MECHANICS OF MATERIALS

Analysis of Strain

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Chapter Description

- Expected Outcomes
  - Identify the concepts of strain.
  - Apply the concept of strain in calculating the normal and shear strain in the body.
  - Calculate the deformation in the body.

1.1 Deformation

- **Strain:** a force or influence that stretches, pulls, or puts pressure on something, sometimes **causing damage**
- **Deformation**: When a **force** is applied to a body, it will change the body's **shape** and **size**
- Eg: A rubber band – will undergo a very large deformation when stretched
- Excessive stress in brittle materials such as concrete has caused it to strain until it fractured
- **Load** will cause all material bodies to **deform**

1.2 Strain

- Strain- the relative **change** in **shape** or **size** of an object due to externally-applied **forces**

- Strain describe the deformation in 2 ways:
  1. Normal strain (ε) - epsilon
  2. Shear strain (γ) - gamma

Normal Strain

- Normal Strain- deformation of the member per unit **length**
  - Deformation -> The **elongation** (+) / **contraction** (-)
- Average normal strain is defined as:

$$\varepsilon_{avg} = \frac{\Delta s' - \Delta s}{\Delta s}$$

$$\varepsilon = \frac{\delta}{L} = \text{normal strain}$$

Δs = Original length

$\Delta s'$ = Final length

δ = Deformation

L = Length

- If the **normal strain is known**, then the approximate final length is

$$\Delta s' \approx (1+\varepsilon)\Delta s$$

- Normal strain is a **dimensionless** quantity since it is a **ratio** of two lengths

Shear Strain

- Change in **angle** that occurs between two small line segments that are originally perpendicular to one another

$$\gamma_{nt} = \frac{\pi}{2} - \lim_{\substack{B \to A \text{ along } n \\ C \to A \text{ along } t}} \theta'$$

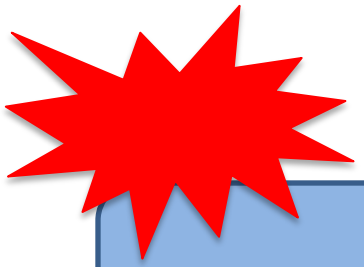
θ<90 ➔ +shear strain

θ>90 ➔ -shear strain

REMEMBER

NORMAL STRAIN - Δ LENGTH

SHEAR STRAIN - Δ ANGLE



STRESS
Force / Unit Area

STRAIN
Measure of Deformation

Normal Stress (σ)

Normal Strain (ε)

Shear Stress (τ)

Shear Strain (γ)

References

- Hibbeler, R.C., Mechanics Of Materials, 9th Edition in SI units, Prentice Hall, 2013.
- Ferdinand P. Beer, E. Russell Johnston, Jr., John T. DeWolf, David F. Mazurek, Mechanics of materials 5th Edition in SI Units, McGraw Hill, 2009.

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