8.5/10

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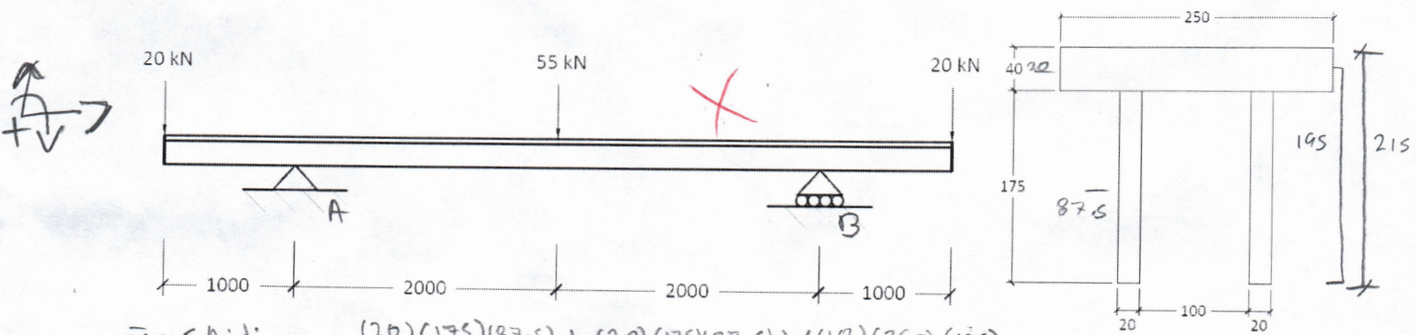
CIV102F Quiz #9: 1300h-1500h Thursday, November 14, 2019

Flexural Stresses

The beam shown below is made from Oak. Do the following:

1. Calculate the relevant cross-sectional properties
2. Draw the shear force and bending moment diagrams caused by the three point loads
3. Calculate the maximum tensile and compressive stresses which occur in the beam. Indicate on the drawing where they occur.
4. Using your results from part 3, calculate the factors of safety against ultimate failure for both tension and compression. How will the beam fail?

All dimensions are in mm.



$\bar{y} = \frac{\sum A_i d_i}{A_i} = \frac{(20)(175)(87.5) + (20)(175)(87.5) + (410)(250)(195)}{2((20)(175)) + (90)(250)}$

$\bar{y} = 150.735\text{mm}$ /+1

$I = \sum A_i \bar{d}_i^2 + I_i$

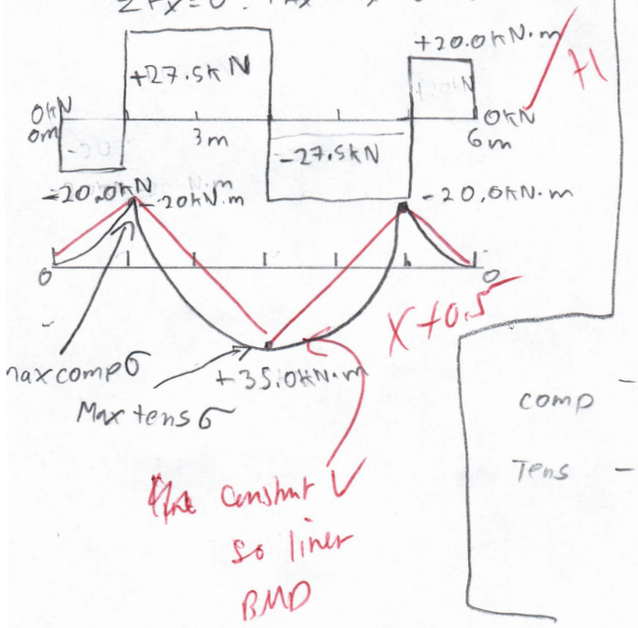
$I = \left[(3500)(63.235)^2 + \frac{20 \times 175^3}{12}\right] \times 2 + \left[(10000)(44.265)^2 + \left(\frac{250 \times 40^3}{12}\right)\right]$

$I = 66782475.49 = 66.78247549 \times 10^6\ \text{mm}^4$ $= 66.8 \times 10^6\ \text{mm}^4 = I$ /+1

2.) Structures is simply supported and symmetrical

$\therefore A_y = \frac{P_T}{2} = \frac{20+55+20\text{kN}}{2} = 47.5\text{kN} = B_y$

$\Sigma F_x = 0 \therefore A_x = B_x = 0\text{kN}$



/+1

X +0.5

The constant V so linear BMD

3.) Min $M = |-20.0\text{kN·m}| = 20.0\text{kN·m}$ $\quad Y_{Top} = 64.625\text{mm}$

$M < 0 \therefore$ Tension on top, comp on bot $\quad Y_{Bot} = 150.735$

$\sigma_{M_{Top}} = \frac{My}{I} = \frac{20 \times 10^6\ \text{N·mm} \times 64.625}{66.8 \times 10^6\ \text{mm}^4} = 19.35\text{MPa}$

$\sigma_{M_{Bot}} = \frac{My}{I} = \frac{20 \times 10^6\ \text{N·mm} \times 150.735\text{mm}}{66.8 \times 10^6} = 45.1\ \text{MPa}$ /+3

Max $M = |35.0\text{kN·m}| = 35 \times 10^6\ \text{N·mm}$

comp -> $\sigma_{Max M_{Top}} = \frac{35 \times 10^6 \times 64.625}{66.8 \times 10^6} = -33.9\ \text{MPa}$

Tens -> $\sigma_{Max M_{Bot}} = \frac{35.0 \times 10^6 \times 150.735}{66.8 \times 10^6} = 79.0\text{MPa}$

Max comp $\sigma = 45.1\text{MPa}$

Max tens $\sigma = 79.0\text{MPa}$

4.) $FoS = \frac{\sigma_{ult}}{\sigma}$ /+1

$FoS_{comp} = \frac{60}{45.1} = 1.330$

$FoS_{tens} = \frac{40}{79.0} = 1.139$

No you didn't!

I probably calculated My Max moment incorrectly. The beam will fail due to cracking, as a result of the σ_u tension being exceeded. /+1