ME 35c Midterm Solution

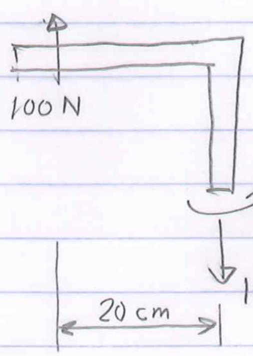
1. $\sigma_x = -20\,\text{ksi}$, $\sigma_z = 0$, $\varepsilon_y = 0$. Find σ_y, ε_x, ε_z
$E = 10{,}000\,\text{ksi}$, $\nu = 0.2$

$$\varepsilon_y = \frac{1}{E}(\sigma_y - \nu\sigma_x - \nu\sigma_z) \Rightarrow \boxed{\sigma_y = +\nu\sigma_x = -4\,\text{ksi}}$$

$$\varepsilon_x = \frac{1}{E}(\sigma_x - \nu\sigma_y - \nu\sigma_z) = -19.2\times10^{-4}$$
$$\varepsilon_z = \frac{1}{E}(\sigma_z - \nu\sigma_x - \nu\sigma_y) = 4.8\times10^{-4}$$

$$\Delta V = (\varepsilon_x + \varepsilon_y + \varepsilon_z)\cdot 4\,\text{in}\cdot 10\,\text{in}\cdot 30\,\text{in} = -1.728\,\text{in}^3$$

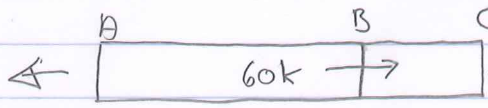
2.



$$\sigma_{max} = \frac{P}{A} + \frac{Mc}{I}$$
$$= \frac{100\,\text{N}}{1\,\text{cm}^2} + \frac{100\,\text{N}\cdot 20\,\text{cm}\cdot \frac{1}{2}\,\text{cm}}{\frac{1}{12}(1\,\text{cm})^4}$$
$$= 12100\,\text{N/cm}^2 = 121\,\text{MPa}$$

3. If behavior is elastic:

$60\cdot\frac{4}{12} = 20\,\text{k}$



$60\cdot\frac{8}{12} = 40\,\text{k}$

$$\sigma_{BC} = -\frac{40\,\text{k}}{1\,\text{in}^2} = -40\,\text{ksi}$$

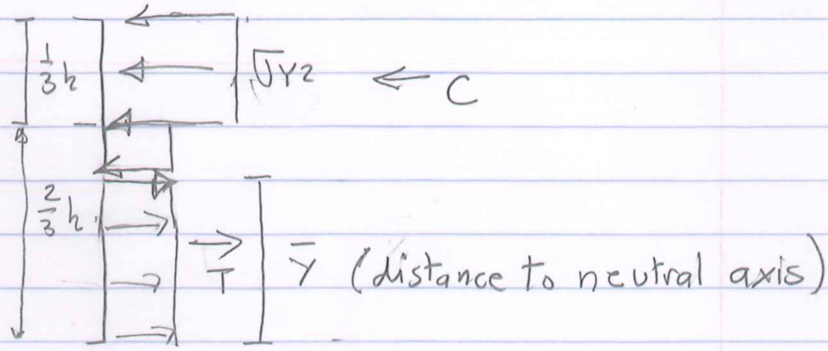
Therefore part B-C yields and $\sigma_{BC} = -36\,\text{ksi}$.
This reduces the reaction at C to 36K, increases the reaction at A to $\boxed{24\,\text{k}.}$

$$\sigma_{AB} = \frac{24\,\text{k}}{1\,\text{in}^2} = 24\,\text{ksi},\quad \varepsilon_{AB} = \frac{\sigma_{A\text{-}B}}{E} = 8\times10^{-4}$$

$$\Delta L_{AB} = 8\,\text{in}\cdot\varepsilon_{A\text{-}B} = 6.4\times10^{-3}\,\text{in}$$

So B moves 6.4×10^{-3} in to the right.

4. Locate neutral axis



$$C = T$$

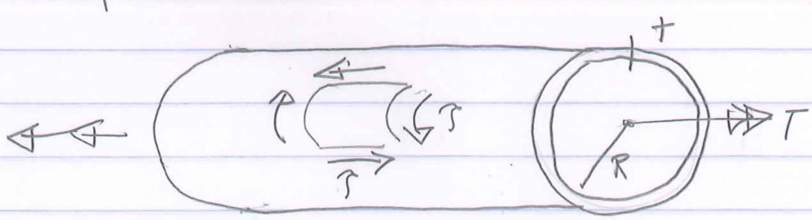
$$\sigma_{Y2}\cdot b\cdot \tfrac{1}{3}h + \sigma_{Y1}\cdot b\cdot\left(\tfrac{2}{3}h - \bar{y}\right) = \sigma_{Y1}\cdot b\cdot \bar{y}$$

$$\sigma_{Y2} = 2\,\sigma_{Y1}$$

get $\bar{y} = \frac{2}{3}h$ (should have been obvious)

$$\boxed{M_p = C\cdot \tfrac{1}{6}h + T\cdot\tfrac{1}{3}h = \sigma_{Y1}\cdot b\cdot\tfrac{2}{3}h\cdot\tfrac{1}{2}h = \sigma_{Y1}\cdot b\cdot\tfrac{1}{3}h^2}$$

5. For repaired tube:



$$\tau = \frac{T}{2t\mathcal{A}} \quad \text{where } \mathcal{A} = \pi R^2$$

so $\tau = \dfrac{T}{2\pi R^2 t}$ along both repaired cracks

So force carried by weld is shear with a value of

$$\tau\cdot t = \frac{T}{2\pi R^2} \text{ per length of weld}$$

for <u>both</u> welds.