ME556 Homework Problem #2

Solution

• Beam theory predicts: $\varepsilon_{xx} = \frac{M_y z}{EI_y} - \frac{M_z y}{EI_z}$

• In this case: $I_z = \frac{bh^3}{12}$ $\qquad$ $I_y = \frac{hb^3}{12}$

$$M_z = M\cos\theta = \frac{Pd}{2}\cos\theta \qquad M_y = M\sin\theta = \frac{Pd}{2}\sin\theta$$

• Combining the above, we have:

$$\varepsilon_{xx} = \frac{6Pd}{hbE}\left[\frac{z\sin\theta}{b^2} - \frac{y\cos\theta}{h^2}\right]$$

• This expression is valid for any point in the cross-section, as defined by coordinates (*y*,*z*). Point a is located at $y = h/2$ and $z = b/2$. Substituting these particular coordinates we have:

$$\varepsilon_{xx} = \frac{3Pd}{hbE}\left[\frac{\sin\theta}{b} - \frac{\cos\theta}{h}\right]$$

• Finally, the problem states to plot ε_{xx} for $0 < P < 500$ lbf, assuming

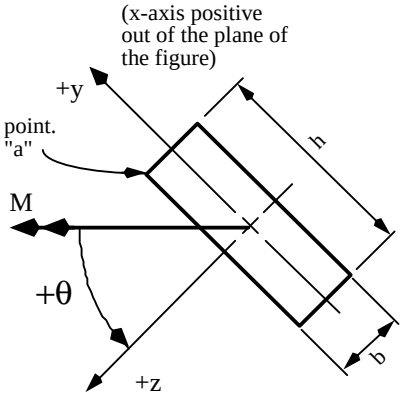
$$E = 10x10^6\ psi\,,\ d = 5.0\ in\,,\ b = 0.5\ in,\ h = 1.0\ in$$

Plots appear on the following page. Note that by inspection it can be seen that:

-strains at point "a" should be of equal magnitude but opposite algebraic sign for two cases:

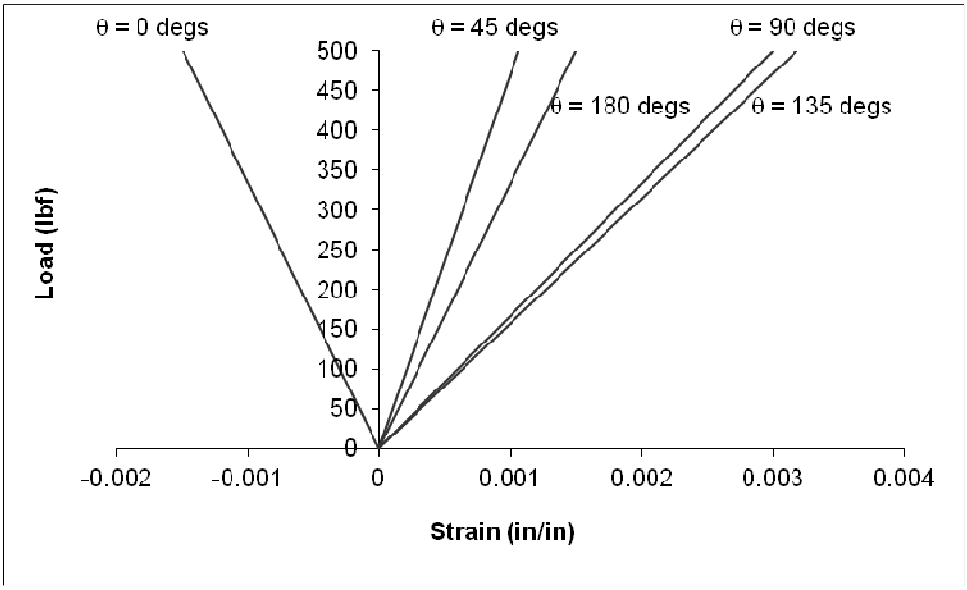
$\theta = 0^o$ (and) $\theta = 180^o$

- strains at point "a" are compressive if $\theta = 0^o$



STRAIN INDUCED AT POINT “a” BY A PURE BENDING MOMENT

Plotted as Load vs Strain:



Or Plotted as Strain vs Load: