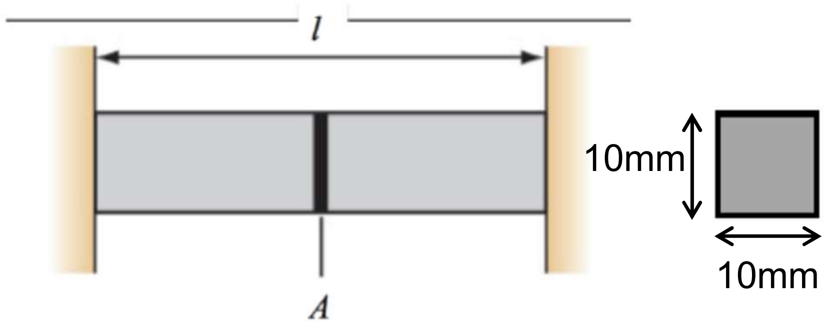
Worked example 1

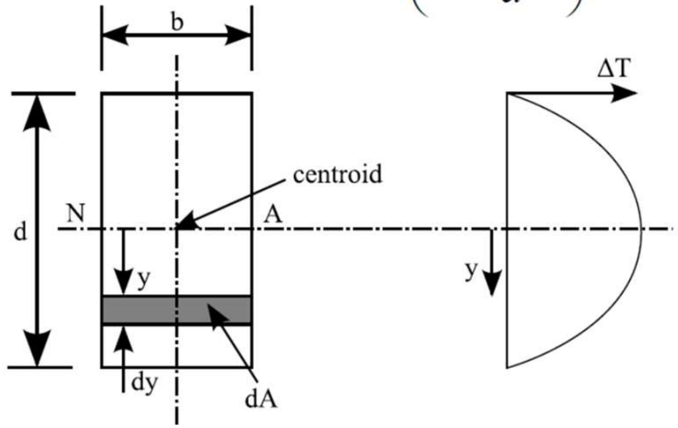
The aluminium bar shown is increased in temperature from an initial value of 20°C to 40°C. Calculate the stress in the bar. Assume $\alpha = 23 \times 10^{-6}$ °C^{-1} and E = 70 GPa.



Worked example 2

A rectangular beam, of width *b* and depth *d*, has a temperature variation shown in the figure. There is no restraint or applied loading, so *P* = *M* = 0. Obtain the stress distribution.

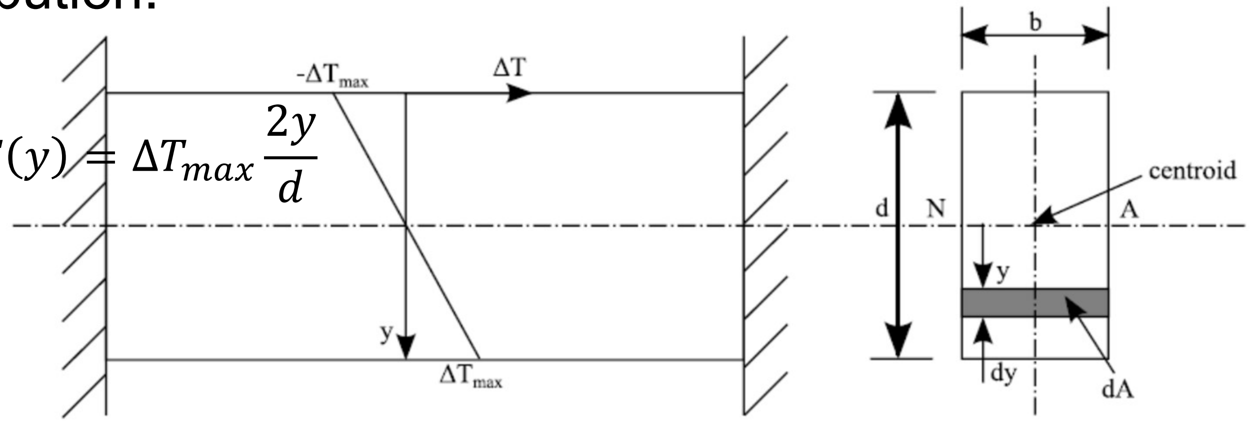
$$\Delta T(y) = \Delta T_{max}\left(1 - \frac{4y^2}{d^2}\right)$$



Worked example 3

A rectangular beam, of width b and depth d, has a temperature variation given by equation shown in the figure, and is constrained so that $\bar{\varepsilon}$ = 0 and 1/R = 0. Determine the reaction forces and the stress distribution.

$$\Delta T(y) = \Delta T_{max} \frac{2y}{d}$$



Exercise question 1

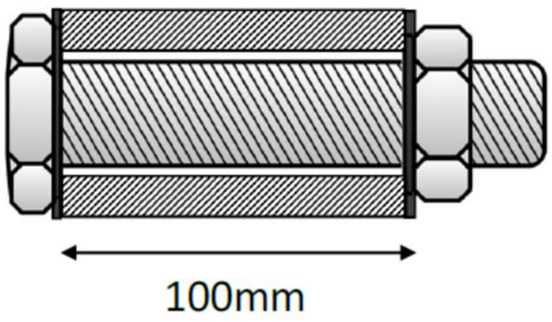
An unrestrained steel bar of length 80 mm is heated from 20 °C to 50 °C, determine the change in length of the bar. Assume $\alpha = 11 \times 10^{-6}$ °C^{-1} for steel.

Exercise question 2

If the bar in Q1 has a Young's modulus of 200 GPa and is restrained from expanding axially, determine the stress in the bar.

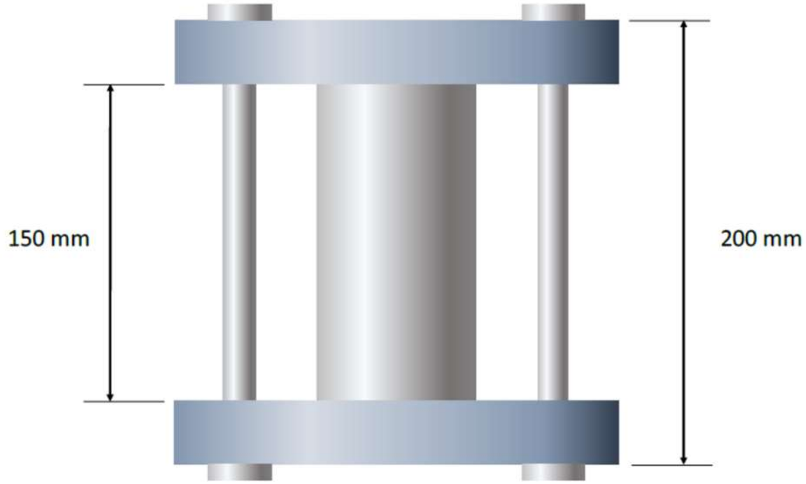
Exercise question 3

The bolt and sleeve assembly shown in Figure Q3 is initially tightened so that there is no pre-stress at a temperature of 20 °C. The temperature of the assembly is increased to 70 °C. Determine the total extension of the assembly and the stress in the sleeve and the bolt if the bolt is made of steel with a cross-sectional area of 80 mm2 and the sleeve of aluminium with a cross-sectional area of 235 mm2. Assume $\alpha = 11 \times 10^{-6}$ °C^{-1} and E = 200 GPa for steel and $\alpha = 23 \times 10^{-6}$ °C^{-1} and E = 70 GPa for aluminium.



Exercise question 4

The 50-mm-diameter central cylinder shown in Figure Q4 is made from aluminium (α = 23 × 10^{-6} °C^{-1} and E = 70 GPa) and is placed in the clamp when the temperature is T_1 = 20° C. If the two steel (α = 11 × 10^{-6} °C^{-1} and E = 200GPa) bolts of the clamp each have a diameter of 10 mm, and hold the cylinder snug with negligible force against the rigid jaws at T_1, determine the stress in the cylinder when the temperature rises to T_2 = 100° C.



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Exercise question 5

An unrestrained rectangular section aluminium beam with the cross-sectional dimensions shown in Figure Q5, has a temperature profile given by the equation shown. Plot the stress distribution and determine the maximum tensile stress in the bar. For aluminium, α = 23 × 10^{-6} °C^{-1} and E = 70 GPa.

$$\Delta T = 50\left(1 - \frac{4y^2}{40^2}\right)$$