

Marwari college Darbhanga

Subject---physics (Hons)

Class--- B.Sc. part 1

Paper—01 ; Group—A

Topic—Relation between Elastic Constant

(Properties Of Matter)

Lecture series—19

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Elastic constant

When an elastic body is subjected to stress, a proportionate amount of strain is produced. The ratio of the applied stresses to the strains generated will always

be constant and is known as elastic constant. Elastic constant represents the elastic behaviour of objects.

Elastic constant Types

1. Young's modulus
2. Bulk modulus
3. Rigidity modulus
4. Poisson's ratio

1. Young's Modulus

According to Hooke's law, when a body is subjected to tensile stress or compressive stress, the stress applied is directly proportional to the strain within the elastic limits of that body. The ratio of applied stress to the strain is constant and is known as Young's modulus or modulus of elasticity.

Young's modulus is denoted by letter "E". The unit of modulus of elasticity is the same as the unit of stress which is megapascal (Mpa). 1 Mpa is equal to 1 N/mm².

$$\text{Young's Modulus}(E) = \frac{\text{Stress}}{\text{Strain}}$$

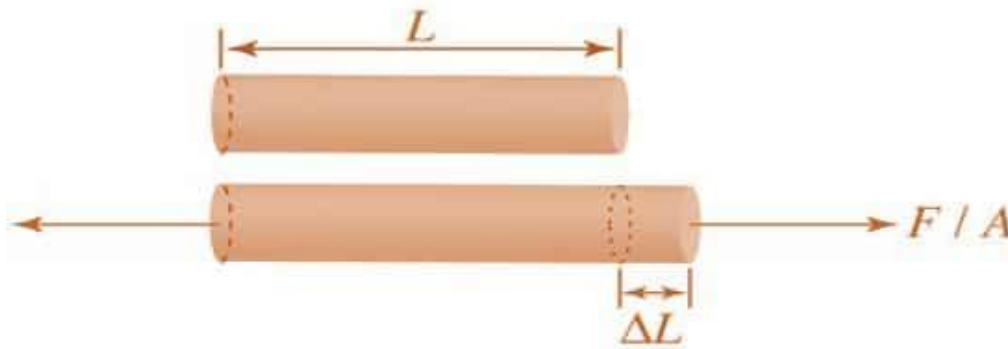


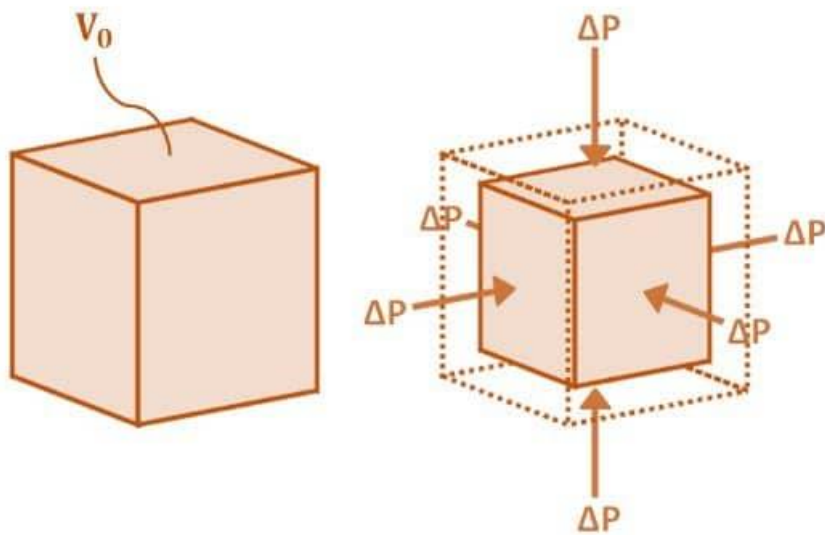
Fig.

1 Body Subjected to Tensile Stress

2. Bulk Modulus

When a body is subjected to mutually perpendicular direct stresses which are alike and equal, within its elastic limits, the ratio of direct stress to the corresponding volumetric strain is found to be constant. This ratio is called bulk modulus and is represented by letter “K”. Unit of Bulk modulus is Mpa.

$$\text{Bulk Modulus}(K) = \frac{\text{Direct Stress}}{\text{Volumetric Strain}}$$



Fig

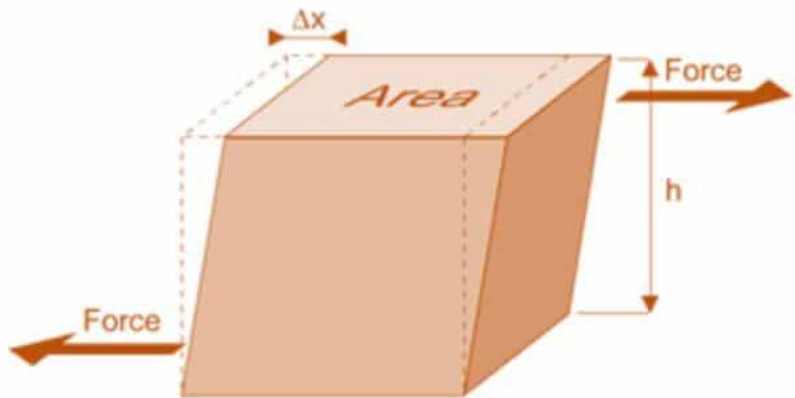
2: Volumetric Change of Body

Fig 2: Volumetric Change of Body

3. Rigidity Modulus

When a body is subjected to shear stress the shape of the body gets changed, the ratio of shear stress to the corresponding shear strain is called rigidity modulus or modulus of rigidity. It is denoted by the letters “G” or “C” or “N”. Unit of rigidity modulus is Mpa.

$$\text{Rigidity modulus}(G) = \frac{\text{Shear Stress}}{\text{Shear Strain}}$$



Fig

3: Shear Deformation of Body

4. Poisson's Ratio

When a body is subjected to simple tensile stress within its elastic limits then there is a change in the dimensions of the body in the direction of the load as well as in the opposite direction. When these changed dimensions are divided with their original dimensions, longitudinal strain and lateral strain are obtained.

$$\text{Poisson's ratio } (\mu) = \frac{\text{Lateral Strain}}{\text{Longitudinal Strain}}$$

The ratio of the lateral strain to the longitudinal strain is called Poisson's ratio. It is represented by the symbol “ μ ”. Poisson's ratio is maximum for an ideal elastic incompressible material and its value is 0.5. For most of the engineering materials, Poisson's ratio lies between 0.25 and 0.33. It has no units.

Relationship between Elastic Constants

- The relationship between Young's modulus (E), rigidity modulus (G) and Poisson's ratio (μ) is expressed as :

$$E = 2G(1 + \mu)$$

- The relationship between Young's modulus (E), bulk modulus (K) and Poisson's ratio (μ) is expressed as :

$$E = 3K(1 - 2\mu)$$

- Young's modulus can be expressed in terms of bulk modulus (K) and rigidity modulus (G) as :

$$E = \frac{9KG}{(3K + G)}$$

- Poisson's ratio can be expressed in terms of bulk modulus (K) and rigidity modulus (G) as :

$$\mu = \frac{(3K - 2G)}{(6K + 2G)}$$