Building Materials

Introduction

Materials that are used in the building industry such as, cement, brick, wood, glass and concrete, ……..etc., are called building materials.

The engineers and the builders must all understand building materials performance under several conditions such as load, heat, weather ………, to use it to the best advantage.

Properties of Materials

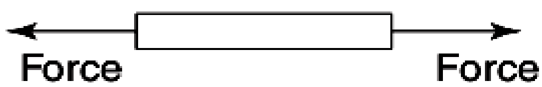
In general, the common properties of engineering materials are:

- Physical Properties: Dimension, Shape2, Density, Porosity, Moisture content, Micro structure, Texture.
- Mechanical Properties: Compression, Tension, Bending, Impact, Stiffness, Ductility, Brittleness, Elasticity, Plasticity.
- Chemical Properties: The compound of composition such as oxides, Acidity, Alkalinity, Resistance to corrosion.
- Thermal Properties: Specific heat, Expansion, Thermal Conductivity.
- Electrical and Magnetic Properties: Electrical Conductivity, Permeability, Galvanic action.
- Acoustical Properties: Sound transmission, Sound reflection, Sound observer.
- Optical Properties: Colour, Light transmission, Light reflection.

In civil engineering application or construction projects, the mechanical properties have the major effect. The mechanical properties of materials are a measure of the resistance these show to the applied load or force.

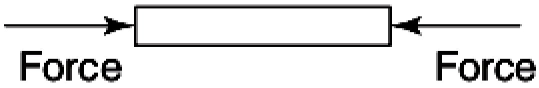
A ***force*** exerted on a body can cause a change in either the shape or the motion of the body. The unit of force is the newton (N). The three main types of mechanical force that can act on a body are:

a) Tensile Force: is the force which tries to increase the dimension of the material in the direction of the force, as shown in figure below:



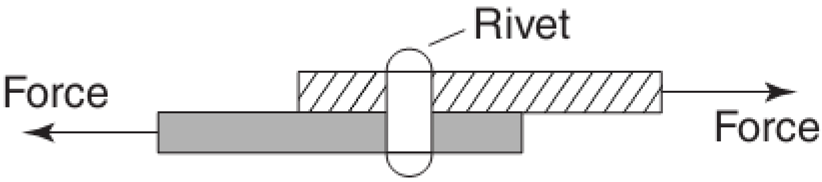
For example, the rope or cable of a crane carrying a load is in tension.

b) Compressive Force: is the force which tries to decrease the dimension of the material in the direction of force, as shown in figure below:



For example, a pillar supporting a bridge is in compression.

c) Shear Force: is a force that tends to slide one face of the material over an adjacent face. For example, a rivet holding two plates together is in shear if a tensile force is applied between the plates, as shown in figure below:



A shear force can cause a material to bend, slide or twist.

Stress: Forces acting on a material cause a change in dimensions and the material is said to be in a state of ***stress.*** Stress is the ratio of the applied force (F) to cross-sectional area (A) of the material. The symbol used for tensile and compressive stress is (σ).

$$\sigma = P/A$$

The unit of stress is the Megapascal (MPa), where F is the force in Newton's and A is the cross-sectional area in square Millimeters.

For tensile and compressive forces, the cross-sectional area is that which is at right angles to the direction of the force. For a shear force the shear stress is equal to F/A, where the cross-sectional area A is that which is parallel to the direction of the force. The symbol used for shear stress is (τ).

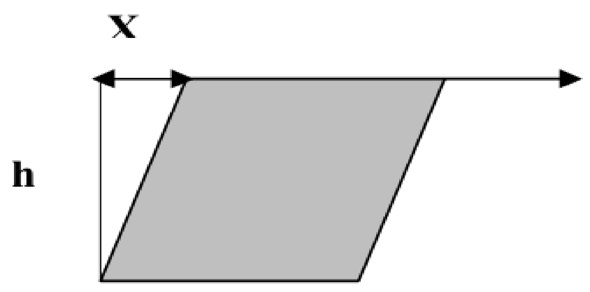
Strain The fractional change in a dimension of a material produced by a force is called the strain. For a tensile or compressive force, strain is the ratio of the change of length to the original length. The symbol used for strain is (ϵ). For a material of length (L) meters which changes in length by an amount (ΔL) meters when subjected to stress, strain calculated by using this formula:

$$\epsilon = \Delta L/L$$

(Strain is dimension-less)

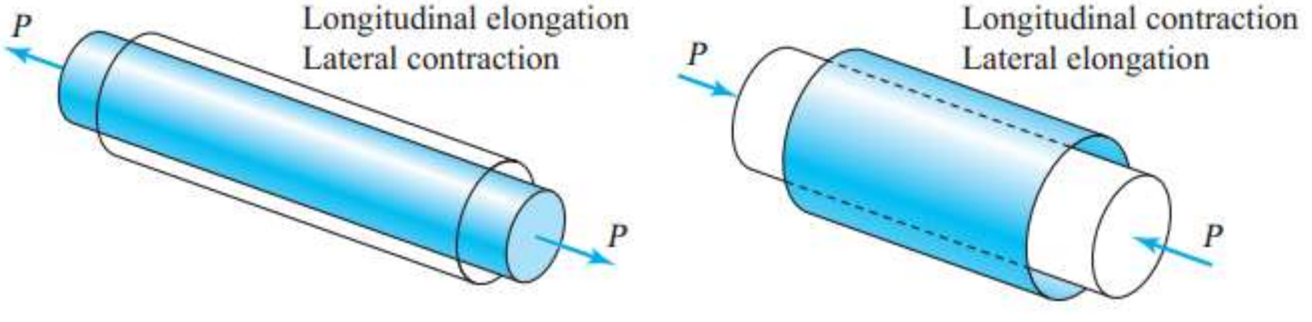
Shear Strain: It is defined as the ratio of displacement (X) to the distance between the planes (h). As shown in figure below:

$$\text{Shear strain} = X/h = \tan \Theta$$



***Possion's Ratio* (μ)**

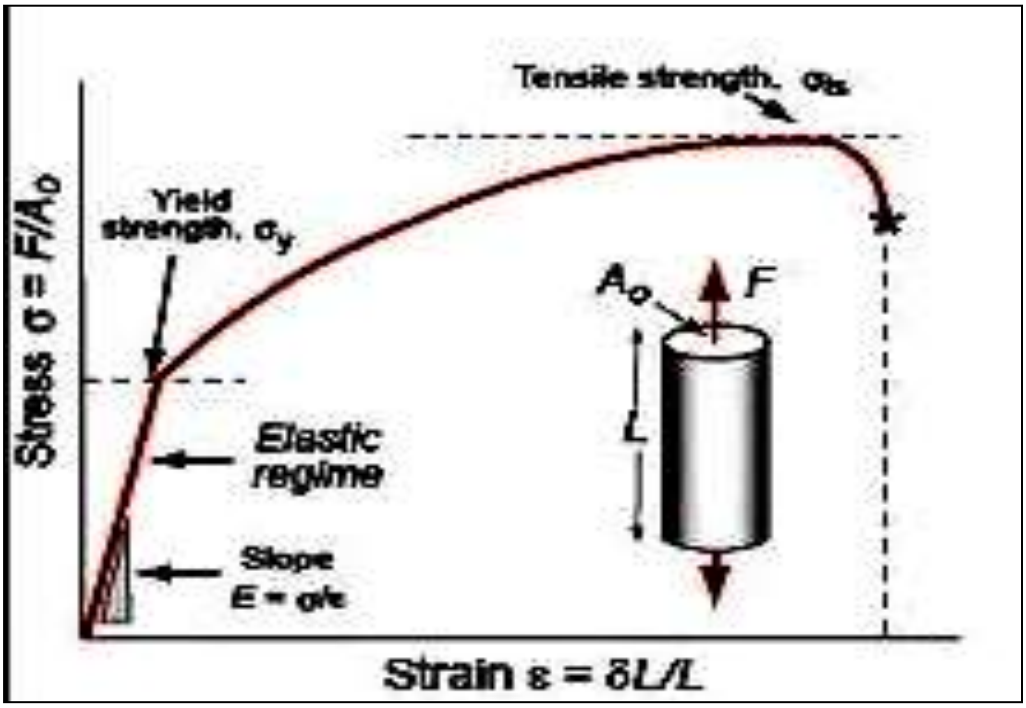
When a material is subjected to stress, strain will be accompanied by changes in lateral dimension (perpendicular to the direction of force), as shown in figure below:



Possion's ratio can be calculated by using this formula:

μ = -Lateral Strain/ Normal Strain

Modulus of elasticity (E): is the mathematical description of an object or substance's tendency to be deformed elastically (i.e., non-permanently) when a force is applied to it. The elastic modulus of an object is defined as the slope of its stress–strain curve in the elastic deformation region, as such; a stiffer material will have a higher elastic modulus.



Modulus of elasticity can be determined by using the following formula:

E = Stress/Strain