MADE EASY

Mechanical Engineering

Toppers Handwritten Notes

STRENGTH OF MATERIAL

By-Krisnah Sir

STREGTH OF MATERIAL

OR

MECHANICS OF MATERIAL

OR

MECHANICS OF SOLIDS

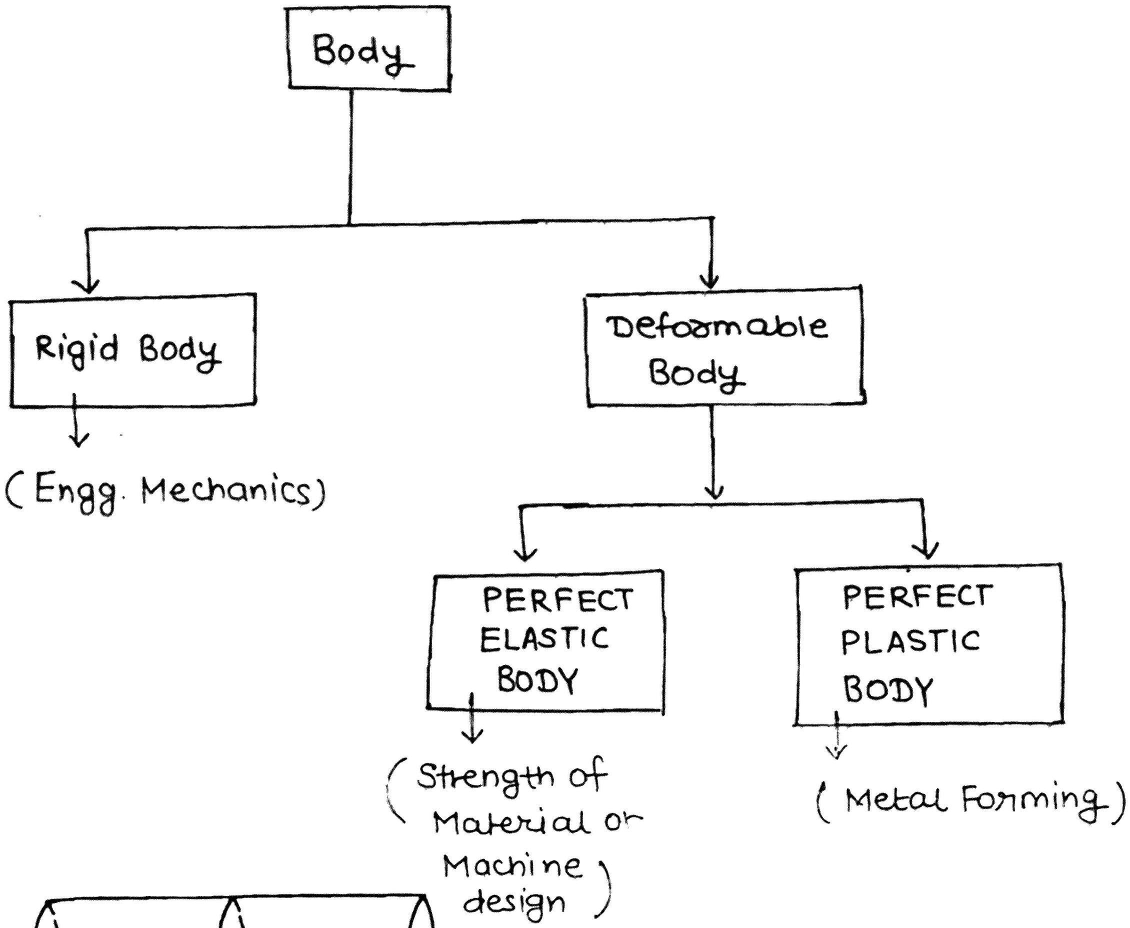
OR

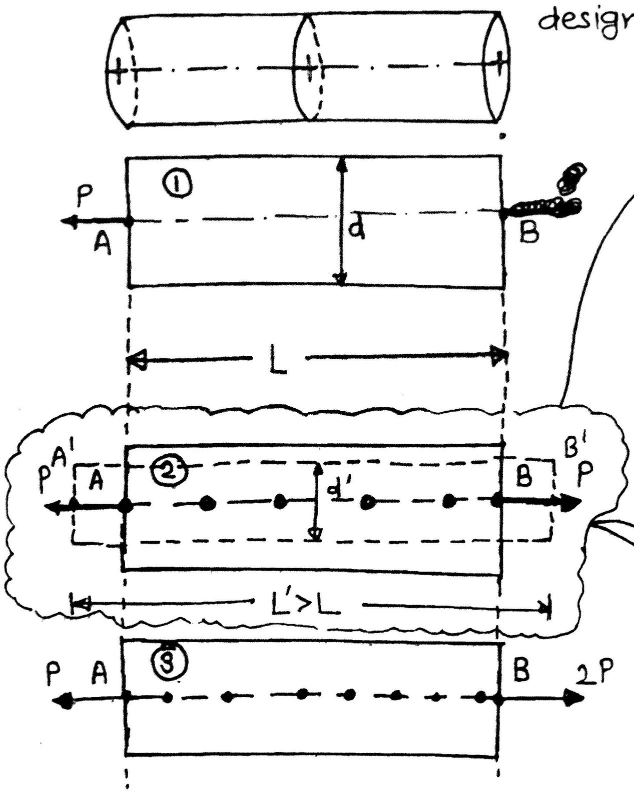
MECHANICS OF STRUCTURE

OR

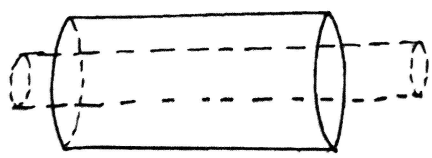
MECHANICS OF PERFECT ELASTIC BODIES

- $\sigma_{induced} \leq$ Elastic Limit $\Rightarrow$ Perfect elastic Body
- $\sigma_{induced} >$ Yield Strength $\Rightarrow$ Perfect Plastic Body



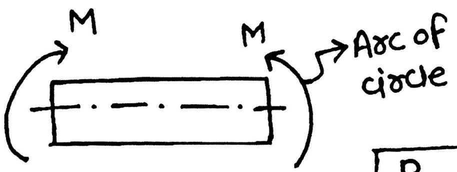


Undergoes Pure elastic deformation



A Prismatic cylindrical Perfect elastic Bar is subjected to Pure Axial tensile Load [PATL]

i.e. $\boxed{\sigma_{induced} \leq \text{Elastic Limit}}$



Pure Bending

i.e.

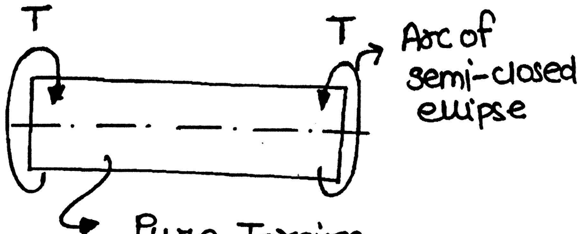
Axial Load = Shear Force = Twisting Moment = ZERO

Bending moment = Constant

i.e. Shear Force = Bending moment = Twisting moment = 0

Axial Load = Constant

Bending Couple → Two equal Parallel opposite eccentric axia load



Pure Torsion

Torsional Couple → Two equal and opposite Parallel eccentric tranverse shear Load.

Axial Load = Shear force = Bending Moment = zero

Torsional Moment = Constant

Pure Axial Load

$\sigma_a = \frac{P}{A}$; $\delta_L = \frac{PL}{AE}$

$\delta V = \frac{PL}{E}(1-2\mu)$

$FOS = \frac{\text{Failure stress}}{\text{Per Stress}}$

Aim of SOM Subject →

Aim of SOM Subject is to derive expressions for Stress, Strain and deformation under different Loading conditions by using expermentally obtained elastic Properties like, Youngs Modulus, Poissons ratio.

- Input data for strength of material Problem
  - (I) Load
  - (II) dimensions
  - (III) elastic Properties like E and μ
- Parameters to be determined
  - (I) Stress
  - (II) Strain, by using elastic constants (Properties)
  - (III) deformations, change in length, change in cross-sectional dimensions and change in volume
- Assumptions made while deriving SOM equations
  1. Perfect elastic member (stress, strain are with in the elastic region)
  2. Homogeneous and Isotropic material is assumed.
  3. Prismatic member is assumed.
  4. Self-weight is neglected.
  5. Static Load (gradually applied Load) is assumed.
  6. Member is under Static equilibrium Condition.

To obtain Safe dimensions in Presence of above mentioned assumptions factor of safety (FOS) should be used in design calculations.

- **Aim of Machine design**

Ultimate aim of design is to develop a drawing in such a way that It should Perform its given functionity Satisfactorily. (that is without any failure)

- **Steps used in design of a Component:**

1. Specify the functionality of that Component.
2. determination of Loads acting on that Component during its functionality.
3. Selection of an appropriate shape.
4. Selection of an appropriate Material.
5. Calculation of dimensions by using Strength of Material equation.

   I^{st} Method : By using Strength & rigidity Criterion

   II^{nd} method : By using Theory of failure (T.O.F.)

6. selection of appropriate manufacturing Process detail (i.e. type of manufacturing, Surface finish, Limits and fits).
7. Part drawing should be Prepared for that Component.

$$E = \frac{\text{Normal stress}}{\text{Longitudonal strain}}$$

↳ Young's Modulus

$$G = \frac{\tau}{\gamma}$$

★

$$\mu = \frac{-\text{Lateral strain}}{\text{longitidunal strain}}$$

↳ Poisson ratio

Hollow cylinder → Better for weight

Solid Cylinder → Better for Torsion

Strength	→ Uniaxial
Theories of failure (criteria)	→ Uniaxial, biaxial, triaxial

HOMOGENEOUS MATERIAL:→

A material is said to be Homogeneous when it ~~exibits~~ exhibits same elastic Properties at any Point in a given direction (that is elastic Properties are independent of Point).

• ISOTROPIC MATERIAL:→

A material is said to be isotropic when it exhibits same elastic Properties in any direction at a given Point (i.e. elastic Properties are Independent of direction)

→ A Material is said to be both Homogeneous and Isotropic when it exhibits same elastic Properties at any Point and in any direction (i.e. elastic Properties are independent of both Point and direction).

→ Every Homogeneous material need not be an isotropic material. and vice- verssa. but few materials are both Homogeneous and isotropic

• Anisotropic Material → (Composite material eg. fiber)

A material is said to be Anisotropic when it exhibits direction dependent elastic Properties at a given Point.

~~Higher weight to strength ratio~~

★ **Advantage of Anisotropic material**

- desirable Property can be achieve as Per requirement.
- Higher strength to weight ratio