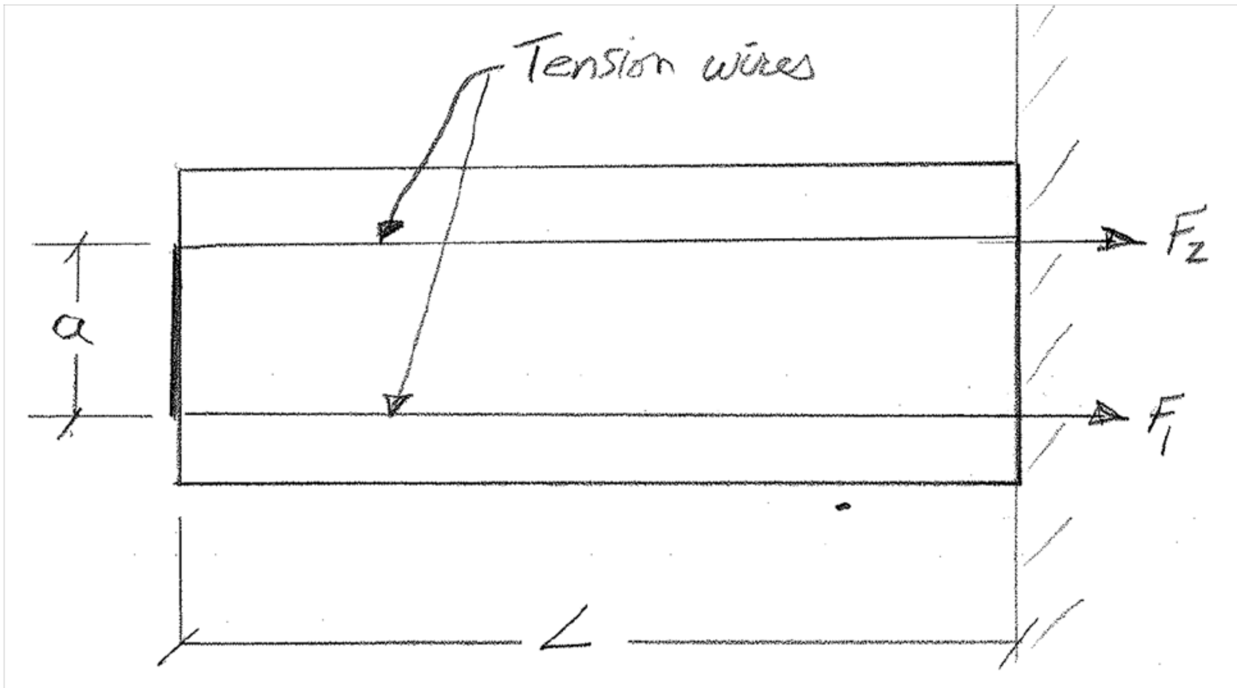

1.0 Define Inputs

$b := 62.5mm$	Side of module
$a1 := 2\cdot(28.14mm)$	Distance between tension rods
$a2 := 2\cdot(56.25mm)$	
$n_L := 194$	Number of layers of lead
$n_s := 194$	Number of layers of scintillator
$t_L := 0.5mm$	Thickness of lead
$t_s := 1.5mm$	Thickness of scintillator
$tgap := .24mm$	Thickness of gap

$\rho_L := .011340 \cdot \frac{kg}{cm^3}$ Density of lead

$E_L := 2560ksi$ Modulus of lead

$\rho_s := .001220 \frac{kg}{cm^3}$ Density of scintillator

$E_s := 460ksi$ Modulus of Scintillator

$\mu := 0.1$ Coefficient of Friction between layers

$D_{rod} := 2.5mm$ Diameter of rods

$Fy := 18000psi$ Yield Strength of brass rods

$E_{brass} := 15000ksi$ Modulus of brass

$E_{steel} := 30000ksi$ Modulus of steel

2.0 Calculate Properties of Calorimeter

$Length := n_L \cdot t_L + n_s \cdot t_s = 388.00 \cdot mm$

$Length = 15.28 \cdot in$

$Area := 100cm^2$

$Weight := n_L \cdot g \cdot \rho_L \cdot Area \cdot t_L + n_s \cdot g \cdot \rho_s \cdot Area \cdot t_s$

$Weight = 32.1 \cdot lbf$

$Weight = 142.7\,N$

$q := \frac{Weight}{Length}$

$q = 2.10 \cdot \frac{lbf}{in}$

$A_{rod} := \frac{\pi \cdot D_{rod}^2}{4}$

$A_{rod} = 0.01 \cdot in^2$

3.0 Pre-Loading

Assume a pre-load is applied to the stack and then four threaded rods are snugged to the stack and then the pre-load is released.

$F_{preload} := 500kg \cdot g = 1102.31 \cdot lbf$

$$k_{BrassRod} := \frac{6A_{rod} \cdot E_{brass}}{Length} = 44827.75 \cdot \frac{lbf}{in}$$

$$k_{SteelRod} := \frac{6A_{rod} \cdot E_{steel}}{Length} = 89655.51 \cdot \frac{lbf}{in}$$

$$k_{stack} := \left(\frac{n_s \cdot t_s}{Area \cdot E_s} + \frac{n_L \cdot t_L}{Area \cdot E_L} \right)^{-1} = 587175.52 \cdot \frac{lbf}{in}$$

$$\Delta_{stack1} := \frac{F_{preload}}{k_{stack}} = 0.001877 \cdot in$$

$$\Delta_{rod1} := \frac{\Delta_{stack1} \cdot k_{stack}}{k_{BrassRod} + k_{stack}} = 0.00174 \cdot in$$

$F_{rod1} := \Delta_{rod1} \cdot k_{BrassRod} = 78.19 \cdot lbf$ Preload in rods due to initial applied load on stack

$N_{req} := \frac{Weight}{\mu} = 320.77 \cdot lbf$ Required normal force to carry the load in friction

Use a preload on the rods that is twice the required value for safety factor

$N_{preload} := 2 \cdot N_{req} = 641.55 \cdot lbf$

$$\Delta_{rodN} := \frac{N_{preload}}{k_{BrassRod}} = 0.014 \cdot in$$

$$\sigma_{rod} := \frac{N_{preload}}{6 \cdot A_{rod}} = 14053.15 \cdot psi$$

4.0 Calculate the increase in rod loading due to being cantilevered.

$$F_{cantilever} := \frac{q \cdot Length^2}{a2 + 2a1 \cdot \left(\frac{a1}{a2}\right)} = 73.73 \cdot lbf$$

$$F_{rod} := \frac{N_{preload}}{6} + F_{cantilever} = 180.65 \cdot lbf$$

$$\Delta_{rodN} := \frac{F_{rod}}{k_{BrassRod}} = 0.004 \cdot in$$

$$\sigma_{rod} := \frac{F_{rod}}{6 \cdot A_{rod}} = 3957.21 \cdot psi$$

$$\sigma_{scintillator} := \frac{F_{rod}}{Area} = 11.65 \cdot psi$$

Tensile stress in rods

$$\tau_{rod} := \frac{F_{rod}}{\pi \cdot D_{rod} \cdot \frac{3}{32} in} = 6231.82 \cdot psi$$

Shear stress in threads

Brass tensile yield strength of 18000psi and the shear yield strength of the threads is 9000psi so both stresses are ok