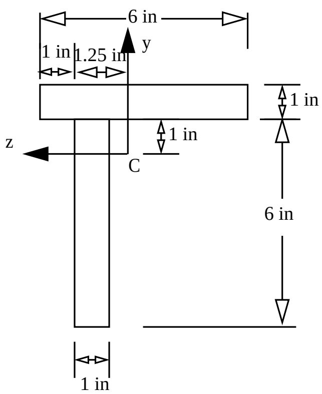
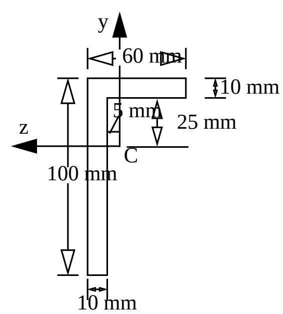
EXAM 2 MEEM 4150 Nov. 18th, 2004

1. (a) Determine I_{yz} for the cross-section shown.



I_{yz} = ------------------

(b) The internal bending moments on a cross-section shown were determined to be $\boldsymbol{M}_y = -20 \ \text{kN}-\text{m}$ and $\boldsymbol{M}_z = (25 \ )\text{kN}-\text{m}$. Determine the orientation of the neutral axis and show it on the cross-section.

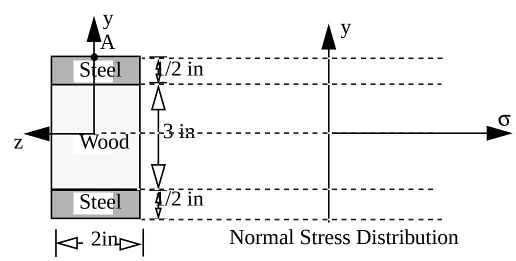


$I_{yy} = 0.4125 \ (10^6) \ \text{mm}^4$

$I_{zz} = 1.5125 \ (10^6) \ \text{mm}^4$

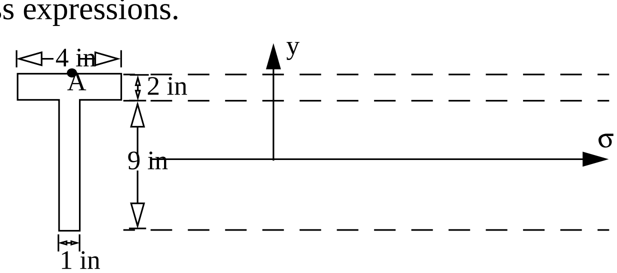
$I_{yz} = 0.45(10^6) \ \text{mm}^4$

(c) The normal strain at point A on a cross-section of a laminated beam in bending was found to be $-1000 \ \mu$. Sketch the normal stress distribution along the line parallel to the y-axis *and* label the stress values. Use E_{steel}= 30,000 ksi and E_{wood}= 8,000 ksi.



Normal Stress Distribution

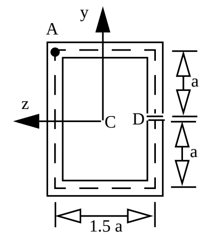
(d) A beam of elastic-perfectly plastic material has a yield stress of 30 ksi. Point A on the cross-section shown just reaches yield stress in *compression* at a given load. (i) Sketch the stress distribution along a line parallel to the y-axis. (ii) Write the expressions for bending normal stress σ_{xx} and the intervals over which each expression is valid. Use coordinate y and parameter 'a' representing the distance of elastic-plastic boundary from neutral axis in writing your stress expressions.



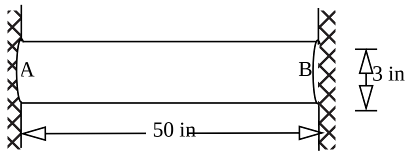
(e) A thin cross-section of uniform thickness t is shown below. If shear stresses were to be found at point A then what values of Q_y and Q_z are needed for the calculation. Assume $t \ll a$ and gap at D is of negligible thickness. Report the values of Q_y and Q_z in terms of t and a.

Q_y = --------------

Q_z = --------------

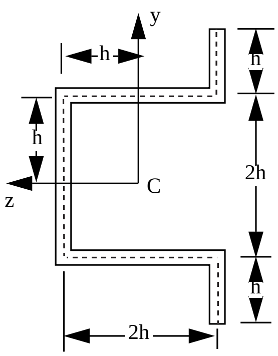


(f) A circular steel (E= 30,000 ksi, ν=0.29, α = 6.6 $\mu/^oF$) bar is held between two rigid walls. Determine the change in diameter of the bar if temperature of the bar is raised by 100^oF.



Δd= -------------------------

2. (a) A cross-section has a uniform thickness t. Assuming t is small determine the shear center with respect to point C in terms of h.



$$I_{yy} = 5.33h^3t$$

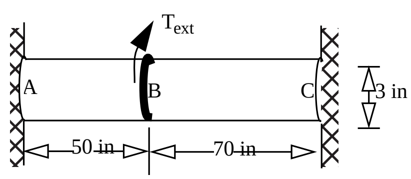
$$I_{zz} = 9.33h^3t$$

$$I_{yz} = 0$$

e_y =-------------------------

e_z =-------------------------

3. A shaft made from elastic-perfectly plastic has a shear yield stress of 15 ksi and a shear modulus of 12,000 ksi. The plastic zone in shaft segment AB was found to be 0.25 inch deep. (a) Determine the external torque T_{ext}. (b) The rotation of section at B.



T_{ext}= ---------------------------

ϕ_B= ---------------------------

ANSWERS

1(a) I_{yz} = -15.75 in^4 (b) $\theta_{N.A.}$= 65.04^o from z (d) $\sigma_{xx} = \begin{cases} 30\text{ksi} & -(11-a) \le y \le -a \\ -30\frac{y}{a} & -a \le y \le (a-2) \\ -30\frac{y}{a} & (a-2) \le y \le a \end{cases}$

(e) Q_y = - 0.75a^2t Q_z = 2a^2t Δd= 2.55(10^{-3}) in.

2. e_y =0 e_z= 1.714h

3. T_{ext}= 158.8 in-kip ϕ_B= -0.05 rad