

The figure shows a small rectangular element with sides of length Δx , Δy parallel to x and y directions. Its thickness normal to the plane of paper is Δz in z – direction. All nine normal and shear stress components may act on the element, only those in x and y directions are shown.

Sign conventions for shear stresses:

Direct stresses or normal stresses

- tensile +ve
- compressive –ve

Shear stresses:

- tending to turn the element C.W +ve.
- tending to turn the element C.C.W – ve.

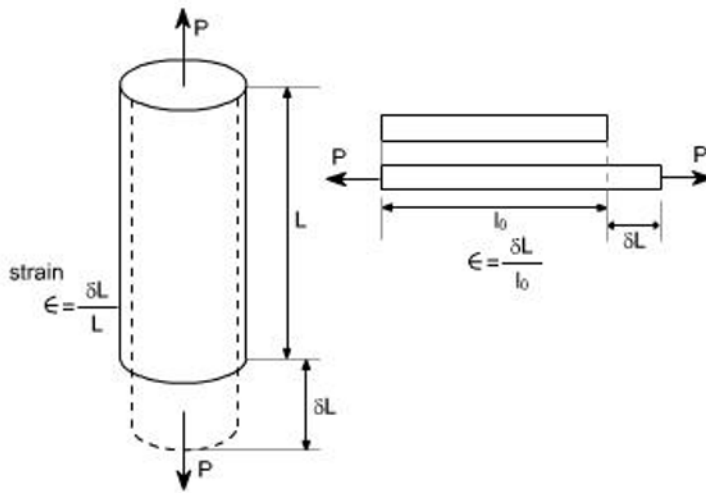
The resulting forces applied to the element are in equilibrium in x and y direction. (Although other normal and shear stress components are not shown, their presence does not affect the final conclusion).

CONCEPT OF STRAIN

Concept of strain : if a bar is subjected to a direct load, and hence a stress the bar will change in length. If the bar has an original length L and changes by an amount ΔL , the strain produce is defined as follows:

$$\text{strain}(\epsilon) = \frac{\text{change in length}}{\text{original length}} = \frac{\Delta L}{L}$$

Strain is thus, a measure of the deformation of the material and is a nondimensional Quantity i.e. it has no units. It is simply a ratio of two quantities with the same unit.



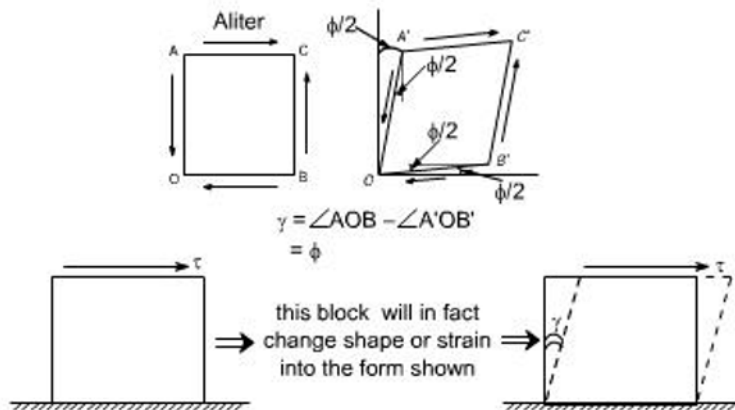
Since in practice, the extensions of materials under load are very very small, it is often convenient to measure the strain in the form of strain $\times 10^{-6}$ i.e. micro strain, when the symbol used becomes $\mu\epsilon$.

Sign convention for strain:

Tensile strains are positive whereas compressive strains are negative. The strain defined earlier was known as linear strain or normal strain or the longitudinal strain now let us define the shear strain.

Definition: An element which is subjected to a shear stress experiences a deformation as shown in the figure below. The tangent of the angle through which two adjacent sides rotate relative to their initial position is termed shear strain. In many cases the angle is very small and the angle itself is used, (in radians), instead of tangent, so that $\gamma = \angle AOB - \angle A'O'B' = \phi$

Shear strain: As we know that the shear stresses acts along the surface. The action of the stresses is to produce or bring about the deformation in the body consider the distortion produced by shear stress on an element or rectangular block



This shear strain or slide is ϕ and can be defined as the change in right angle. or The angle of deformation ϕ is then termed as the shear strain. Shear strain is measured in radians & hence is non – dimensional i.e. it has no unit. So we have two types of strain i.e. normal stress & shear stresses.

Hook's Law :

A material is said to be elastic if it returns to its original, unloaded dimensions when load is removed.

Hook's law therefore states that Stress \propto strain.