ME 243

Mechanics of Solids

Lecture 1: Introduction

Ahmad Shahedi Shakil

Lecturer, Dept. of Mechanical Engg, BUET

E-mail: sshakil@me.buet.ac.bd, shakil6791@gmail.com

Website: teacher.buet.ac.bd/sshakil

Reference Books

- *Strength of Materials*

  ---- Andrew Pytel

  Ferdinand L. Singer.
- *Mechanics of Materials*

  ---- Beer, Johnston, Dewolf, Mazurek
- *Elements of mechanics of materials*

  ---- Gerner A. Olsen
- *Mechanics of materials*

  ---- Amalesh Chandra Mandal, Md. Quamrul Islam

*** Collect the books of latest SI editions*

What is Mechanics of Solids?

- 3 fundamental areas of engineering mechanics are-
  1. *Statics*
  2. *Dynamics*
  3. *Mechanics of Solids (Strength of Materials).*
- Statics and dynamics deal with the external effects of forces on rigid bodies.
- Strength of materials deals with the external loads and their internal effects on bodies.
- The deformations, however small, are of major interest.

Stress

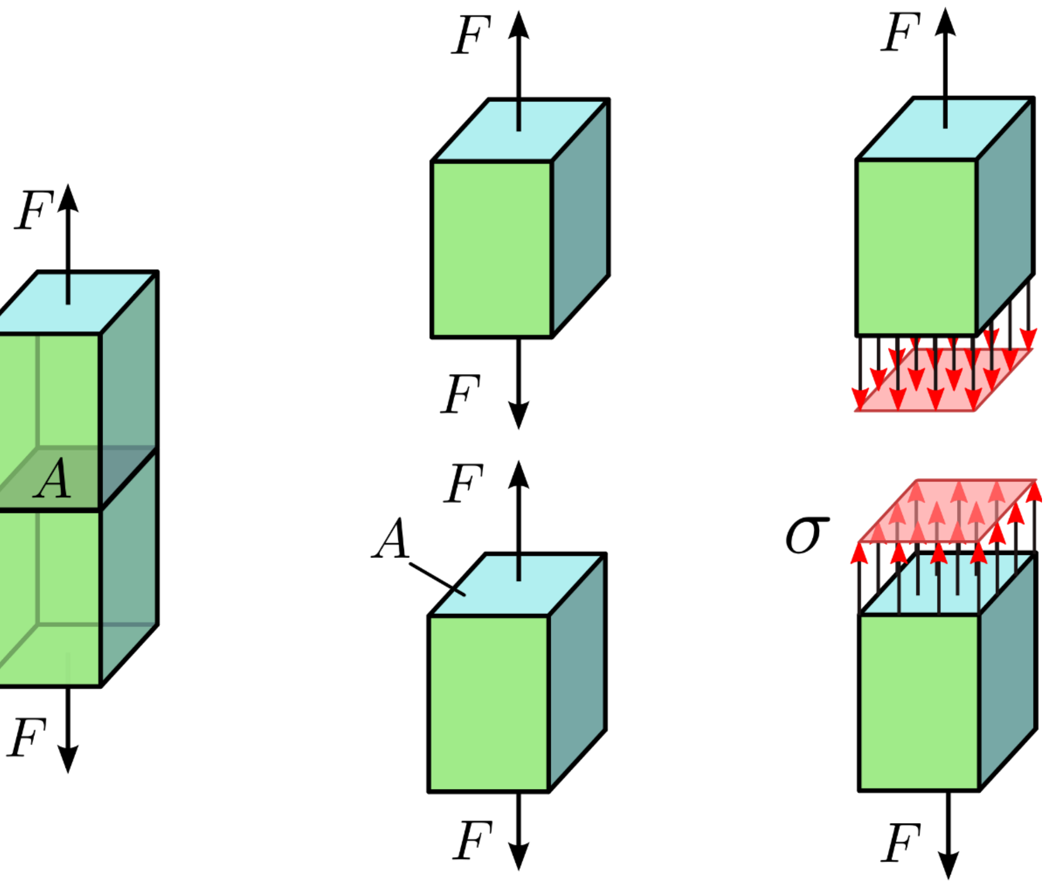
- When an external force is applied on a body, an internal force is developed in order to resist the external force.
- The internal force per unit area at any section is known as unit stress or stress. Therefore,

$$\text{Stress} = \frac{F}{A},$$

F is the force acting on the body,

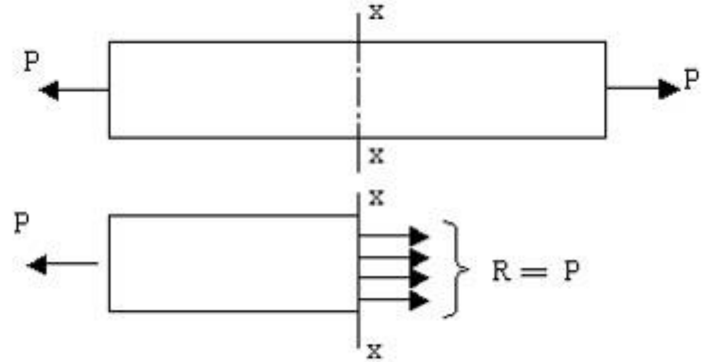
A is the cross sectional area.

Stress

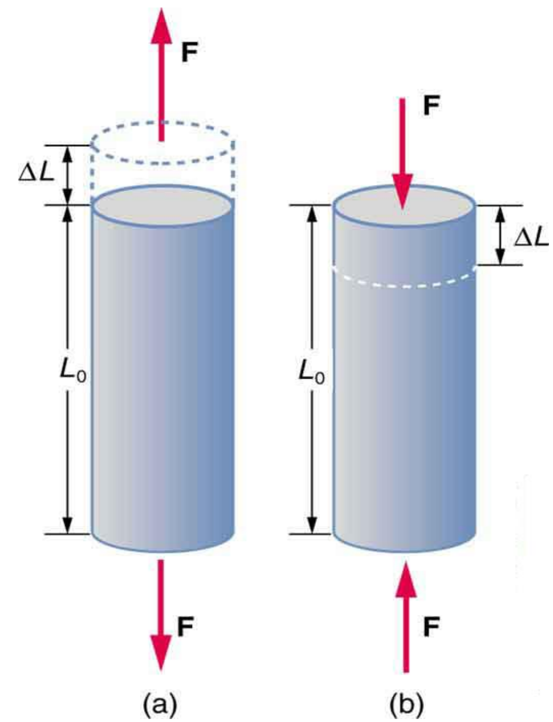


Normal stress

- When the resultant of internal forces acts in the direction perpendicular to the reaction plane, the stress is called normal stress. It is denoted by 'σ'.
- Normal stress can be of 2 types.
  1. Tensile stress.
  2. Compressive stress.

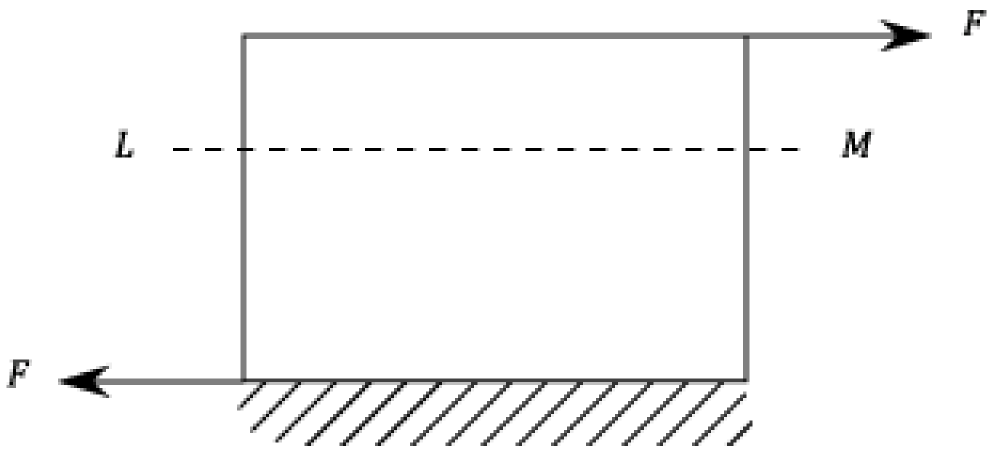


- When the load elongates the member, it is called tension and the stress is called *tensile stress* [fig. (a)].
- When the load shortens the member, it is called compression and the stress is called *compressive stress* [fig. (b)].

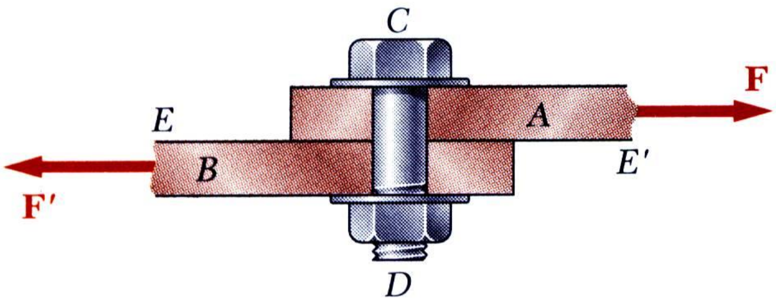


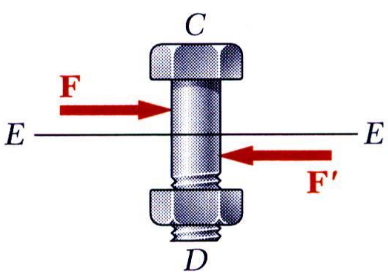
Shear stress

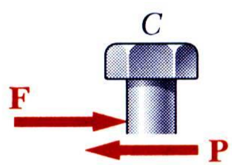
- When the resultant of internal forces acts in the direction parallel to the reaction plane, the stress is called shear stress. It is denoted by ‘τ’.



Single Shear

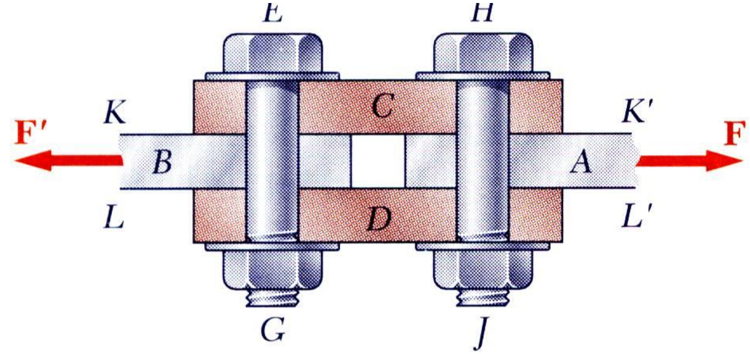


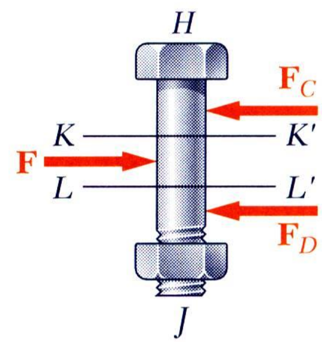


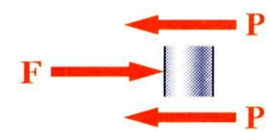


$$\tau_{\text{ave}} = \frac{P}{A} = \frac{F}{A}$$

Double Shear







$$\tau_{\text{ave}} = \frac{P}{A} = \frac{F}{2A}$$

Strain

- Strain is the deformation per unit length of the member.
- Strain is expressed as,

$$\varepsilon = \frac{\delta}{L}$$

Where, δ= total deformation

L= Original length

Unit of unit is m/m , mm/mm, in/in

Normal strain

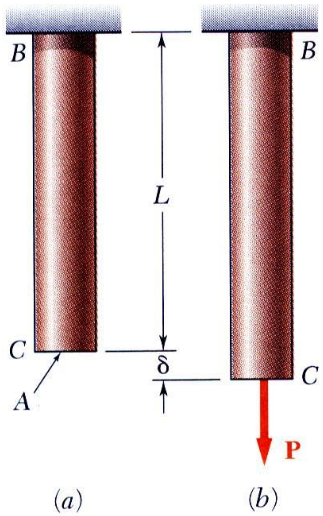


Fig. 2.1

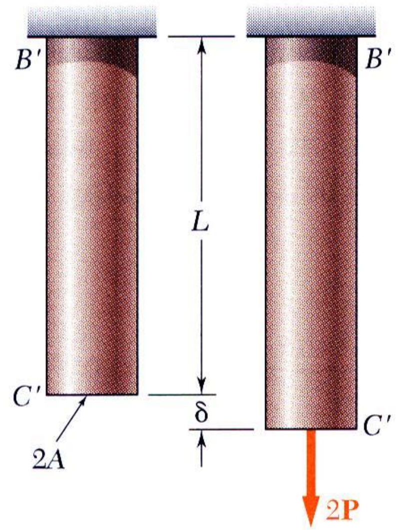


Fig. 2.3

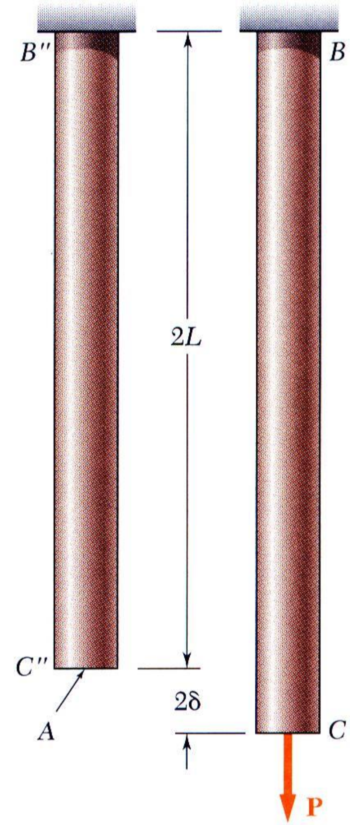


Fig. 2.4

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

$$\varepsilon = \frac{\delta}{L} = \text{normal strain}$$

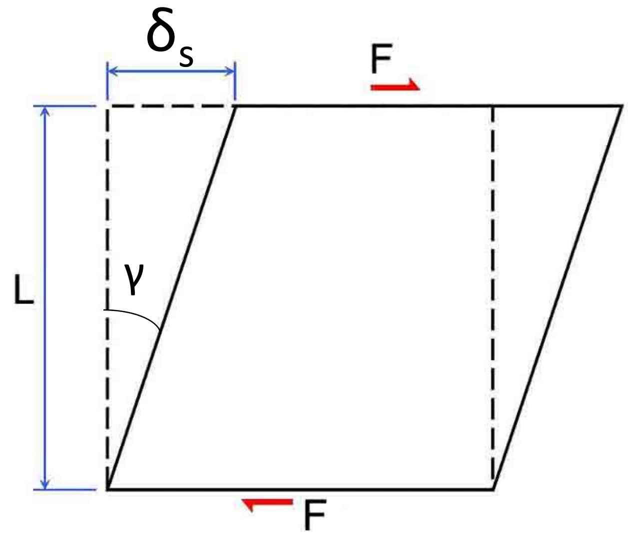
$$\sigma = \frac{2P}{2A} = \frac{P}{A}$$

$$\varepsilon = \frac{\delta}{L}$$

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

$$\varepsilon = \frac{2\delta}{2L} = \frac{\delta}{L}$$

Shear strain



Shear strain= $\frac{\delta_s}{L}$

From figure, tan γ = $\frac{\delta_s}{L}$

For small value of γ,

$\tan\gamma \approx \gamma$

So shear strain, γ can be defined as the angular change between two perpendicular faces of a differential element.