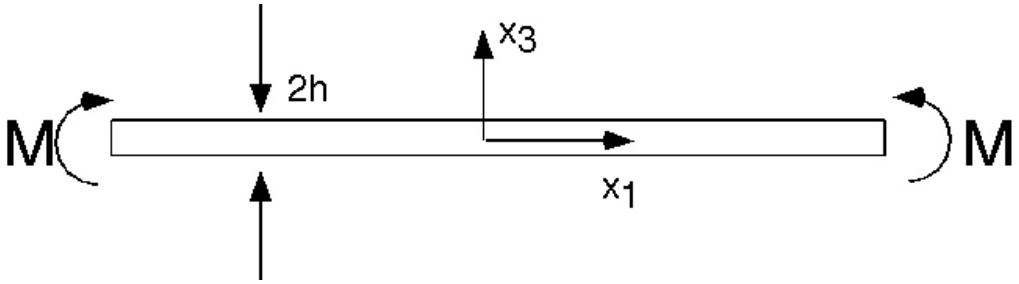
Problem M13 (Materials and Structures)

a) The state of axial stress through the thickness of a beam in pure bending (i.e. loaded only by a moment) is given by:



$$\sigma_{11} = \left(\frac{M}{I}\right) x_3 \qquad \text{for } -h < x_3 < +h$$

M is the bending moment (which is constant in x_1), and I is the second moment of area of the cross-section of the beam (which is also constant). If $\sigma_{12} = \sigma_{32} = \sigma_{22} = \sigma_{33} = 0$ what can you say about the variation of the shear stress σ_{13} with x_1, x_2 and x_3?

b) The bending moment M now varies as a function of x_1 according to $M = cx_1$ The axial stress is still give by $\sigma_{11} = \left(\frac{M}{I}\right) x_3$. Again, $\sigma_{12} = \sigma_{32} = \sigma_{22} = \sigma_{33} = 0$. How does σ_{13} vary with x_1, x_2 and x_3? Note $\sigma_{13} = 0$ for $-h = x_3$ and $x_3 = +h$ (the top and bottom surfaces of the bean are free surfaces and do not have any stress acting on them).