

Thermal Stresses

19.24 We want to show that Equation 19.8 is valid beginning with Equation 19.3. Upon examination of Equation 19.3b,

$$\frac{\Delta l}{l_0} = \alpha_l \Delta T$$

it may be noted that the term on the left-hand side is the same expression as that for the definition of engineering strain (Equation 6.2); that is

$$\varepsilon = \frac{\Delta l}{l_0}$$

Furthermore, elastic stress and strain are related through Hooke's law, Equation 6.5:

$$\sigma = E\varepsilon$$

Making appropriate substitutions and algebraic manipulations gives

$$\frac{\Delta l}{l_0} = \varepsilon = \frac{\sigma}{E} = \alpha_l \Delta T$$

Or, solving for σ

$$\sigma = E\alpha_l \Delta T$$

which is the form of Equation 19.8.