Structural Analysis-I

Unit-1

Introduction to structural Analysis

- **Structural analysis** is the determination of the effects of loads on physical structures and their components. Structures subject to this type of analysis include all that must withstand loads
- Structural Analysis can be briefly described as the study of the behaviour of structures using the knowledge of mechanics. Such a description needs some understanding of the terms “structure” and “mechanics”. Structures include a wide variety of systems, such as buildings, bridges, dams, aircrafts, etc., that are built to serve some specific human needs (for example, habitation, transportation, storage, etc.).
- Structural analysis incorporates the fields of applied mechanics, materials science and applied mathematics to compute a structure's deformations, internal forces, stresses, support reactions, accelerations, and stability.

Properties of Materials: Elasticity and Plasticity

- Elasticity: It is the property of a material by virtue of which it regains it's original shape and size after removal of external load applied on it.
- Plasticity: It is the property of a material by virtue of which it deforms permanently (doesn't regain it's original shape and size) after removal of external load applied on it.

Properties of Materials: Ductility, Malleability and Brittleness

- **Ductility** is a solid material's ability to deform under tensile stress; this is often characterized by the material's ability to be stretched into a wire.
- **Malleability**, a similar property, is a material's ability to deform under compressive stress; this is often characterized by the material's ability to form a thin sheet by hammering or rolling.
- Both of these mechanical properties are aspects of plasticity, the extent to which a solid material can be plastically deformed without fracture.
- A material is **brittle** if, when subjected to stress, it breaks without significant deformation (strain). Brittle materials absorb relatively little energy prior to fracture, even those of high strength.

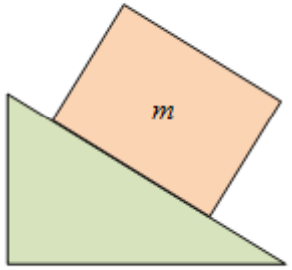
Properties of Materials: Toughness and Strength

- **Toughness** is the ability of a material to absorb energy and plastically deform without fracturing. Also it is defined sometimes as the amount of energy per volume that a material can absorb before rupturing. It is also defined as the resistance to fracture of a material when stressed.
- **Strength** is ability of the material to resist deformation under load.

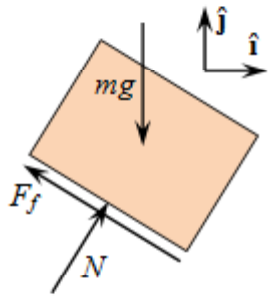
Basics of Engineering Mechanics

- **Free body diagram:** A **free body diagram**, sometimes called a force diagram, is a pictorial device, often a working sketch, used by engineers to analyze the forces and moments acting on a body.

A block on a ramp

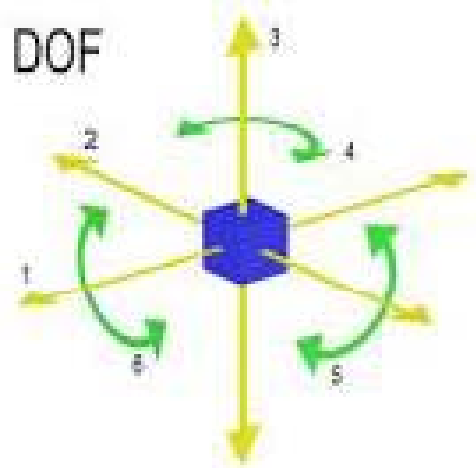


Free body diagram of just the block



Basics of Engineering Mechanics

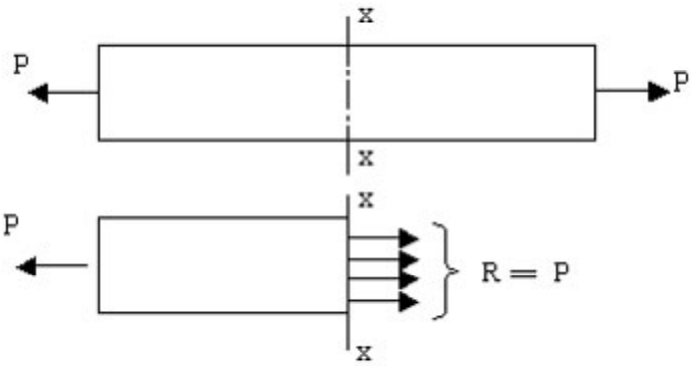
- **Degree of freedom:** Degrees of freedom of a system is the number of parameters of the system that may vary independently. For example, the position of a figure in the plane has three degrees of freedom.

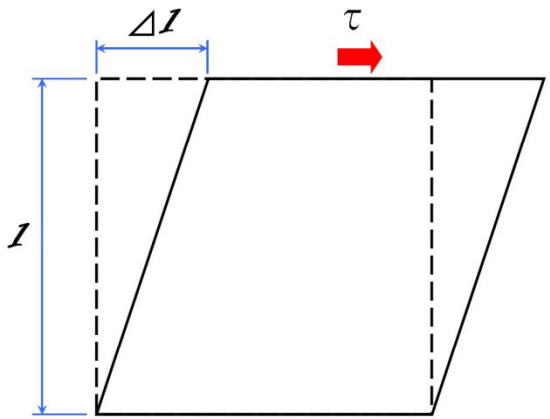


Stresses

Stress may be defined as normal component of force per unit area p = (P/A).

- Unit of stress N/m2
- There are following king of stresses:
  - Normal Stresses
    - Tensile stress
    - Compressive stress
  - Shear stress or tangential stress
  - Bending stress
  - Torsional stress
  - Bearing stress





Strain

- It may defined as change in length per unit length of any object on which loads are acting.

$$e = \Delta L / L$$

Unit of strain: Unitless

Hooke's Law:

- Hooke's law states that within elastic limits, stress is directly proportional to strain:

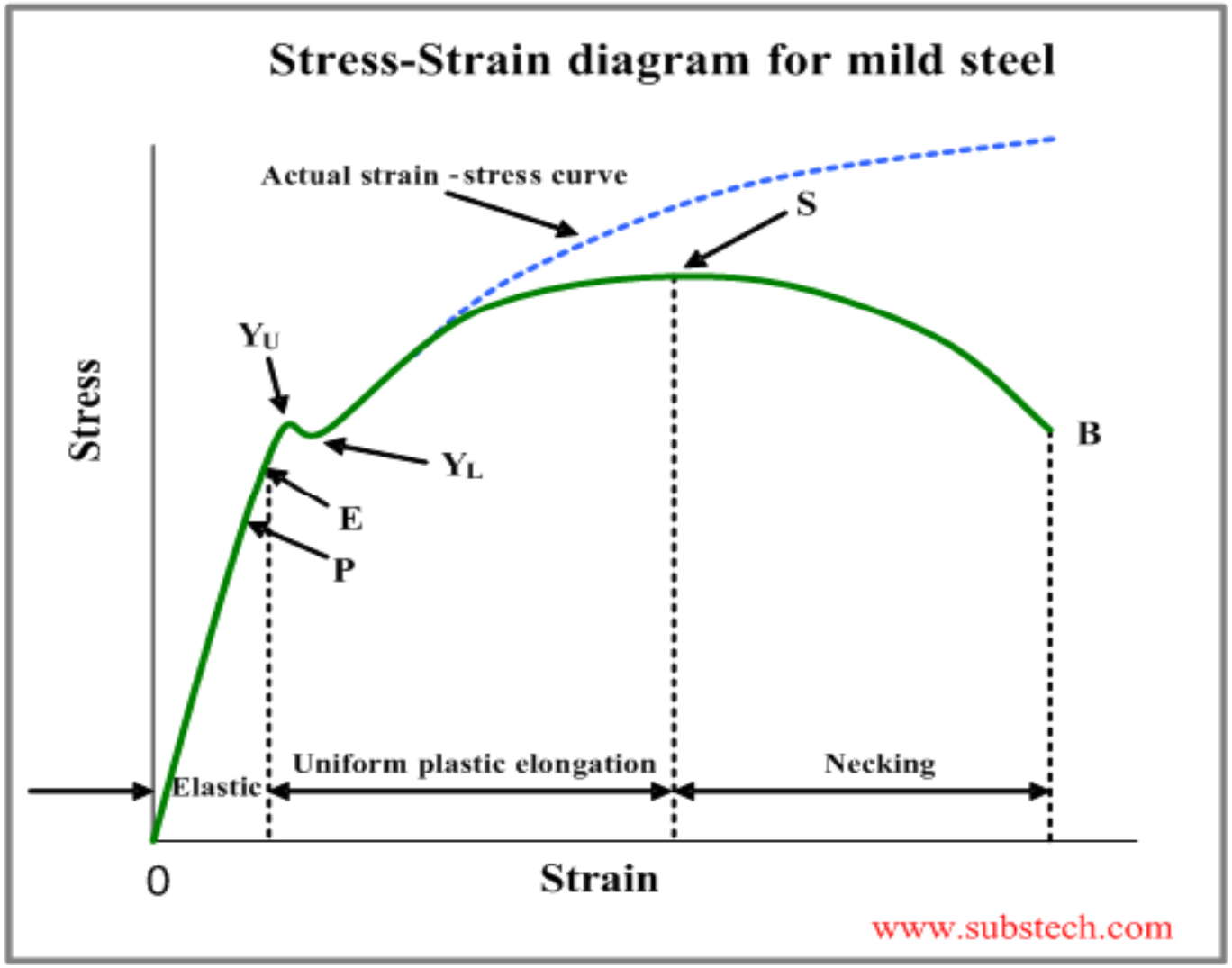
$$p \alpha e$$

or $p = E e$

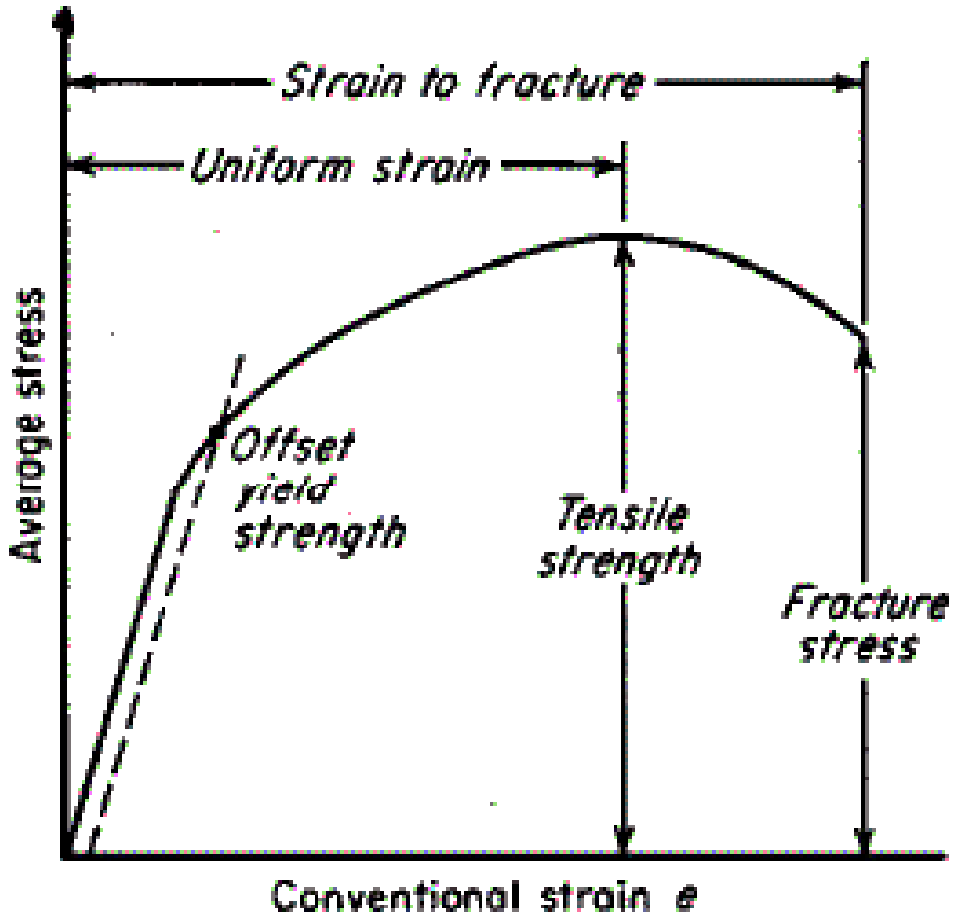
$p = (P/A)$ and $e = \Delta L/L$

Hence $\Delta L = (PL)/(AE)$

Stress strain diagram (Ductile Material):



Typical stress-strain curve for brittle materials:



Composite Sections:

- Sections in parallel:
- Sections in series: