University of Illinois

TAM 251

Mechanics of Materials

Notes

Interpretor:
James Kristoff

Instructor:
Dr. Keane

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Review

$$\perp \text{Stress} = \sigma = \frac{F}{A} \tag{1}$$

Strain

$$\varepsilon = \frac{L^* - L}{L} = \frac{\delta}{L} \tag{2}$$

In a Stress Vs. Strain plot the linear region towards the beginning of the plot is known as the elastic region. Everything else is in the Plastic region, in which the material no longer returns to its original shape after forces are removed.

These graphs are made from taking measurements during a tensile test.

Hooke's Law

$$\sigma_n = E\varepsilon_n \tag{3}$$

Where E is Young's modulus (The Slope of the σ vs ε plot).

- Tension

  $\varepsilon > 0$

- Compression

  $\varepsilon < 0$

Connections to Earlier Work

When Eq. (1) and Eq. (3) are combined and are then solved for δ the result is

$$\delta = \frac{FL}{EA} \tag{4}$$

Failure of Material

- Ductile fractures occur when $\%\ \varepsilon > 10\%$
- Brittle fractures occur when $\%\ \varepsilon < 10\%$

Maximum displacement a material can undergo before failure is

$$\delta_{\text{max}} = \frac{\sigma_y L}{E} \tag{5}$$

Where L is the undeformed Length.

3D Strain

$$\varepsilon_y = -\nu\varepsilon_X \tag{6}$$

$$\varepsilon_z = -\nu\varepsilon_X \tag{7}$$

Where ν is known as Passon's ratio. $\nu > 0$ always holds true in nature.

For a cube of sides a in the x-direction, b in the y, and c in the z, with forces being applied along the x-direction the equation

$$V_f = a\left(1+\varepsilon_x\right)\cdot b\left(1-\nu\varepsilon_x\right)\cdot c\left(1-\nu\varepsilon_x\right) \tag{8}$$

Multiplying out this equation and ignoring all ε_x^2, which can be approximated as 0 gives the final deformed volume. (I think)