

$$T_1 = 10^\circ\text{C}$$

$$T_2 = 54^\circ\text{C}$$

The Joint filler is assumed to be compressed up to 50% of its thickness

$$\delta' = \frac{\delta}{2} = \frac{2.5}{2} = 1.25 \text{ cm}$$

$$\delta' = L_e \alpha (T_2 - T_1)$$

$$\Rightarrow 1.25 \times 10^{-2} = L_e \times 10 \times 10^{-6} \times (54 - 10)$$

$$\Rightarrow L_e = \frac{1.25 \times 10^{-2}}{10 \times 10^{-6} \times (54 - 10)}$$

$$= 28.40 \text{ m}$$