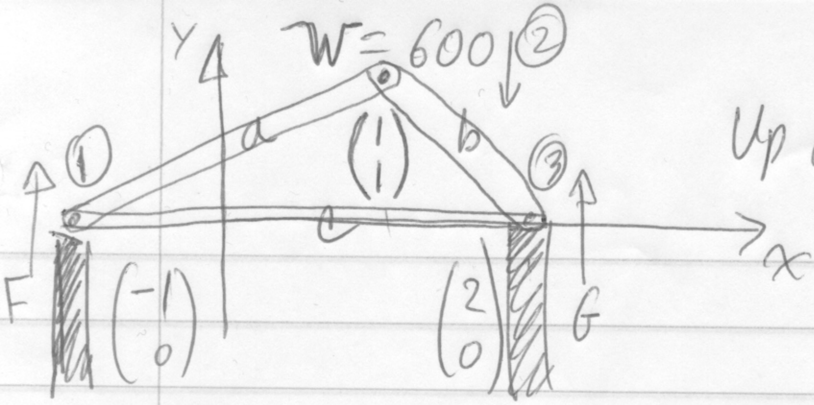

Up on THE ROOF!

The problem is to find the $\left(\frac{\text{tension}}{\text{length}}\right)$'s $= \tau$ in each beam a, b, and c.

They satisfy

$$\begin{pmatrix}-2\\-1\end{pmatrix}\tau_a + \begin{pmatrix}-3\\0\end{pmatrix}\tau_c = \begin{pmatrix}0\\F\end{pmatrix}$$ Equil. at NODE 1

$$\begin{pmatrix}2\\1\end{pmatrix}\tau_a + \begin{pmatrix}-1\\1\end{pmatrix}\tau_b = \begin{pmatrix}0\\-600\end{pmatrix}$$ Equil at NODE 2

$$\begin{pmatrix}1\\-1\end{pmatrix}\tau_b + \begin{pmatrix}3\\0\end{pmatrix}\tau_c = \begin{pmatrix}0\\G\end{pmatrix}$$ Equil at node 3

OR

$$\begin{pmatrix}-2 & 0 & -3\\ -1 & 0 & 0\\ 2 & -1 & 0\\ 1 & 1 & 0\\ 0 & 1 & 3\\ 0 & -1 & 0\end{pmatrix}\begin{pmatrix}\tau_a\\ \tau_b\\ \tau_c\end{pmatrix} = \begin{pmatrix}0\\F\\0\\-600\\0\\G\end{pmatrix}$$

These equations have a lot of zeros, so it won't be hard to solve them,

ESPECIALLY if we do some rearranging!

ORIGINAL AUGMENTED MATRIX IS

$$\left(\begin{array}{ccc|c} -2 & 0 & -3 & 0 \\ -1 & 0 & 0 & F \\ 2 & -1 & 0 & 0 \\ 1 & 1 & 0 & -600 \\ 0 & 1 & 3 & 0 \\ 0 & -1 & 0 & G \end{array}\right) \rightarrow \left(\begin{array}{ccc|c} -1 & 0 & 0 & F \\ 0 & -1 & 0 & G \\ -2 & 0 & -3 & 0 \\ 2 & -1 & 0 & 0 \\ 1 & 1 & 0 & -600 \\ 0 & 1 & 3 & 0 \end{array}\right)$$

is clearly going to be way simple now:

$$\rightarrow \left(\begin{array}{ccc|c} -1 & 0 & 0 & F \\ 0 & -1 & 0 & G \\ 0 & 0 & -3 & -2F \\ 0 & 0 & 0 & 2F-G \\ 0 & 0 & 0 & F+G-600 \\ 0 & 0 & 0 & G-2F \end{array}\right)$$

where I did several steps in the same matrix, but did not swap any more rows.

THEREFORE a solution exists provided $G = 2F$, $F + G = 600$

$\Rightarrow 3F = 600 \quad F = 200 \quad G = 400$

(this is ANOTHER linear system!)

FROM the first 3 rows we have $-\tau_a = F \Rightarrow \boxed{\tau_a = -200}$
(the $-$ indicates COMPRESSION instead of TENSION)

and $-\tau_b = 400 \Rightarrow \boxed{\tau_b = -400}$ (also COMPRESSION)

AND finally $-3\tau_c = -400 \Rightarrow \boxed{\tau_c = 400/3}$

To get the actual tensions, multiply the τ's by the beam lengths

$$L_a = \sqrt{1^2+2^2} = \sqrt{5} \qquad L_c = \sqrt{3^2+0^2} = 3$$

$$L_b = \sqrt{1^2+1^2} = \sqrt{2}$$

$$\Rightarrow T_a = L_a \tau_a = -200\sqrt{5} \approx -446$$

$$T_b = L_b \tau_b = -400\sqrt{2} \approx -566 = -566$$

$$T_c = L_c \tau_c = 3(400/3) = +400$$

These would be in units of POUNDS if $W = 600$ pounds

This was NOT NECESSARY for the homework!

But it is good to see how to translate results from abstract numbers into physical quantities.