

Lecture : 11

B. Sc. (Hon.) Part-I

Paper - I

**Physics Course: Mechanics and
Properties of Matter**

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I. POISSON'S RATIO

Poisson's ratio of the material of a wire is defined as the ratio between lateral strains per unit stress to the longitudinal strain per unit stress.

II. RELATION BETWEEN ELASTIC CONSTANTS

The Bulk modulus can be expressed as

$$B = \frac{1}{3(\alpha - 2\beta)} \quad (1)$$

where α be the increase per unit length per unit tension along the direction of the force and β is the contraction produced per unit length per unit tension, in a direction perpendicular to the force.

The modulus of rigidity can be written as

$$S = \frac{1}{2(\alpha + \beta)} \quad (2)$$

The Young's modulus is given by

$$Y = \frac{1}{\alpha} \quad (3)$$

From (1),

$$\alpha - 2\beta = \frac{1}{3B}. \quad (4)$$

From (2)

$$\alpha + \beta = \frac{1}{2S} \quad (5)$$

Equations (4) and (5) yield

$$\beta = \frac{3B - 2S}{18BS}$$

and

$$\alpha = \frac{3B + S}{9BS},$$

so,

$$\frac{1}{Y} = \frac{3B + S}{9BS}.$$

This implies

$$\frac{9}{Y} = \frac{3}{S} + \frac{1}{B}.$$

This is the desired relation between elastic constants.

III. BENDING OF BEAMS

We must first define beam and bending moment.

A. Beam

A beam is a rod of uniform cross-section, circular or rectangular, whose length is very great compared with its thickness, so that the shearing stresses over any section are small and may be neglected.

B. Bending Moment

When a beam is fixed at one end and loaded at the other, it bends due to the moment of the load, the plane of bending being the same as that of the couple applied. Restoring forces are called into play by this deformation of the beam and, in the equilibrium state, the restoring or resisting couple is equal and opposite to the bending couple, both being in the plane of bending.

When a beam bends, along a section, there is a layer or surface in which the filaments are neither compressed nor extended. This surface is called the neutral surface and its section by the plane of bending which is perpendicular to it, is called the neutral axis.

IV. CANTILEVER

A cantilever is a beam fixed horizontally at one end and loaded at the other.