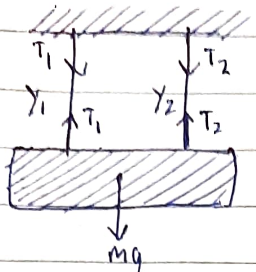
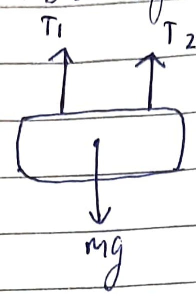


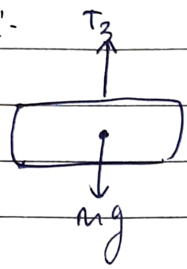
FBD of block with 2 strings :-



As the block is in equilibrium, $\Sigma F_y = 0$

$\therefore T_1 + T_2 = Mg$

FBD of block with 1 string :-



We know that $Y = \frac{\text{Stress}}{\text{strain}}$

As the block is in eq.

$T_3 = mg = T_1 + T_2$ —— (i)

$\therefore Y_1 = \frac{F_1/A}{\Delta L/L}$

$Y_1 = \frac{F_1 L}{A \Delta L_1}$ = Young ~~md~~ modulus of 1st wire

$Y_2 = \frac{F_2 L}{A \Delta L_2}$ = Young ~~md~~ modulus of 2nd wire

$F_1 = T_1 = \frac{A Y_1 \Delta L_1}{L}$ —— (ii)

$F_2 = T_2 = \frac{A Y_2 \Delta L_2}{L}$ —— (iii)

putting value of T_1 & T_2 from (ii) & (iii) in eq^n (i) :

$T_3 = \frac{A Y_1 \Delta L_1}{L} + \frac{A Y_2 \Delta L_2}{L}$

$T_3 = \frac{A}{L}\left[Y_1 \Delta L_1 + Y_2 \Delta L_2 \right]$ —— (iii)

If Y_3 = Y of equivalent wire, then

$Y_3 = \frac{T_3 L}{A \Delta L_3}$ $\quad T_3 = \frac{A}{L} Y_3 \Delta L_3$ —— (v) putting eq^n value of T_3 from eq^n (v) in eq^n (iv) we get:-

$$\frac{A}{L} y_3 \Delta L_3 = \frac{A}{L}\left[y_1 \Delta L_1 + y_2 \Delta L_2\right]$$

$$y_3 \Delta L_3 = y_1 \Delta L_1 + y_2 \Delta L_2$$

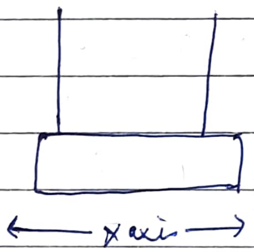
Now elongation of the single wire will be equal to sum of elongation of both the wires so,

$$\Delta L_3 = \Delta L_2 + \Delta L_1$$

$$y_3 \Delta L_2 + y_3 \Delta L_1 = y_1 \Delta L_1 + y_2 \Delta L_2$$

$$\Delta L_2\left[y_3 - y_2\right] = \Delta L_1\left[y_1 - y_3\right]$$

Now in the diagram the block was parallel to the x-axis, As the wires had equal initial length, this is possible only if their elongations were also equal. i.e $\Delta L_1 = \Delta L_2$



~~then thus~~

$\therefore$ We have $y_3 - y_2 = y_1 - y_3$

or $$\boxed{y_3 = \frac{y_1 + y_2}{y_3}}$$