Hooke’s Law

Within the elastic region of the stress-strain diagram, stress is linearly proportional to strain.

That relationship was formalized by Robert Hooke in 1678.
Hooke’s Law

- In mathematical terms

\[ \sigma = E \varepsilon \]

- \( \sigma \) (sigma) is the axial/normal stress
- \( E \) is the elastic modulus or the Young’s modulus
- \( \varepsilon \) (epsilon) is the axial/normal strain

Hooke’s Law

- For shear stress in the same region

\[ \tau = G \gamma \]

- \( \tau \) (tau) is the shear stress
- \( G \) is the shear modulus or the modulus of rigidity
- \( \gamma \) (gamma) is the shear strain
Poisson’s Ratio

As a material deforms along an axis due to an applied stress on that axis, the material also deforms along any axis lateral to the axis.
Poisson’s Ratio

- The strain developed in the lateral and axial directions have a fixed ratio based on the material
- The ratio is known as Poisson’s Ratio
Poisson’s Ratio

- The Ratio is

\[ \nu = - \frac{\varepsilon_{\text{lat}}}{\varepsilon_{\text{axial}}} \]

\( \nu \) (nu) is Poisson’s Ratio
\( \varepsilon_{\text{lat}} \) is the strain in the lateral direction
\( \varepsilon_{\text{axial}} \) is the strain in the axial/normal direction
Poisson’s Ratio

Poisson’s Ratio is also used in an expression relating the elastic modulus $E$ to the shear modulus $G$

$$G = \frac{E}{2(1 + \nu)}$$

Problem P3.4

A 0.75-in. thick rectangular bar is subjected to a tensile load $P$ by pins at A and B as shown. The width of the bar is $w = 3.0$ in. Strain gages bonded to the specimen measure the following strains in the longitudinal ($x$) and traverse ($y$) directions: $\varepsilon_x = 840\mu\varepsilon$, $\varepsilon_y = -250\mu\varepsilon$
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(a) Determine Poisson's ratio for this specimen

(b) If the measured strains were produced by an axial load of $P = 32$ kips, what is the modulus of elasticity for this specimen?
Problem P3.16 (Clicker)

Hooke's Law

Problem 3.25

Hooke's Law

Upper scale

Lower scale

Strain (in./in.)

Stress (ksi)

Problem 3.25
Homework

- P 3.15
- P 3.22
- P 3.24

Hooke's Law