Mechanics of Materials III:

Beam Bending

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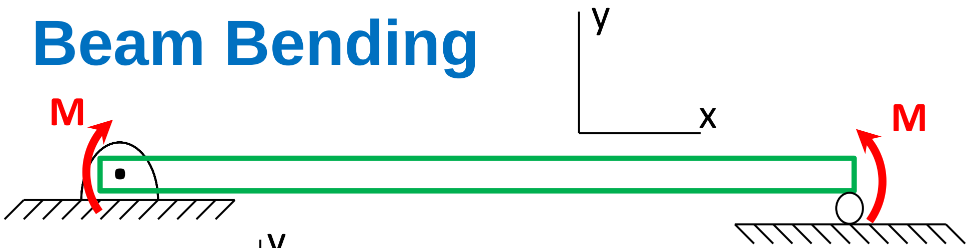
Mechanics of Materials III: Beam Bending

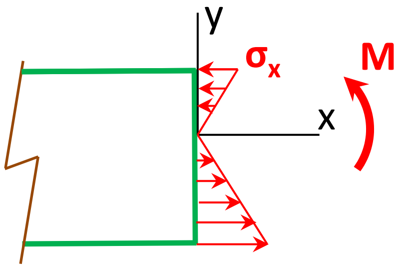
- ✓ Shear Force and Bending Moment Diagrams
- ✓ Elastic Flexural Stresses and Strains
- ❑ Elastic Flexural Formula
- ❑ Properties of Sections
- ❑ Inelastic Bending
- ❑ Shear Stress in Beams
- ❑ Principal Stresses in Bending

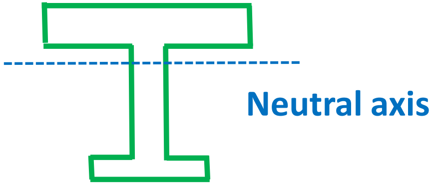
Module 10 Learning Outcome

- Derive the elastic flexural formula

Beam Bending







$$\sigma_x = -\frac{E\,y}{\rho} = -E\,\kappa\,y$$

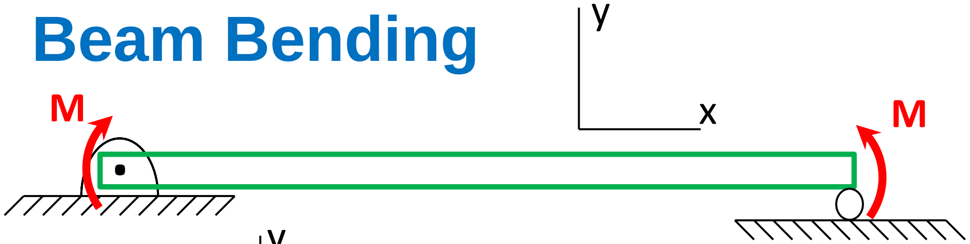
For linear elastic material, stress is also proportional to curvature and varies linearly with distance, y, from the neutral axis.

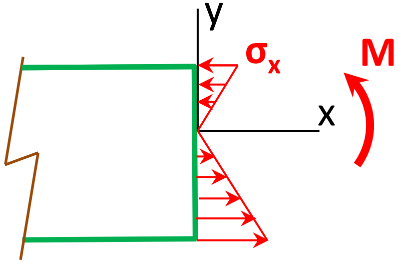
Moment-curvature relationship

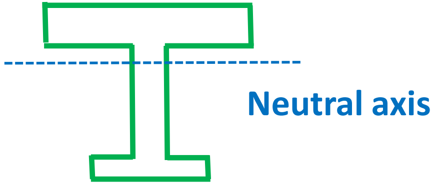
$$\kappa = \frac{1}{\rho} = \frac{M}{EI}$$

Curvature is proportional to moment

Beam Bending





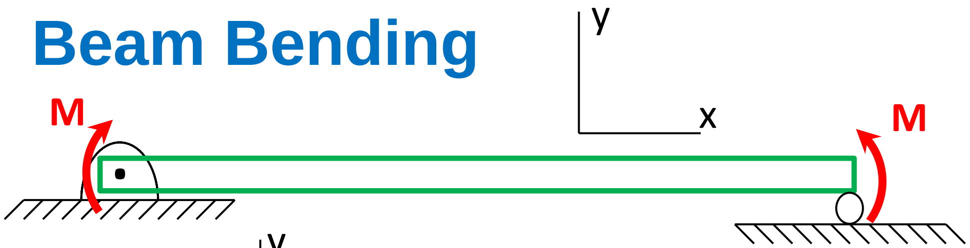


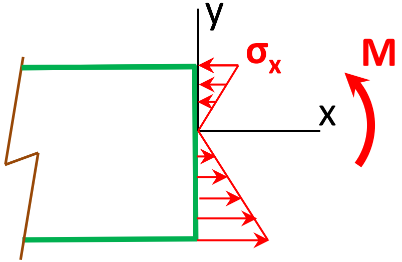
$$\sigma_x = -\frac{E\ y}{\rho} = -E\ \kappa\ y$$

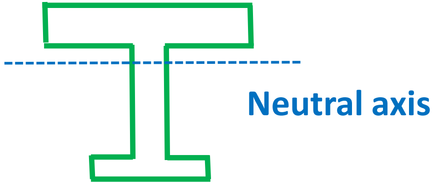
$$\kappa = \frac{1}{\rho} = \frac{M}{EI}$$

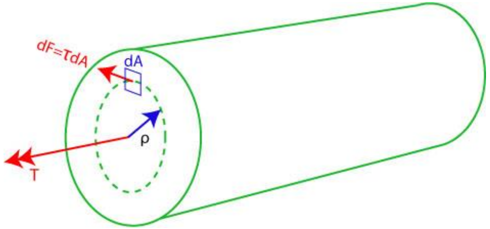
Elastic Flexural Formula

Beam Bending









Elastic Flexural Formula

$$\sigma_x = -\frac{M\ y}{I}$$

Stress is directly proportional to bending moment, M.

Stress is inversely proportional to the area moment of inertia, I.

Stress varies linearly with the distance from the neutral axis, y.

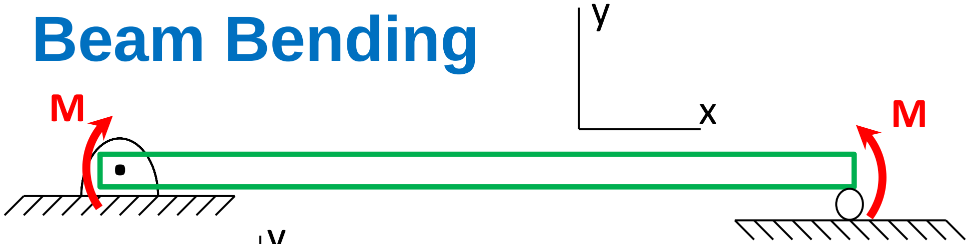
(linear elastic material)

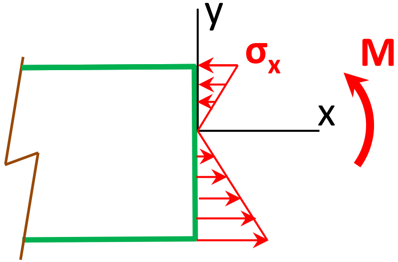
analogous to:

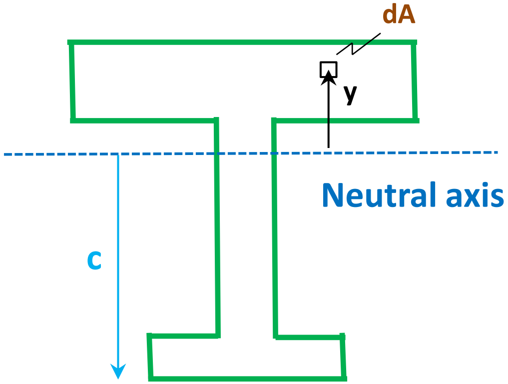
$$\tau = \frac{T\ \rho}{J}$$

τ is the shearing stress on a transverse plane at a distance ρ from the center axis

Beam Bending







Elastic Flexural Formula

$$\sigma_x = -\frac{M\ y}{I}$$

Maximum Stress

$$\sigma_{MAX} = \frac{M\ c}{I}$$

c is the furthest distance on the cross section from the neutral axis