The beam shown below is loaded in pure bending. The beam has a cross section at location C on the beam as shown below right. The origin O is located on the neutral axis of the beam.

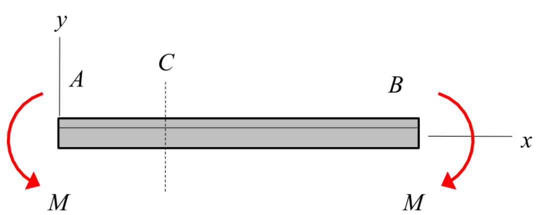
a) Determine the location of the centroid for the cross of this beam; i.e., what is the distance d?

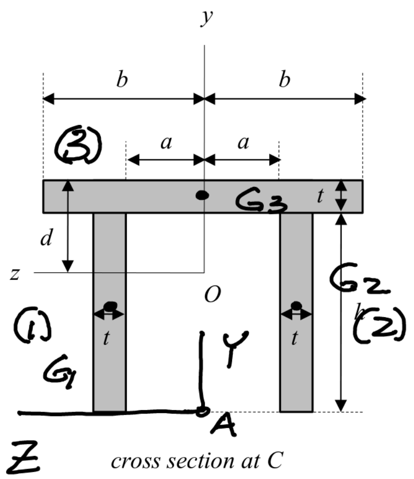
b) Determine the second area moment I_{Oz} corresponding to the neutral axis of the beam.

c) Determine the distribution of normal stress on the cross section of the beam as a function of y.

d) Determine the maximum (magnitude) normal stress occurring on the cross-sectional face at C.

Use the following dimensions: $M = 2000\ N \cdot m$, $t = 20\ mm$, $b = 80\ mm$, $a = 40\ mm$ and $h = 80\ mm$.





cross section at C

First, locate centroid:

$$(A_1 + A_2 + A_3)\bar{Y}_o = A_1\bar{Y}_1 + A_2\bar{Y}_2 + A_3\bar{Y}_3$$

w/ $A_1 = th$ & $\bar{Y}_1 = \frac{h}{2}$

$A_2 = th$ & $\bar{Y}_2 = h/2$

$A_3 = 2bt$ & $\bar{Y}_3 = h + \frac{t}{2}$

$$\therefore \quad \bar{Y}_o = \frac{(\cancel{t}h)(\frac{h}{2}) + (th)\frac{h}{2} + (2b\cancel{t})(h + \frac{t}{2})}{2\cancel{t}h + 2b\cancel{t}} = \frac{h^2 + 2b(h + \frac{t}{2})}{2(h+b)}$$

$$d = h + t - \bar{Y}_o$$

Then using P.A.T.:

$$(I_o)_1 = I_{G_1} + A_1\left(\frac{h}{2} + t - d\right)^2 \quad ; \quad \begin{cases} I_{G_1} = \frac{1}{12} h^3 t \\ A_1 = ht \end{cases}$$

$$(I_o)_2 = I_{G_2} + A_2\left(\frac{h}{2} + t - d\right)^2 = (I_o)_1$$

$$(I_O)_3 = I_{G3} + A_3\left(d - \frac{t}{2}\right)^2 \; ; \quad I_{G3} = \frac{1}{12}(2b)t^3$$
$$A_3 = 2bt$$

Therefore:

$$I_O = (I_O)_1 + (I_O)_2 + (I_O)_3$$

<u>Stress distribution</u>

$$|\sigma|_{max} = \frac{M(t+h-d)}{I_O}$$