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. α = 11 × 10^{-6} °C^{-1} for steel.
   [Ans.: 0.0264 mm]

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.
   [Ans.: -66 MPa]

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 85 mm^2 and the sleeve of aluminium with a cross-sectional area of 235 mm^2. α = 11 × 10^{-6} °C^{-1} and E = 200 GPa for steel and α = 23 × 10^{-6} °C^{-1} and E = 70 GPa for aluminium.
   [Ans.: extension: 0.084 mm; bolt stress: 59 MPa; sleeve stress: -21 MPa]

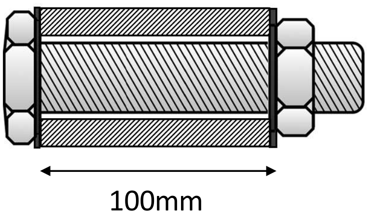

Figure Q3

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 = 200 GPa) 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.
   [Ans.: -6.83 MPa]

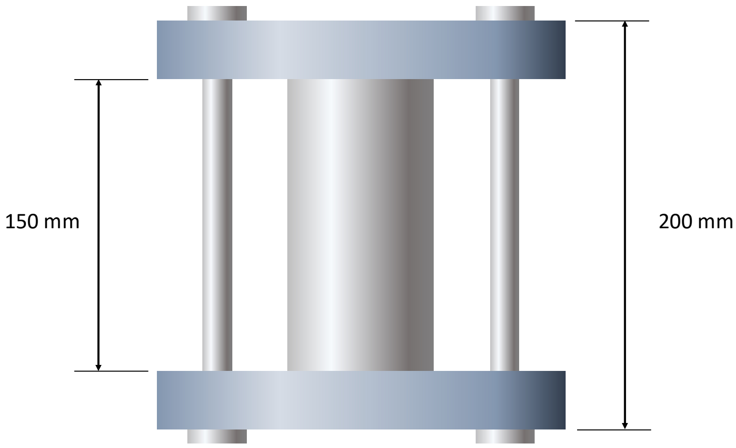

Figure Q4

5. An unrestrained rectangular section aluminium beam with the cross-sectional dimensions shown in Figure Q5, has a temperature profile given by:

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

   Plot the stress distribution and determine the maximum tensile stress in the bar. For aluminium, α = 23x 10^{-6} °C^{-1} and E = 70 x 10^9 GPa.
   [Ans.: 53.7 MPa]

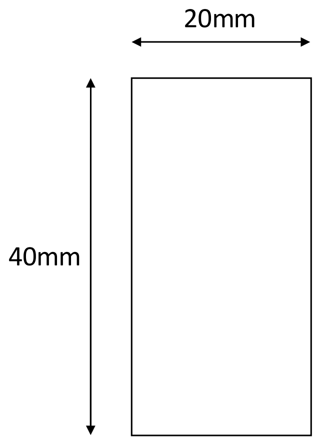

Figure Q5