Mechanics of Materials III:

Beam Bending

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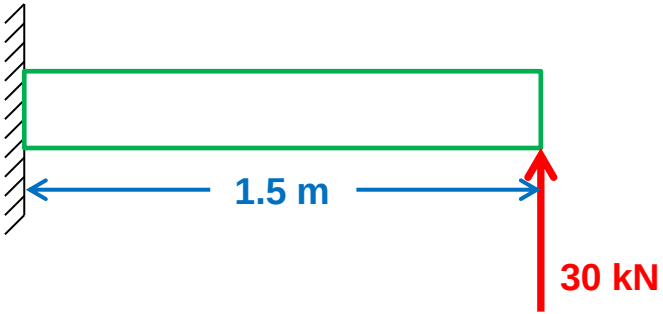
Module 15 Learning Outcome

- Solve an elastic beam bending problem

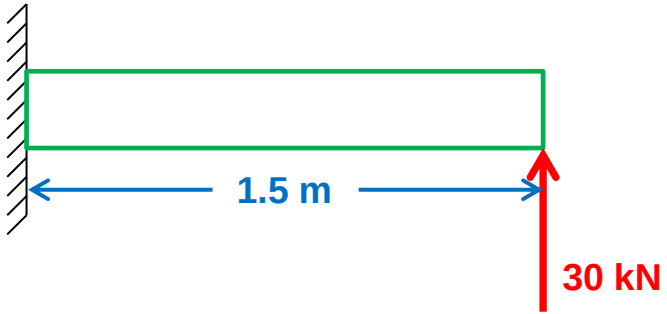
Elastic Beam Bending

Try to draw a model on your own



We are going to analyze the situation using a steel S Type I-Beam.
We will need the structure properties to complete this analysis.
Let's choose an S 305 X 74 beam.

Do research on your on and find the area moment of inertia, I, the section modulus, S, and the depth of the I-beam, D, for an S 305 X 74 I-beam.



For an S 305 X 74 I-beam:

$$I = 127 \ x10^{6} \ mm^{4}$$

$$S = 832 \ x10^{3} \ mm^{3}$$

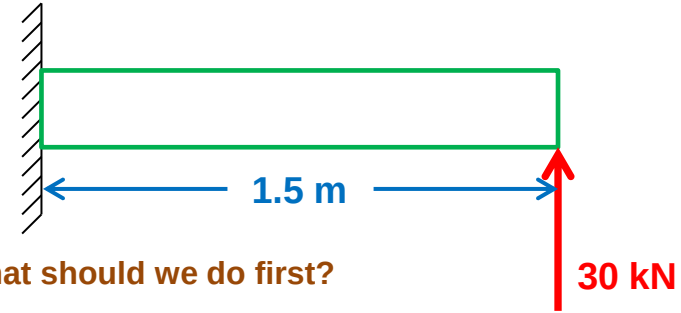
$$D = 304 \ .8 \ mm$$

Also note that the cross section is symmetrical and the neutral axis is through the center

Worksheet:

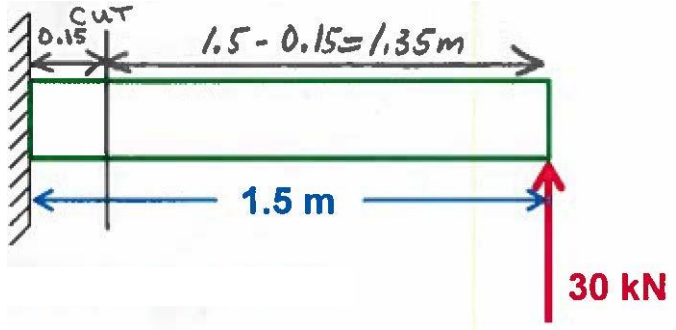
At a point 0.15 meters to the right of the left fixed end, find:

- **the normal stress due to bending at a point 50 mm below the top of the beam**
- **the maximum normal stress experienced in the beam**



What should we do first?

Draw a FBD and solve for the moment experienced at a point 0.15 meters to the right of the left fixed end.



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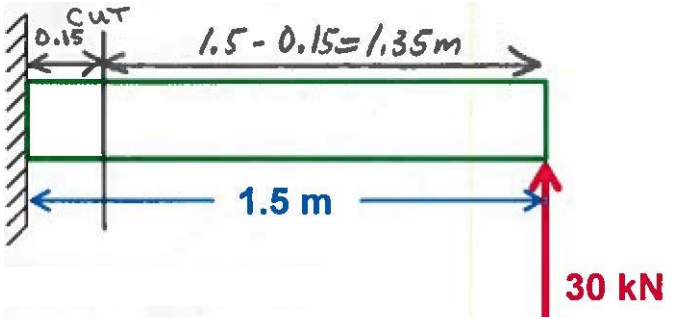

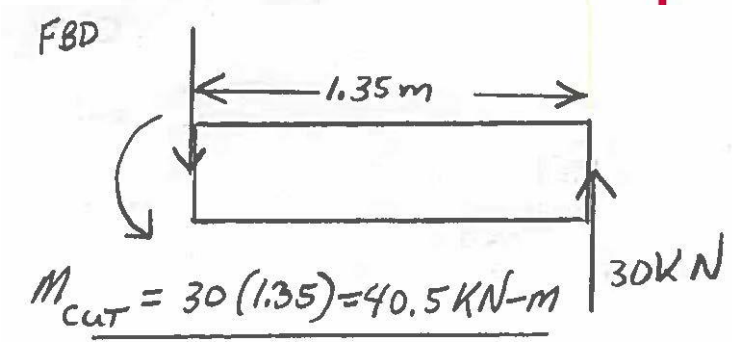

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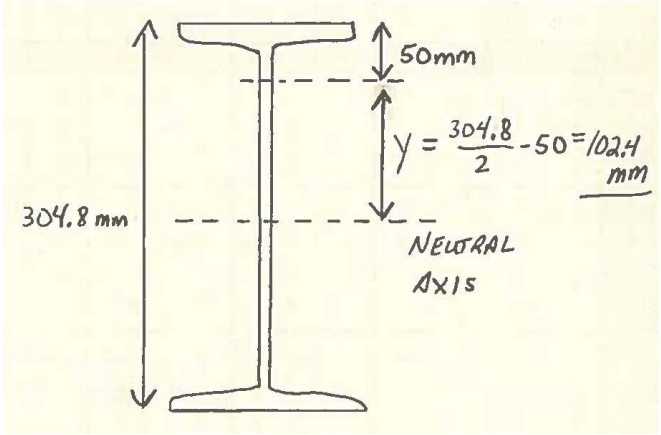
$$M_{CUT} = 40.5\ kN \cdot m \quad CCW$$

What should we do next?

Elastic Flexural Formula

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

$$I = 127\ x10^{6}\ mm^{4}$$



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Elastic Flexural Formula

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

$$M_{CUT} = 40.5\ kN \cdot m \quad CCW$$

$$y = 102.4\ mm$$

$$I = 127\ x10^{6}\ mm^{4}$$

$$\sigma_x = \frac{40.5\ kN \cdot m\left(\frac{1000\ N}{kN}\right)\left(\frac{1000\ mm}{m}\right)102.4\ mm}{127\ x10^{6}\ mm^{4}}$$

$$\sigma_x = 32.7\ \frac{N}{mm^{2}} = 32.7\ MPa \quad (C)$$

at a point 50 mm below the top of the beam

ANS

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At a point 0.15 meters to the right of the left fixed end, find:

- **the normal stress due to bending at a point 50 mm below the top of the beam**
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What should we do next?

Section Modulus

$$M_{CUT} = 40.5\ kN \cdot m \quad CCW$$

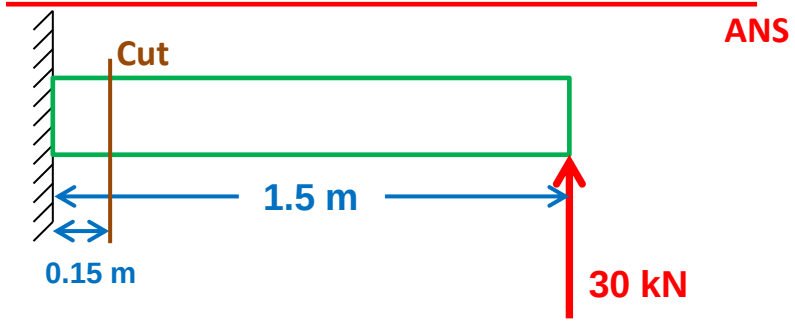
$$S \equiv \frac{M}{c} \qquad \sigma_{MAX} = \frac{M}{S} \qquad S = 832\ x10^{3}\ mm^{3}$$

$$\sigma_{MAX} = \frac{40.5\ kN \cdot m \left(\frac{1000\ N}{kN}\right)\left(\frac{1000\ mm}{m}\right)}{832\ x10^{3}\ mm^{3}}$$

$$\sigma_{MAX} = 48.7\ \frac{N}{mm^{2}} = 48.7\ MPa$$

compression on top
tension on bottom

ANS



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What should we do next?

$$\sigma_{MAX} = 48.7 \frac{N}{mm^2} = 48.7\ MPa$$

compression on top
tension on bottom

ANS

Make sure the beam remained in the elastic region!

$$48.7\ MPa < 250\ MPa = \sigma_{\substack{YIELD \\ STEEL}}$$

Ok!