



# **Mechanics of Materials I:**

## **Fundamentals of Stress & Strain and Axial Loading**

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## Module 41 Learning Outcome

- Design engineering structural members to meet a specified Factor of Safety

# Design

Create a new engineering component or structure that will meet specifications and performance criteria

## Factor of Safety (FoS)

$$\text{Factor of Safety} = FoS = \frac{\text{Failure Stress}}{\text{Actual Stress}} = \frac{\text{Strength of Material}}{\text{Max Computed Stress}}$$

$FoS > 1$  avoids failure



The design criteria  
the engineering  
component/structure  
must achieve



The designer defines failure;  
component/structure doesn't  
meet performance criteria;  
e.g. excessive deformation,  
fracture, etc.

## Example:



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**Truss Members**

## Example:

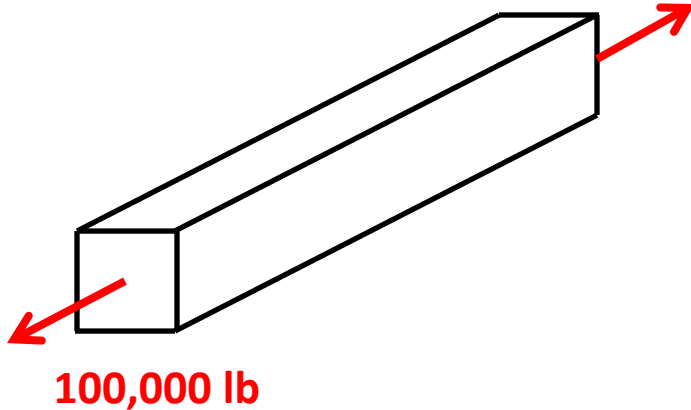
A wooden truss member is required to support a 100,000 lb load in tension.

You should design for a  $FoS \geq 2$  with respect to yielding.

The Yield Stress for the wood being used is 4000 psi.



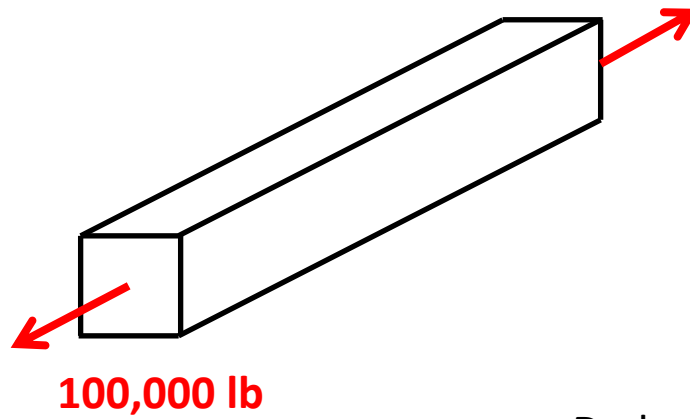
What cross sectional area of beam should be designed for?



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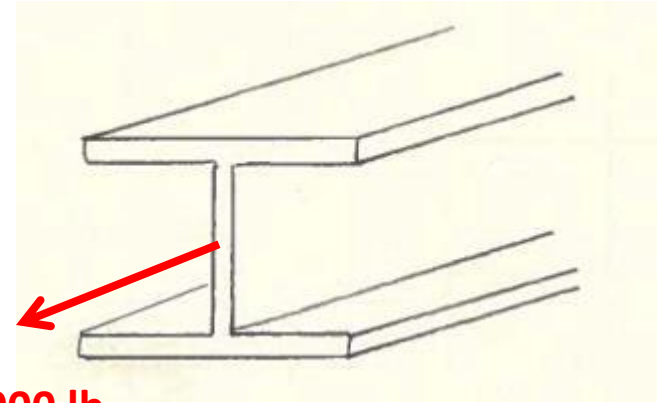
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Do by hand

# Worksheet:



An I-beam in Georgia Tech's Campus Recreation Center is made of A36 steel and is subjected to a 130,000 lb tensile load.

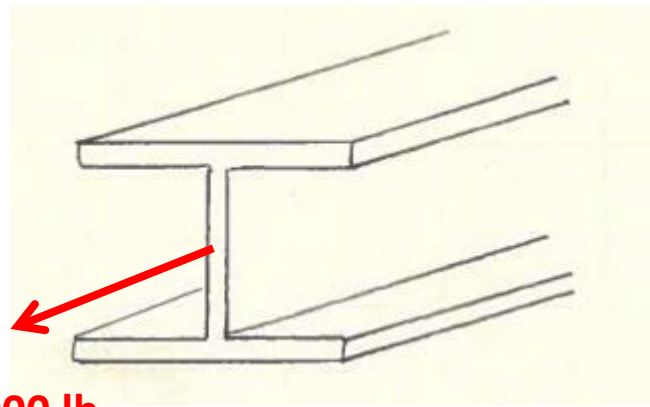
The I-beam has a total cross-sectional area of 8.79 square inches and the Yield Stress for A36 steel is 36,000 psi.

If the design calls for a 2.5 Factor of Safety with respect to yielding, is the design with the current I-beam adequate?

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130,000 lb

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$$FOS = \frac{\text{STRENGTH OF MATERIAL}}{\text{MAX COMPUTED STRESS}}$$

$$FOS = \frac{36000 \text{ psi}}{14,790 \text{ psi}} = 2.43$$

$$\text{MAX COMPUTED STRESS} = \sigma = \frac{N}{A} = \frac{130,000 \text{ lb}}{8.79 \text{ in}^2}$$

$$\sigma_{\text{COMPUTED}} = 14,790 \text{ psi}$$

$$\sigma_{\text{YIELD}} = 36,000 \text{ psi}$$

SINCE

$$FOS_{\text{ACTUAL}} = 2.43 < 2.5 = FOS_{\text{REQUIRED}}$$

DESIGN IS NOT ADEQUATE  
ANS