PHYSICS-MJ-1: Mechanics & Properties of Matter

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Semester I, 2024-2025

Lecture #2

Prerequisites: A good understanding of force.

Stress & Strain

Three important terms to understand before going further.

- Elasticity is the tendency to regain its original shape.
- Deforming force is an applied force.
- Restoring force is the spring force.

Stress is the restoring force per unit area.

Stress Type:

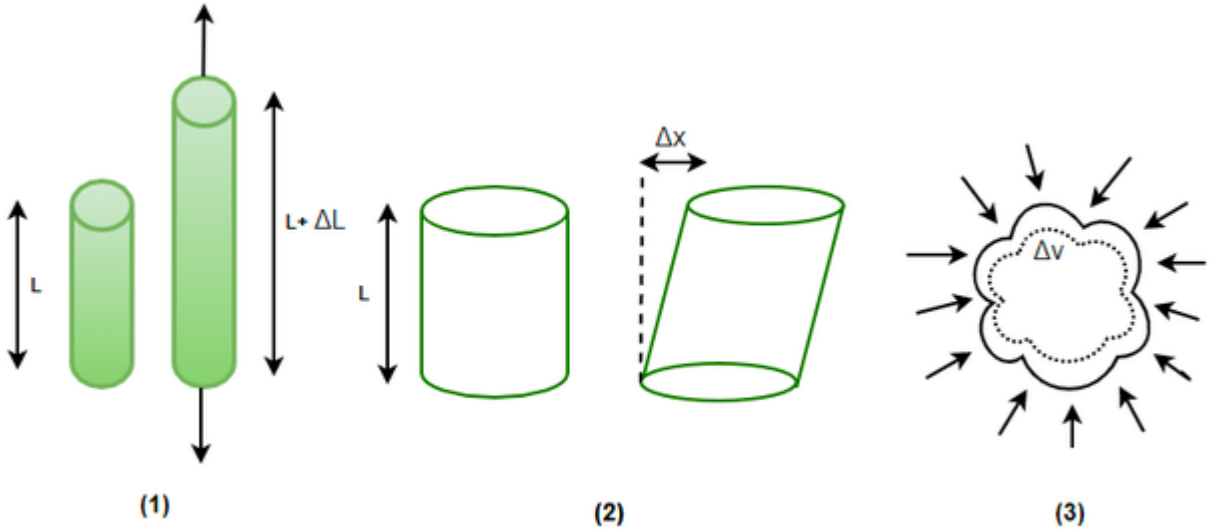
1. Longitudinal stress
2. Shear stress
3. Hydraulic stress

Strain is the amount of deformation experienced by the body in the direction of force applied, divided by the initial dimensions of the body.

Strain Type:

1. Longitudinal strain
2. Shear strain
3. Hydraulic strain

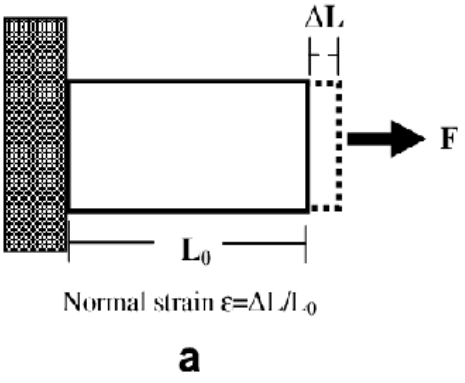
A body when deformed due to external force takes the following shapes as shown in figure below depending on the type of stress.



Longitudinal strain, *Shear* strain and *Hydraulic* strain are shown in *fig-1, 2 & 3* respectively.

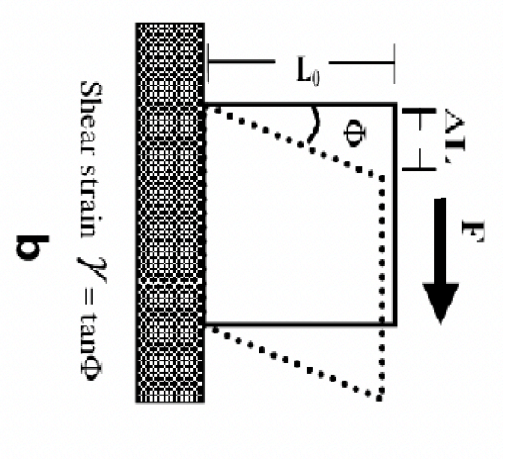
Mathematical Definition:

★ Let's consider a material of length L_0 which is deformed by length ΔL due to Longitudinal stress.



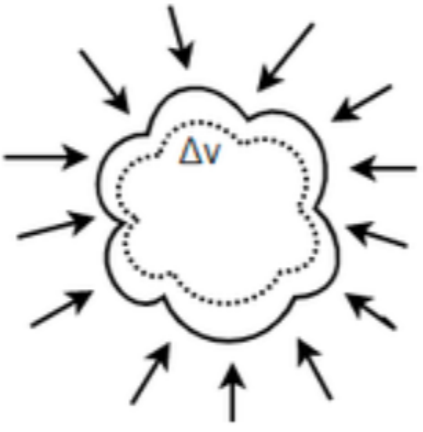
$$\text{Longitudinal strain} = \frac{\Delta L}{L_0}$$

★ Let's consider a material of length L_0 which is deformed by length ΔL due to Shear stress.



$$\text{Shear strain} = \frac{\Delta L}{L_0} = \tan\Phi = \gamma$$

★ Let's consider a material of volume V which is deformed by volume ΔV due to Hydraulic stress.



$$\text{Hydraulic strain} = \frac{\Delta V}{V}$$

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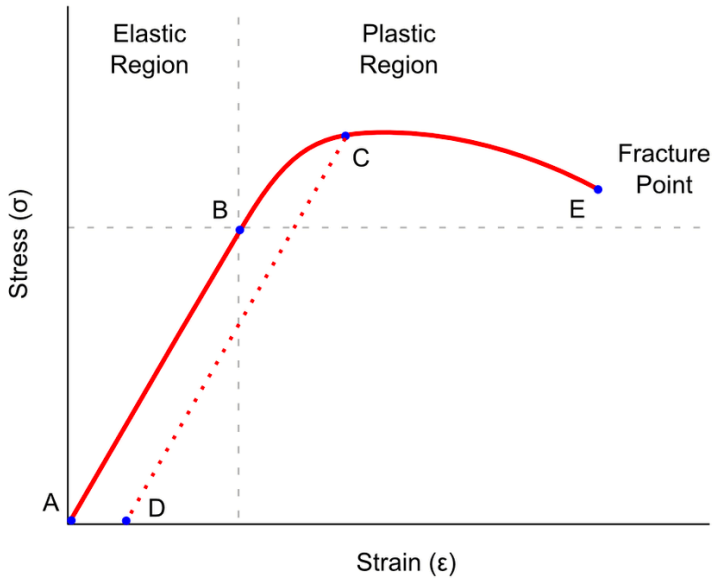
Lecture #3

Prerequisites: A good understanding of Stress & Strain

Elasticity

Stress-Strain Curve



Description: Stress-Strain curve for an elastic material is plotted as a red curve in the above figure. Elastic and Plastic regions are separated by a vertical line passing through B. Within the elastic region, if the material is elongated from (A) to (B) and then released, *no irreversible deformation* will be created. However, if the elongation continues into the plastic region (C), then after the release of the strain, *a macroscopic deformation will be stored internally*. This plastic deformation is irreversible (D). Finally, if the strain is too large, the material will break (C).

Hooke's Law: For small deformation stress is directly proportional to strain. Mathematically it is expressed as:

$$\frac{\text{Stress}}{\text{Strain}} = \text{Constant}$$

This constant is called **Modulus of Elasticity**.

Elasticity Type:

1. Young's Modulus Of Elasticity: Y
2. Bulk Modulus Of Elasticity: K
3. Modulus Of Rigidity: η

α and β Coefficients

Two important coefficients α and β are defined in order to study the relationship between elastic constants Y, K and η.

α: Change in length along the tension per unit stress per unit length.

β: Change in length perpendicular to the tension per unit stress per unit length.

Note: Tension -> Stretched situation

Continued in next lecture :-->