Mechanics of Materials III:

Beam Bending

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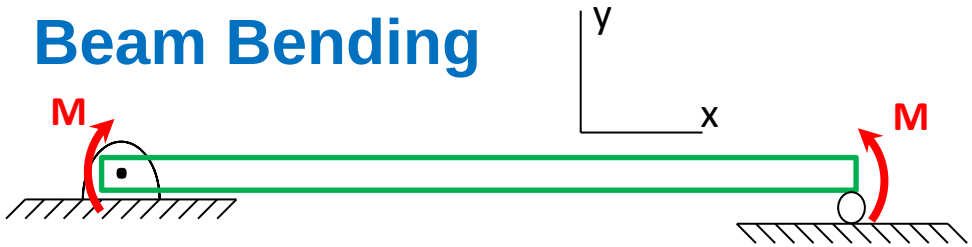
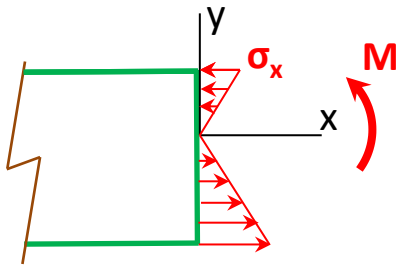
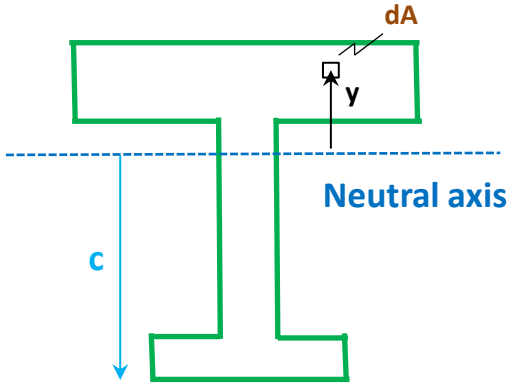
Module 12 Learning Outcome

- Determine how to find and use the section property of Section Modulus, S

Beam Bending







Recall Maximum Stress

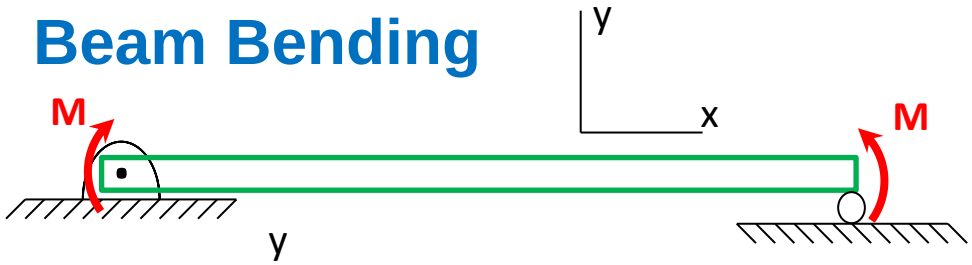
$$\sigma_{MAX} = \frac{M\ c}{I}$$

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

Section Modulus

$$S \equiv \frac{I}{c} \qquad \sigma_{MAX} = \frac{M}{S}$$

Beam Bending



Section Modulus

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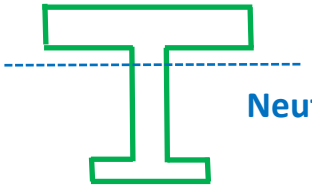


Neutral axis

For Design

maximum bending moment expected

$$S \geq \frac{M_{MAX}}{\sigma_{ACTUAL\ (ALLOWED)}}$$

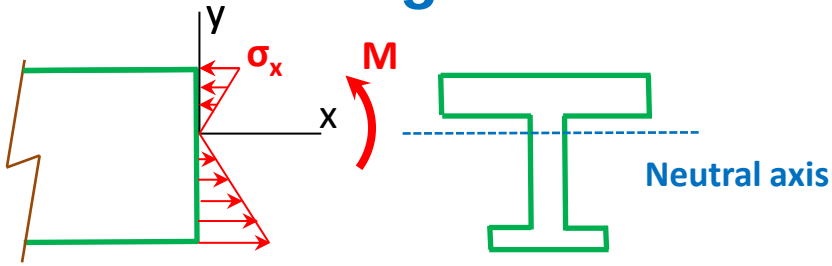
Factor of Safety (FoS)

$FoS > 1$ avoids failure

$$FoS = \frac{Failure\ \ Stress}{Actual\ \ Stress} = \frac{\sigma_{FAILURE}}{\sigma_{ACTUAL\ (ALLOWED)}}$$

Listed in tables in "Manual of Steel Construction," American Institute of Steel Construction (most of the resources are free to the public)

Beam Bending



Elastic Flexural Formula

$$\sigma_x = -\frac{M\ y}{I} \qquad \sigma_{MAX} = \frac{M}{S}$$

Area Moment of Inertia, I

$$I = \int_A r^2\, dA$$

A cross section's resistance to bending about a certain axis

Therefore more area further from the neutral axis provides greater resistance to bending.
This is the reason for I-beam shapes, etc.

Recall from my 2D and 3D Dynamics courses

$$I_{zz}^{P} = \int_B \left(x^2 + y^2\right) dm$$

= **Mass Moment of Inertia about the z-axis through point P**

How much mass is located how far from the axis of rotation. Resistance to angular acceleration.