Introduction to Stress and Strain

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Abstract

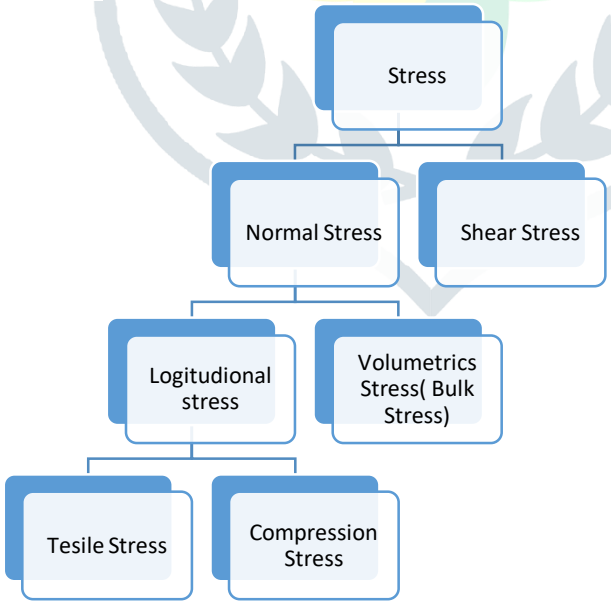
Stress word is taken form Physics and introduced by Hans Sayle in 1936. It means some force is applied to the body to change its shape or deformation. It is purely a geometrical concept. It depends upon velocity, density, force and mass of the body. When stress is applied on body it distributed over whole body. This word is mainly used in physics, engineering and some part of mathematics. Stress concept is used on making of bridges, dams etc. Stress has two types according to direction of application of force. In case of fluid is called Shear stress. How small is the stress applied on the fluid it changes the shape of the body.

Keywords: Stress, Strain, Force, Shear, tensile, normal, volumetric.

Introduction

When some external force is applied to a body, then the body offers internal resistance to these force. This internal opposing force per unit area is called stress. It is denoted by σ and its S.I. unit is Pascal or N/m^2

Stress(σ) = F/A



When fluid is at rest shear stress = 0 and normal stress is pressure.

Normal stress: If the stress is normal to the surface, it is called normal stress. Stress is always normal in case of a change in length of a wire or in the case of change in volume of body (But Shape of body not Change).

Longitudinal Stress: When normal Stress change the length of a body then it is called longitudinal stress. It is given by longitudinal stress.

$$\text{Longitudinal Stress} = \frac{\text{deforming force}}{\text{Area of cross-section}}$$

Longitudinal Stress further divided into two type:

a) Tensile stress is the stress state leading to expansion; that is the length of the material tends to increase in the tensile direction. The Volume of the material stays constant. Ex. When a wire or a rod is stretched by the two ends by equal and opposite forces.
b) Composite Stress: the two ends by equal and opposite forces, it will be under compression. The stress in such a case is called composite stress.

Volumetric stress (Bulked Stress): When a normal stress changes the volume of the body then it is called volume stress. When a solid body immersed in a fluid, the force at a point normal to the surface of the body & the magnitude of the force on any small area is proportional to the area. i.e. the body is under the action of pressure P (pressure is defined as F/A applied to an object in direction proportional to the surface).

$$\text{Bulked Stress} = \frac{\text{Force}}{\text{Area}} = \text{Pressure}$$

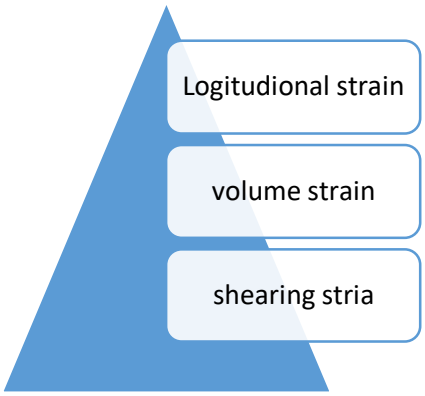
Shear Stress: when the stress is tangential to the surface due to the application of forces parallel to the surface, then the stress is called tangential of shear stress. It changes the shape of the body.

$$\tau = \frac{\text{Force}}{\text{Surface Area}}$$

Strain: Normal stress on a body causes change in length or volume and tangential stress produces change in the shape of a body. The ratio of change produced in the dimension of a body by a system of forces or couples in equilibrium, to its original dimensions is called strain.

$$\text{Strain} = \frac{\text{change in dimension}}{\textit{origional dimension}}$$

Strain is of three types depending upon the change produced in a body & the stress applied. The three types of strain are



Longitudinal Strain: It is the ratio of the change in length of a body to the original length of a body. Ex. If L is the original length of a wire of rod and the find length of the wire or the rod is L+ ΔL under the action of normal stress the change in length is ΔL.

$$\text{Longitudinal Strain} = \frac{\Delta L}{L}$$

If the length increase due to tensile stress, the corresponding strain is called tensile strain. If the length decreases due to compressive stress, the strain is called “Compressive strain”.

Volumetric Strain: It is the ratio of the change in volume if a body to its orgional volume. If V is the original volume of body and V + ΔV is the volume of the body under the action of a normal stress, the change in volume is ΔV .

$$\text{Volume Strain} = \frac{\Delta V}{V}$$

Shear Strain: It is the angle through which is perpendicular to the fixed face is turned (or) it is the ratio of the displacement of a leyer. Or it is the amount of deformation perpendicular to a given line rather parallel to it.

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