STRENGTH OF MATERIAL

OR

MECHANICS OF MATERIALS

OR

MECHANICS OF SOLID

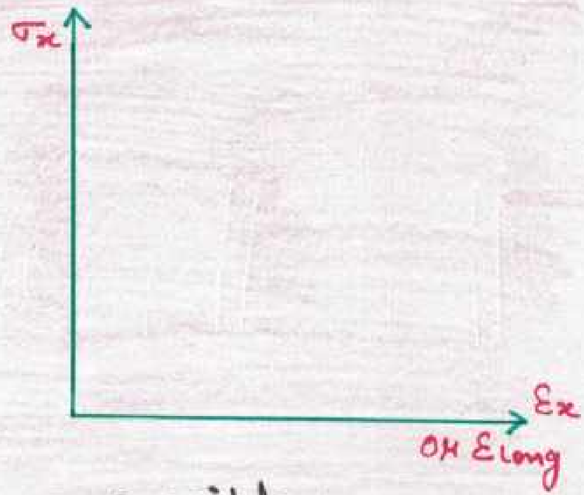
OR

MECHANICS OF STRUCTURES

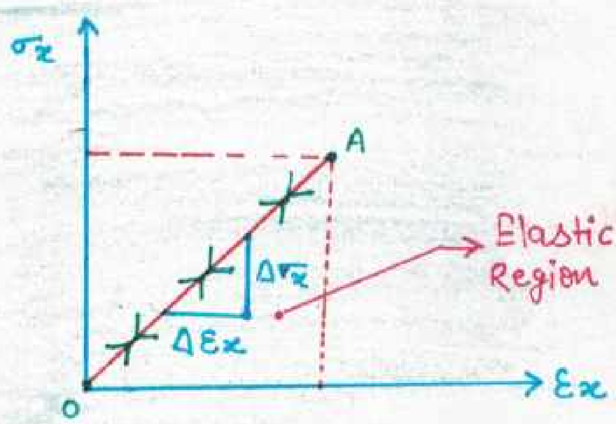
OR

MECHANICS OF DEFORMABLE BODIES
i.e ELASTIC BODIES

- only External force but in SOM both external as well as internal Resisting force (σ)



- only Stress no Strain but in SOM Both stress, Strain.
- $\varepsilon_x \rightarrow$ strain in the direction of load - longitudinal strain.
- 3 ε / Logitudinal strain are there possible.



Other $\varepsilon \rightarrow$ Lateral Strain $\perp^r$ to applied load

if load Removed, $\varepsilon = 0$
Before elastic limit regain its shape.

fig. Stress v/s strain curve For Perfect elastic Body

YOUNG'S MODULUS

$$E = \frac{\Delta\sigma_x}{\Delta\varepsilon_x} \text{ or } \frac{\Delta\sigma_x}{\Delta\varepsilon_{long}}$$

= Slope of ε_{long} Curve in the Elastic Region.

HOOKE'S LAW

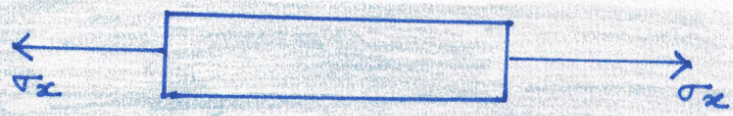
$\sigma_x \propto \varepsilon_x$ or ε_{long}

$$\boxed{\sigma_x = E\,\varepsilon_x}$$

But also

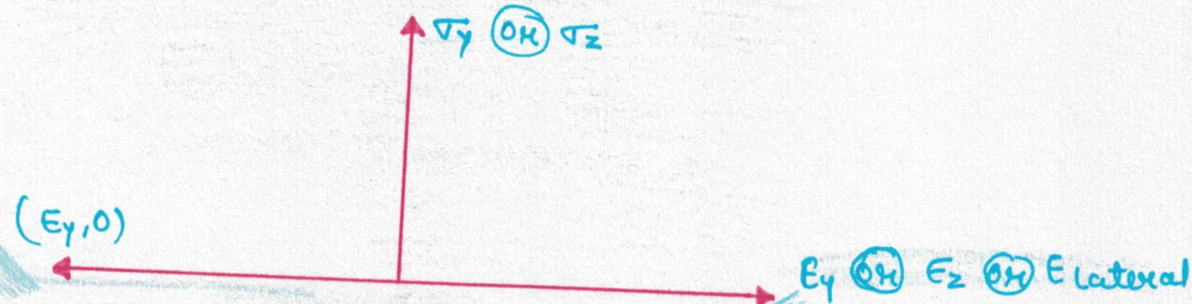
Shear Stress $\leftarrow \tau \propto \gamma \rightarrow$ Shear Strain

$$\boxed{\tau = G\,\gamma}$$

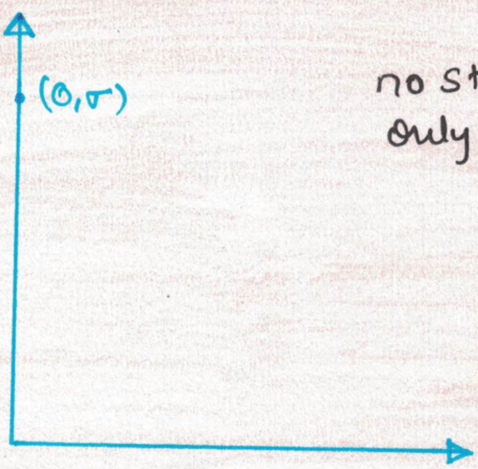


3 Strain → 2 lateral strain + 1 Elong

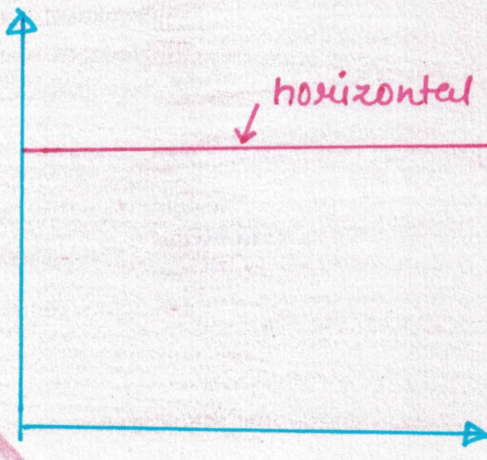
1 Stress



in a deformable member σ & ϵ both are there



Fg. Perfect Rigid Body



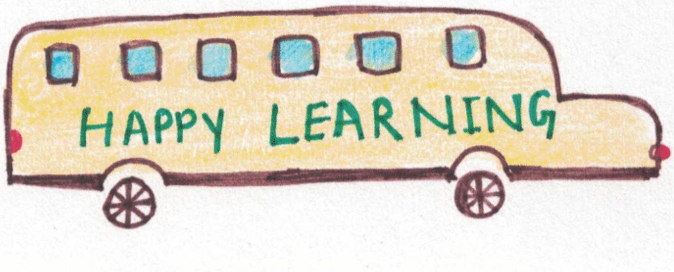
Fg. Perfect Plastic Body

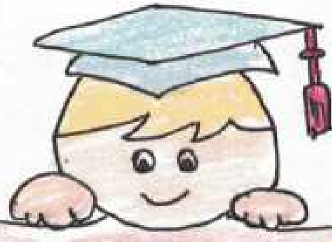
In a deformable member, σ, ϵ occur in the direction of load.

Rigid Body → Displacement only.

Displacement Body → Displaced particle has no Relative

spring → Particle's relative position displaced.





- AIM of Strength of Material subject is to derive expression for deformation, strain and stress which are develop under different loadings conditions by using experimentally obtained elastic properties like young's Modulus (E) and poisson Ratio.

- Ultimate aim of design is to develop a drawing or a plan.
  [i.e Selection of an appropriate shape, Selection of an appropriate material, Calculation of appropriate dimensions by using strength of materials equation, selection of manufacturing process details like type of manufacturing, surface finish, Limits and Fits]
  in such a way that the resulting component should satisfy, perform its functionality satisfactorily.

  [i.e without any Failure]

- A component is said to be failure when it is unable to perform its given functionally satisfactorily.

SOM ← assumptions → not pratically correct/ Satisfied.

SOM → Design (Safe Design)
so F.O.S, Permissible stress
not yield stress
not ult. stress

SOM → unreality of assumptions

ASSUMPTION MADE WHILE DERIVING SOM EQUATION

- Material is assumed to be homogeneous and Isotropic.
- Material obeys Hooke's Law (That is induced deformation, Strain, stress are assumed to be within the elastic region)
- Member is assumed to be Prismatic. (That is cross sectional dimensions remains same throughout the length of the member).

M/c components → Non-Prismatic

Shaft → Non-Prismatic

Key ways → Non-Prismatic

Bolt → Non-Prismatic

- Load is assumed to be as Static Load. (That is direction & magnitude of the load remains constant with respect to time).

Structural Component → Static load

- Self weight of the component is neglected.
- Member is assumed to be under static equilibrium condition

HOMOGENEOUS & ISOTROPIC DEFINITION

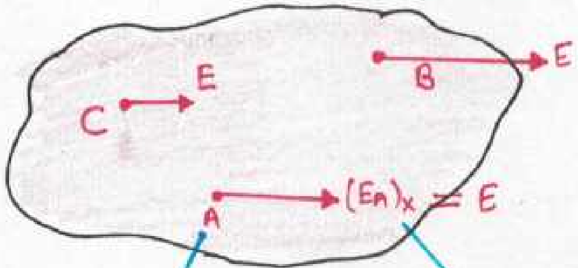
- A material is said to be homogenous when it exhibits same elastic properties at any Point in a given direction. (That is elastic properties are independent of Point).
- Isotropic material :- A Material is said to be isotropic when it exhibits same elastic properties in any dir^n at a given Point. (That is elastic Properties are independent of direction.)

- A material is said to be with both homogeneous and Isotropic when it exhibits Same elastic properties at any direction and Point. (That is elastic properties are independent of both Point and direction).

- Every homogeneous material need be an isotropic material and vice-versa.

- **ANISOTROPIC MATERIAL** :- A material is said to be aniso-tropic when it exhibits direction dependent elastic properties.

All composite materials



Point change

E doesn't change

↓

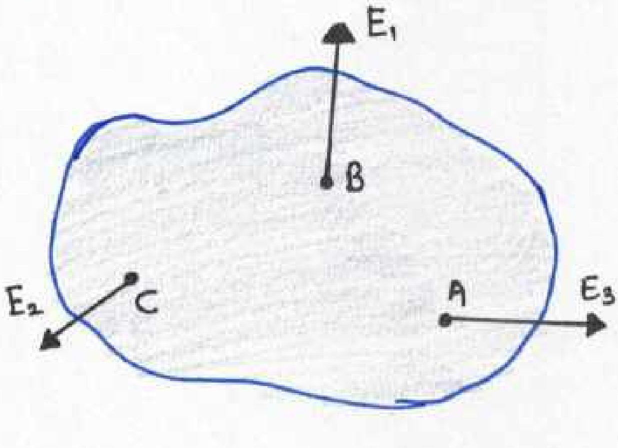
Homogeneous ← 2 Points Required

(composition is same)

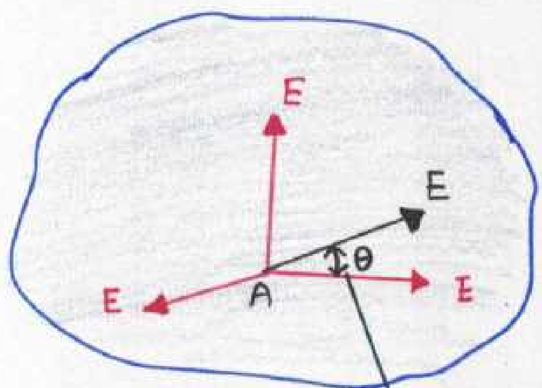
Homogenenous Material

at Point A along x-dir^n

Same Direction is Required to define Properties at 2 Points.

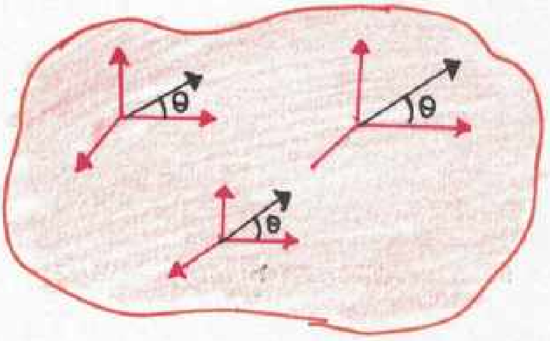


Nothing



Isotropic Material

Arbitrary if θ Changes



Both Homogeneous and Isotropic material.

← 1E Young's Modulus

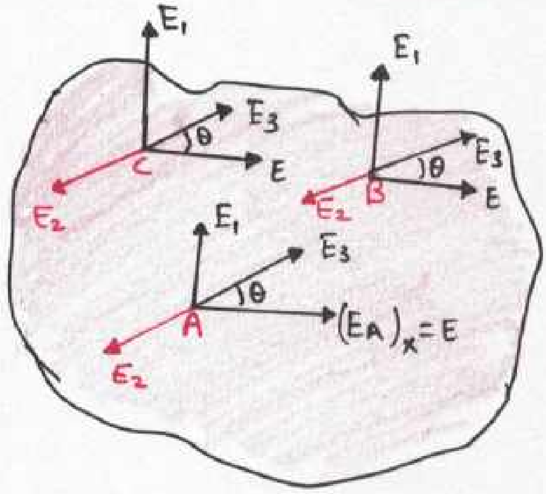
E G K and μ

Young's Modulus

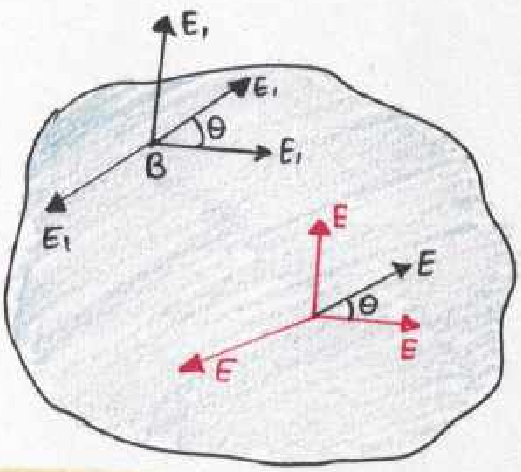
Modulus of Rigidity

Bulk modulus

Poisson's Ratio



Homogeneous & Isotropic material



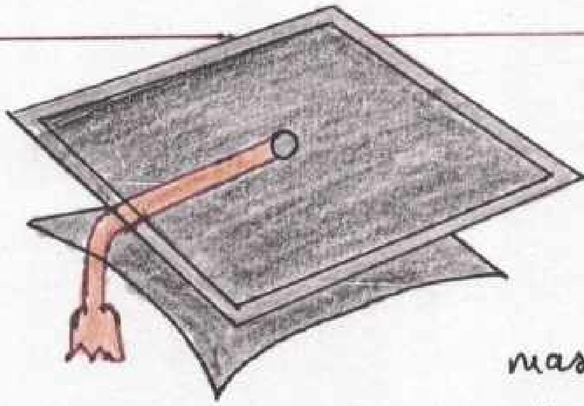
Isotropic & Non-homogeneous material

LOAD DEFINITION

Load is defined as an external force or a couple to which a component is subjected during its functionally.

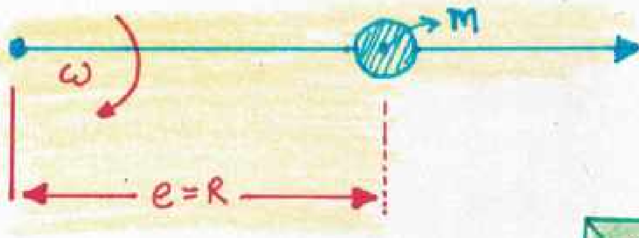
Examples :-

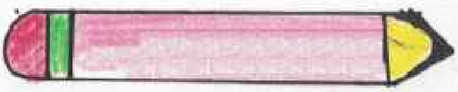
- Weight of component w.r.t. another component
- Centrifugal force
- Inertial force
- Belt tension
- twisting and Bending couples etc.

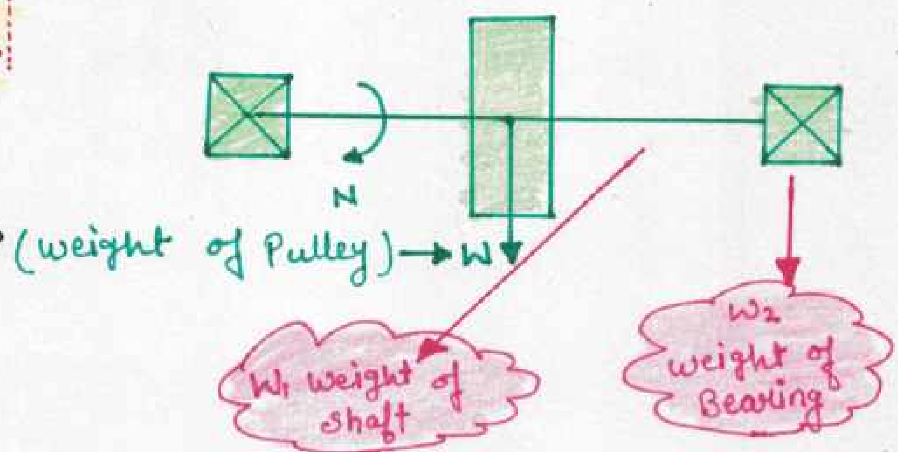


$F_c = m e \omega^2$

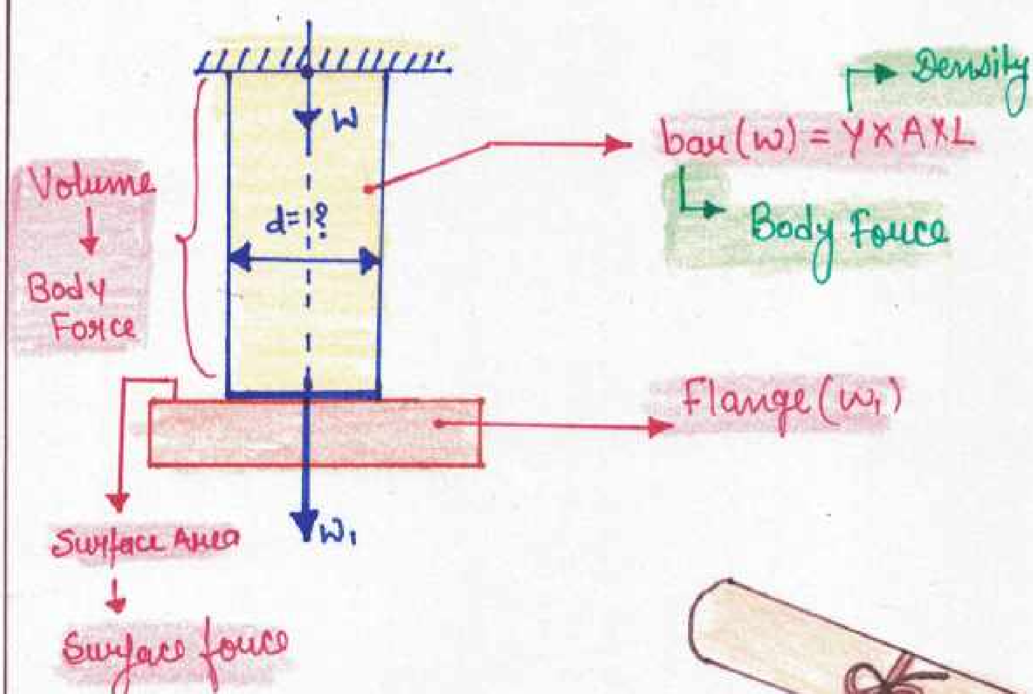
mass should be away from the point of Rotation







- In the design of the Shaft, weight of Pulley (W) is considered as a load (i.e. Shaft W_1 weight is neglected)
- In the design of the bearings, W and W_1 are considered as Loads (W_2 is neglected).



Flange (W_1)

↓

is consider

Since bar is supporting flange