Unit-III (ME-201)

Simple Stress-Strain

Stress:

The force of resistance per unit area, offered by a body against deformation is known as stress.

Let, P = Pull (or force) acting on the body,

A = Cross – sectional area of the body,

σ = Stress induced in the body

At equilibrium, Applied force P = Resisting force,

This resisting force per unit area is known as stress or intensity of stress.

Normal stress (σ) = Resisting force (R)/ Cross sectional area

$$\sigma = P/A$$

Types of Normal Stress:

(i) Tensile Stress:

The stress induced in a body, when subjected to two equal and opposite pulls as shown in fig 1 as a result of which there is an increase in length, is known as tensile stress.

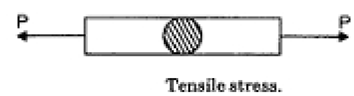

Fig 1

Fig 2

(ii) Compressive Stress:

The stress induced in a body, when subjected to two equal and opposite pushes as shown in fig 2 as a result of which there is a decrease in length, is known as compressive stress.

Shear Stress:

Stress and strain produced by a force tangential to the surface of a body are known as shear stress and shear strain.

Shear stress exists between two parts of a body in contact, when the two parts exert equal and opposite force on each other laterally in a direction tangential to their surface of contact.

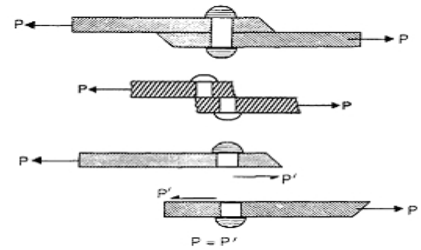

Fig 3

Figure 3 shows a section of rivet subjected to equal and opposite forces P causing sliding of the particles one over the other.

From figure it is clear that the resisting force of the rivet must be equal to P. Hence, shearing stress τ is given by

$$\tau = \text{total tangential force}/(\text{Surface Area})$$

$$= P/A, \text{ here } A = \Pi.d.t$$

Strain:

When a body is subjected to some external force, there is some change in dimension of the body. The ratio of change in dimension of the body to the original dimension is known as strain.

Strain is dimensionless.

$$\text{Strain} = \text{Change in dimension}/\text{Original dimension}$$

Types of Longitudinal Strain:

(i) Tensile Strain: When a tensile load acts on a body then there will be a decrease in cross-sectional area and an increase in length of the body. The ratio of the increase in length to the original length is known as tensile strain.

$$e_t = \delta L/L$$

The above strain which is caused in the direction of application of load is called longitudinal strain.

(ii) Compressive Strain: When a compressive load acts on a body then there will be an increase in cross-sectional area and decrease in length of the body. The ratio of the decrease in length to the original length is known as compressive strain.

$$e_c = \delta L/L$$

Shear Strain:

In case of a shearing load, a shear strain will be produced. This is measured by the angle through which the body distorts.

In Fig.4 is shown a rectangular block LMNP fixed at one face and subjected to force F. After application of force, it distorts through an angle Φ and occupies new position LM'N'P. The shear strain (e_s) is given by

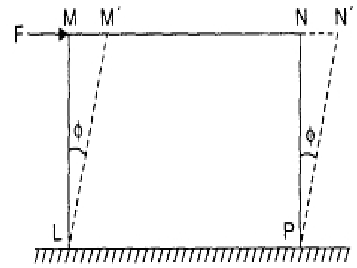

Fig 4

$$e_s = NN'/NP$$
$$= \tan\Phi$$
$$= \Phi \text{ (radians) ...... since } \Phi \text{ is very small.}$$

Volumetric Strain (e_v):

It is defined as the ratio between change is volume and original volume of the body, and is denoted by e_v,

$$\mathbf{e_v} = \text{change in volume/ original volume} = \delta V/V$$
$$e_v = e_x + e_y + e_z$$

i.e., volumetric strain equals the sum of the linear normal strains in x, y and z direction.

Lateral Strain:

Lateral strain is the lateral deformation expressed as a dimensionless constant and is defined as the ratio of change in lateral dimension to the initial lateral dimension.

Lateral strain = Change in lateral dimension/ Original lateral length

= Change in diameter/ Original diameter; for circular bar

= Change in width or depth / Original width or depth; for rectangular bar

Poisson's Ratio (1/m or µ)

Poisson's ratio is the ratio of lateral strain to the longitudinal strain. It is an elastic constant having the value always less than 1. It is denoted by 'µ' (l/m).

Poisson's Ratio (µ) = Lateral Strain / Longitudinal Strain;

Its value is always less than 1.