# GATE/ESE

## MECHANICAL ENGINEERING

# Strength of Materials

## [Student Problem Set]

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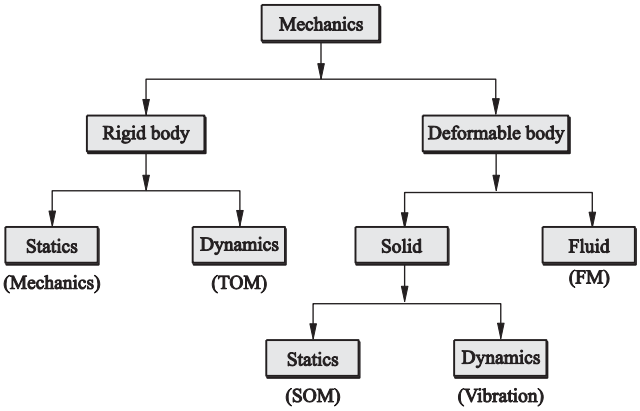
# Chapter-1

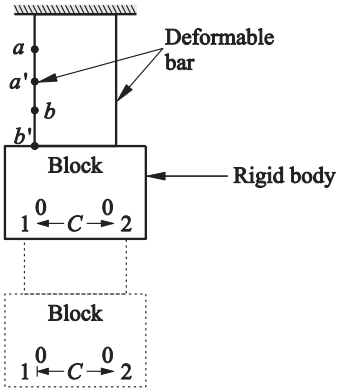
# STRESS, STRAIN & ELASTIC CONSTANTS

## 1.1 Introduction

Mechanics deals with forces (both internal and external) and their effects.




**Ex :**




A body is said to be a rigid body if the distance between any two points in the body or on the body, is invariant.

- In engineering mechanics we treat the body as rigid and we deal only with external forces. In SOM, the body is treated as a deformable body and we deal with internal forces.

**Aim :** The aim of SOM is to develop equations for stress, strain and to obtain the size by using mechanical properties.

**NOTE**

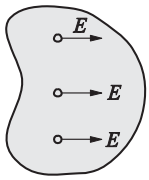
- SOM is also known as solid mechanics, or mechanics of solids or mechanics of deformable bodies.

### ❖ Homogeneous Materials

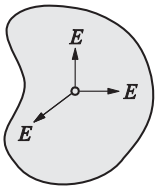
A material is said to be homogeneous if it exhibits same properties (elastic properties E, G, K) at any point in the given direction, i.e., for a homogeneous, material properties are independent of point.

### ❖ Isotropic Materials

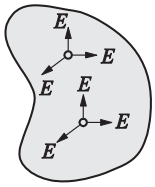
A material is said to be isotropic, if it exhibits same elastic properties in any direction at a given point i.e. for a isotropic material properties are independent of direction.



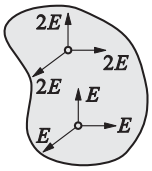

Homogeneous
(May or may not be isotropic)



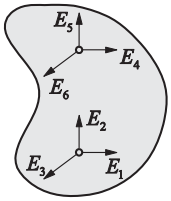

Isotropic
(May or may not be Homogeneous)



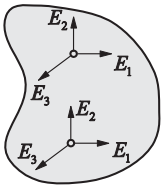

Homogeneous + Isotropic




Non - homogeneous & isotropic




Non - homogeneous
& non - isotropic




Homogeneous & non - isotropic

**NOTE**

- Every homogeneous material need not be isotropic and similarly every isotropic material need not be homogeneous.
- Fortunately, most of the common engineering material are both homogeneous and isotropic.
- Wood, crystal are anisotropic material i.e., these material have different properties in different directions.
- Even if the body is not have homogeneous and isotropic, it is assumed to be homogeneous and isotropic.

## 1.2 Load

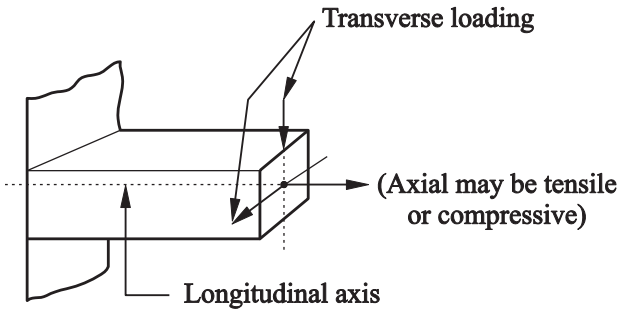
Load is an external force or moment experienced by the member.

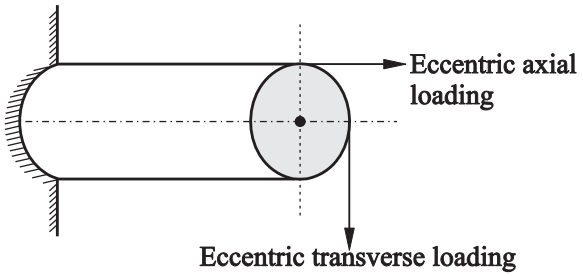
### 1.2.1 Type of Load

#### ❖ Based on the direction of loading

(a) Longitudinal (axial) (parallel to the axis)

(b) Transverse (perpendicular to the axis)



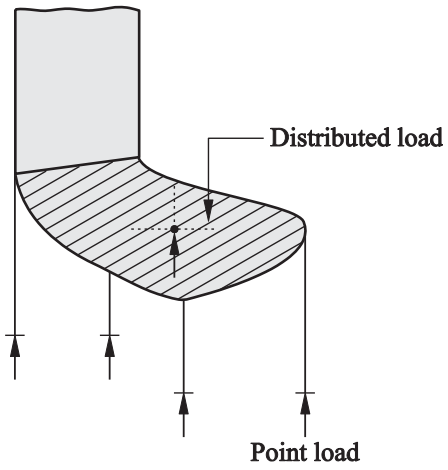




#### ❖ Based on the extent of loading :

(a) Point load

(b) Distributed load

- If the load acts on a very small area, then it is a point load.
- If the load is distributed over a larger area then it is a distributed load.




#### ❖ Based on dimensions :

(a) Force $\propto$ Volume

Ex : Buoyancy force, weight, centrifugal force etc.

(b) Force $\propto$ Area

Ex : Pressure force, drag force, etc.

(c) Force $\propto$ Length

Ex : Surface tension force, cylindrical roller bearing

#### ❖ Based on variation wrt time :

(a) Static load

(b) Dynamic load

- A load is said to be static load if the magnitude, direction and point of application (POA) does not change wrt time.

  Ex : Self weight
- If any of the three (magnitude, direction and POA) changes wrt time then it is a dynamic load.

  Ex : Crank, connecting rod, piston, gears, cam and followers, bearings etc.