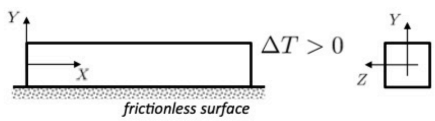
Quiz 3 - Solution

Q1 Conceptual question 7.3
Q2.1 Conceptual question 7.4, Part i)
Q2.2 Conceptual question 7.4, Part ii)
Q3.1 Conceptual question 7.5, First part
Q3.2 Conceptual question 7.5, Second part

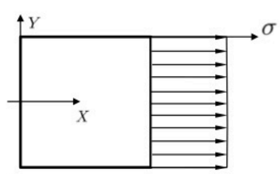
Conceptual question 7.3

For each loading configuration shown below, indicate the correct stress distribution over a cross section perpendicular to the x-axis.

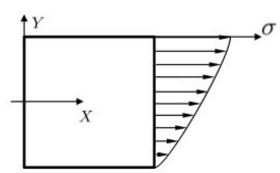
(c) A prismatic bar resting on frictionless surface is subjected to a positive change in temperature ΔT.

(c) 

Answer: ________



(1)

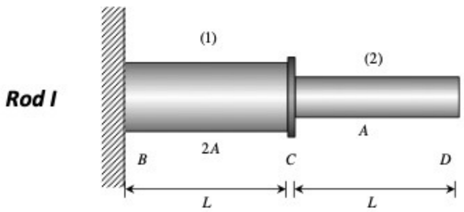


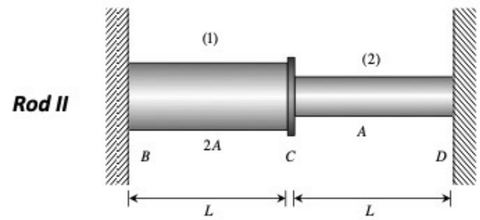
(2)

(3) Stress free (all stress components are zero)

Since the bar is unconstrained against expansion, the bar experiences strain due to temperature change, but no stress.

Conceptual question 7.4





i) Rod I shown above is made up of a material with a Young's modulus of E and thermal expansion coefficient α. The cross-sectional areas of elements (1) and (2) are given by 2A and A, respectively. Both elements are heated in such a way that each has a temperature increase of ΔT. Let σ_1 and σ_2 represent the stress in elements (1) and (2), respectively. Circle the correct description below of these two stresses:

a. $|\sigma_1| > |\sigma_2|$

b. $|\sigma_1| = |\sigma_2|$

c. $|\sigma_1| < |\sigma_2|$

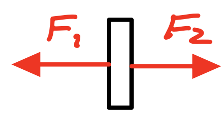
Since rod is not constrained against thermal expansion, there is no stress $\Rightarrow \sigma_1 = \sigma_2 = 0$

ii) Rod II is exactly the same as Rod I, except its right end is attached to a rigid wall. Again, both elements are heated to the same temperature increase ΔT. Circle the correct description below of the stresses in the two elements:

a. $|\sigma_1| > |\sigma_2|$

b. $|\sigma_1| = |\sigma_2|$

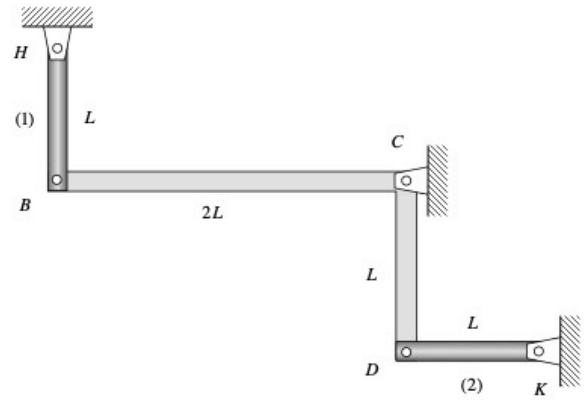
c. $|\sigma_1| < |\sigma_2|$



$$\Sigma F = F_2 - F_1 = 0 \Rightarrow F_1 = F_2$$

$$\therefore \left.\begin{array}{l} \sigma_1 = \dfrac{F_1}{2A} \\ \sigma_2 = \dfrac{F_2}{A} \end{array}\right\} \Rightarrow \sigma_2 > \sigma_1$$

Conceptual question 7.5



Identical elements (1) and (2) (each having a Young's modulus E, coefficient of thermal expansion α and cross-sectional area A) are connected between ends B and D, respectively, of a rigid, L-shaped bar. The temperature of (1) is *increased* by an amount of $\Delta T > 0$, with the temperature of element (2) being held constant.

Consider the *load* (force) carried by element (1):

a) The load in (1) is *compressive*.

b) The load in (1) is *zero*.

c) The load in (1) is *tensile*.

Since $\Delta T_1 > 0$ and $\Delta T_2 = 0 \Rightarrow$ element (1) will expand $\Rightarrow$ (1) will push against BCK $\Rightarrow$ BCK pushes back against (1) $\Rightarrow$ compressive load.

Consider the *strain* in element (1):

a) The strain in (1) is *compressive*.

b) The strain in (1) is *zero*.

c) The strain in (1) is *tensile*.

Since $\Delta T_1 > 0$ and $\Delta T_2 = 0 \Rightarrow$ element (1) will expand $\Rightarrow$ $e_1 > 0 \Rightarrow$ tensile strain