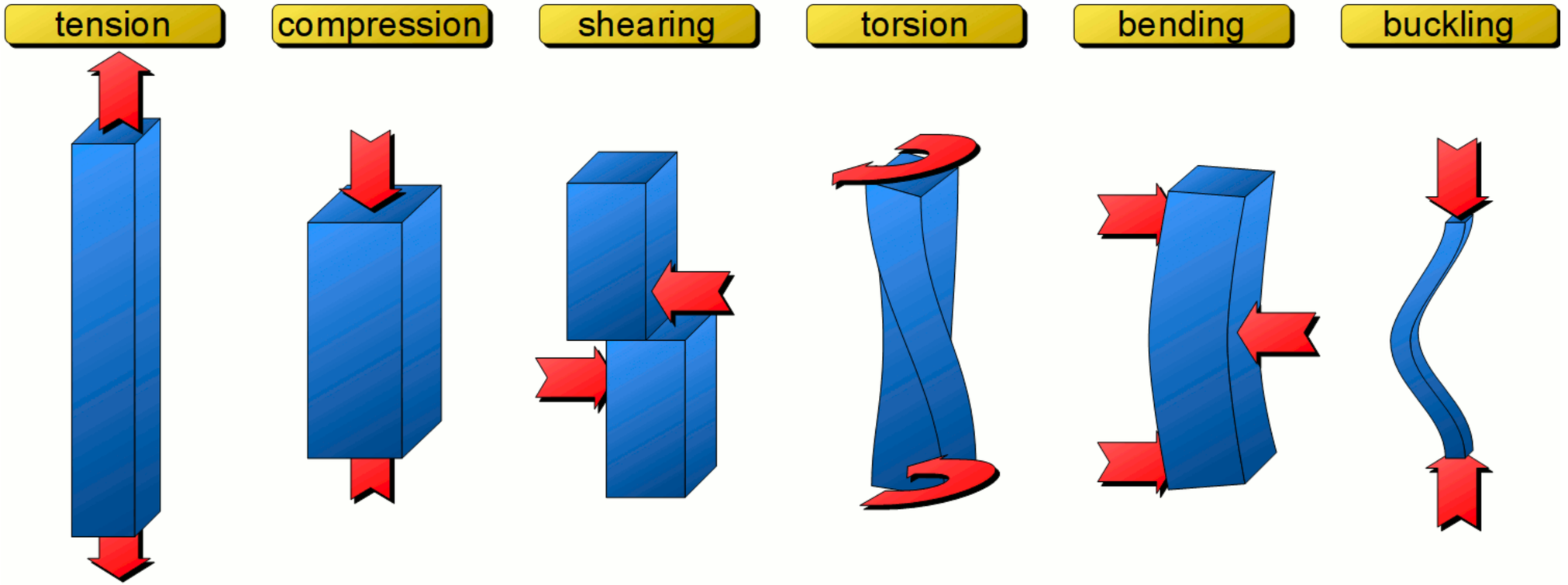
- Dimensional formula of the stress = $\frac{[MLT^{-2}]}{L^2}$

$$\therefore = [ML^{-1}T^{-2}]$$

- The SI unit of stress is $Nm^{-2}$ = $Pascal$

Same as that of pressure

# BEHAVIOR OF SOLID OBJECTS



# TYPES OF STRESS...

- The stress developed in a body depends upon how the external forces are applied over it. On this basis, there are two types of stress ,

**i. Normal Stress**

**ii. Tangential Stress**

# NORMAL STRESS

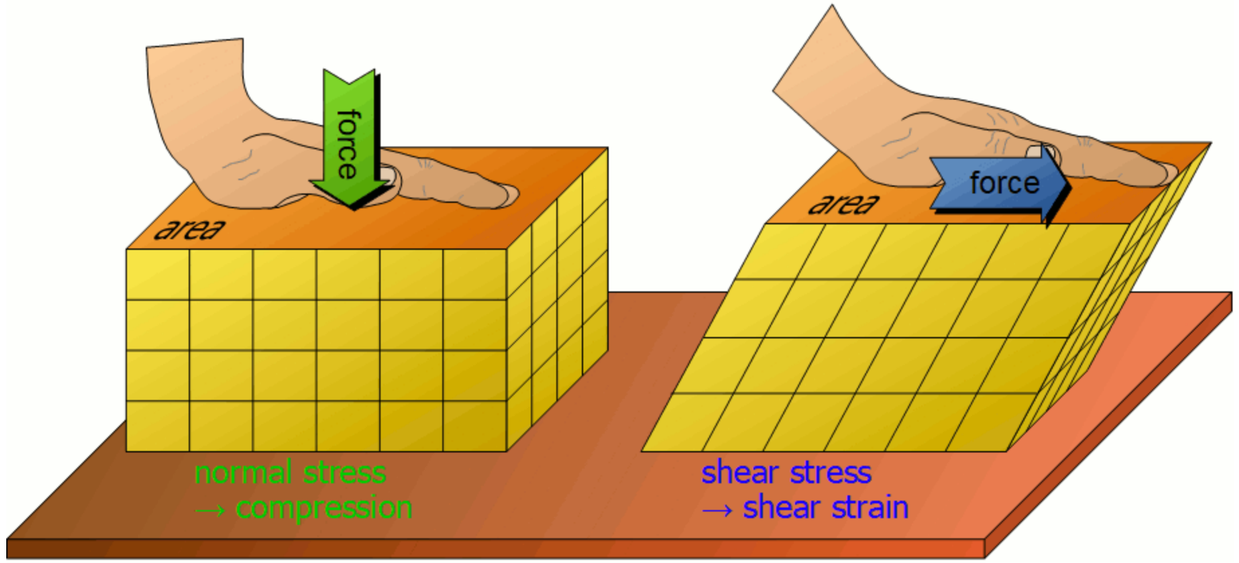
- Is a stress that occurs when the surface of the body is loaded by an axial force.

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

$\sigma$ – Normal Stress

P – Axial Force

A – Cross Sectional Area




- Normal stress is of two types;

**i. Tensile stress**

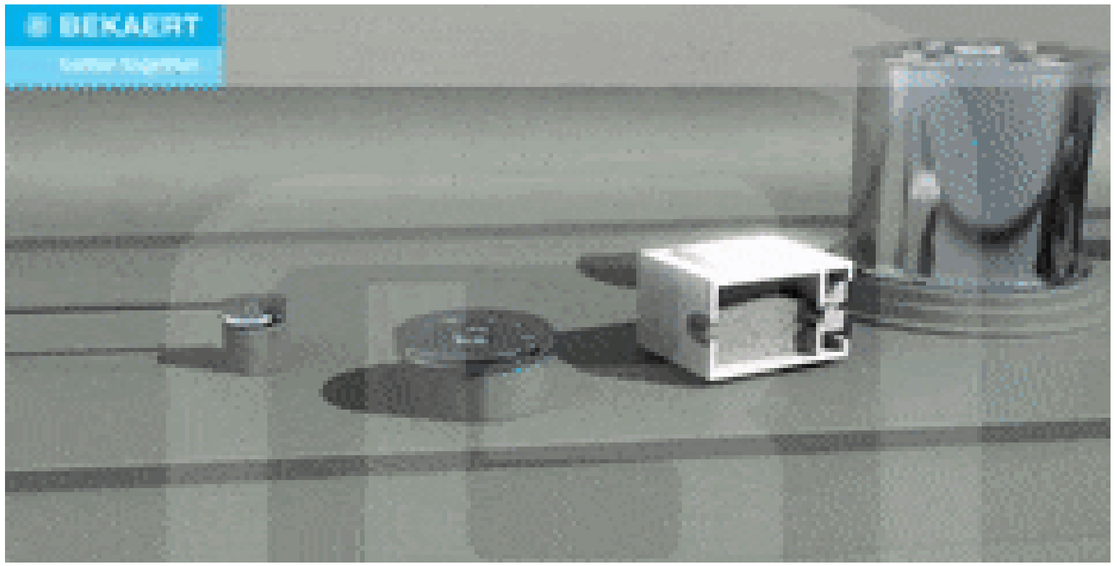
**ii. Compressive stress**

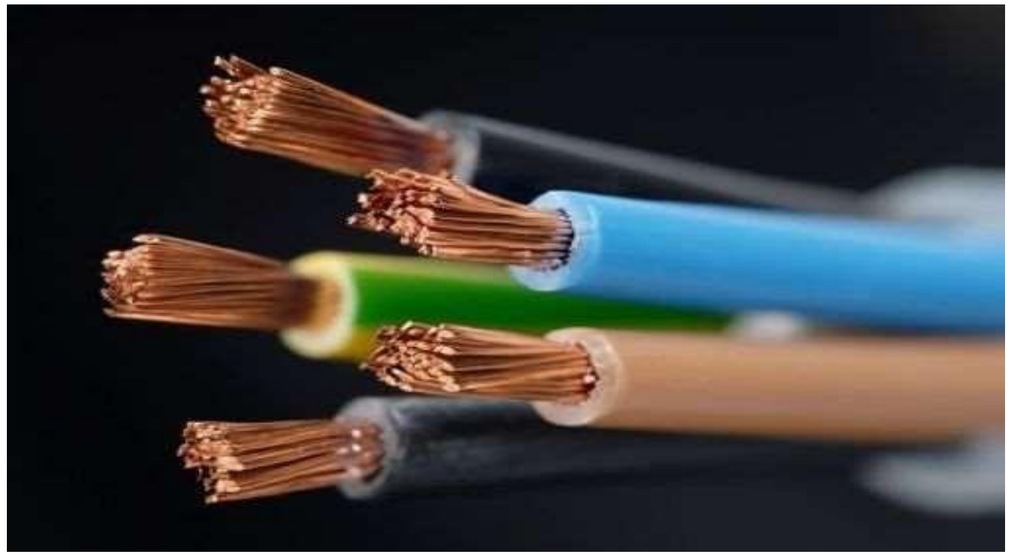
# TENSILE STRESS

- Is the stress state leading to expansion; that is, the length of a material tends to increase in the tensile direction.
- This is an example of tensile stress tester (Universal Testing Machine)

# DUCTILE BEHAVIOR

- Ductility is a solid material's ability to deform under  tensile stress.



Copper wires

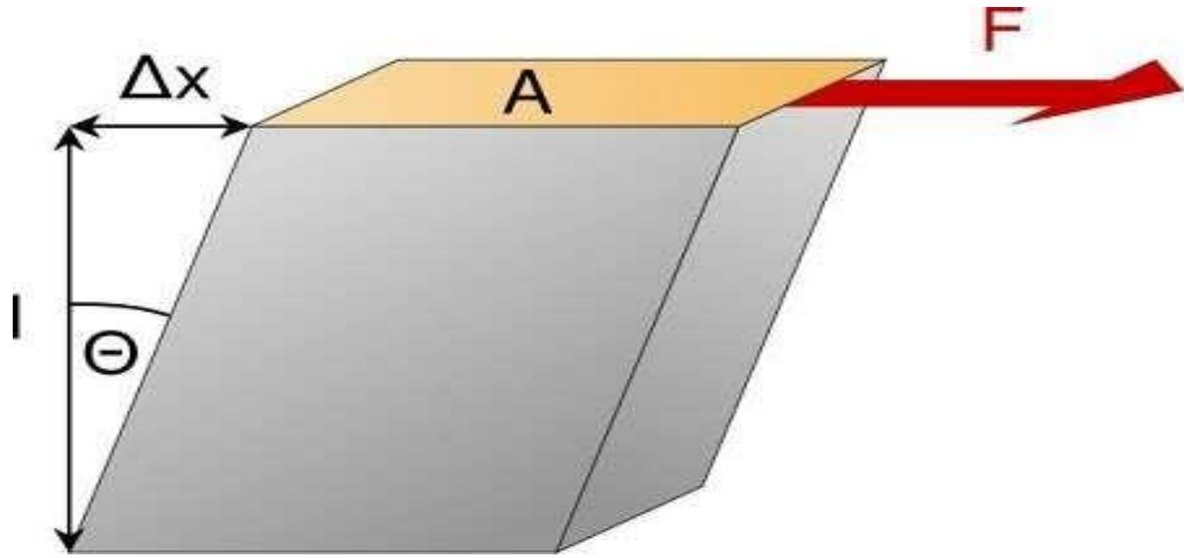
# COMPRESSIVE STRESS

- A force that attempts to squeeze or compress a material.

- Here, the Universal Testing Machine (UTM) is testing a concrete block.

# TANGENTIAL STRESS

- A force acting in a generally horizontal direction; *especially* **:** a force that produces mountain folding and over thrusting



# BRITTLE BEHAVIOR

- A material is brittle if, when subjected to stress, it breaks without insignificant deformation.

- Glass is a good example.

# STRAIN ($\varepsilon$)

- Is the change in the size or shape of a body due to the deforming force.Type equation here.

$$Strain = \frac{Change\ in\ Dimension}{Original\ dimension}$$

- i.e.

- **Strain is Dimensionless hence no unit**

# TYPES OF STRAIN

- Since the deforming force can produce three of deformations (i.e. Change in length, or volume or shape) in a body, there are three types of strain;

i. Longitudinal strain

ii. Volumetric strain

iii. Shearing strain

# LONGITUDINAL STRAIN

- Is when the deforming force produces change in length.
- $Longitudinal\ Strain = \dfrac{Change \quad in\ Length}{Original\ Length} = \dfrac{l}{L}$

$$\therefore \varepsilon_{long} = \frac{l}{L}$$

# VOLUMETRIC STRAIN

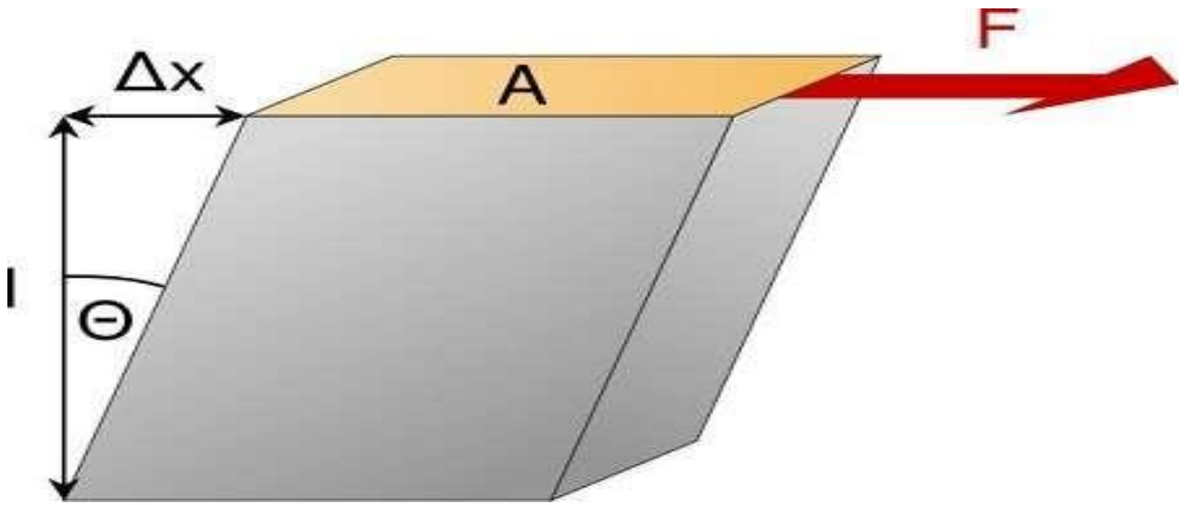
- Is when the deforming force produces change in the volume.

$$Volumetric\ Strain = \frac{Change\ in\ Volume}{Original\ Volume} = \frac{\Delta V}{V}$$

$$\therefore\ \varepsilon_{vol} = \frac{\Delta V}{V}$$

# SHEARING STRAIN

- Is when the deforming force produces change in the shape of the body.
- It is measured by the angle $\theta$ (in radian) through which a line originally perpendicular to the fixed face is turned due to the application of the tangential force.




- Shearing strain = $\theta$

$$= \tan\theta$$

$$= \frac{\Delta x}{l}$$

- The figure below is said to be sheared through an angle $\theta$.

| S.NO | QUESTION | ANSWER |
|---|---|---|
| 1 | The ability to resist applied load is called | |
| 2 | The force required to produce unit deflection is called | |
| 3 | The materials having same properties in all directions are called | |

| OPTION | | |
|---|---|---|
| | A | Isotropic materials |
| | B | Strength |
| | C | Stiffness |