88. We take absolute values of Eq. 19-9 and Eq. 13-25:

$$|\Delta L| = L\alpha|\Delta T| \qquad \text{and} \qquad \left|\frac{F}{A}\right| = E\left|\frac{\Delta L}{L}\right| \ .$$

The ultimate strength for steel is $(F/A)_{\text{rupture}} = S_u = 400 \times 10^6\,\text{N/m}^2$ from Table 13-1. Combining the above equations (eliminating the ratio $\Delta L/L$), we find the rod will rupture if the temperature change exceeds

$$|\Delta T| = \frac{S_u}{E\alpha} = \frac{400 \times 10^6\,\text{N/m}^2}{\left(200 \times 10^9\,\text{N/m}^2\right)(11 \times 10^{-6}/\text{C}^\circ)} = 182^\circ\text{C} \ .$$

Since we are dealing with a temperature decrease, then, the temperature at which the rod will rupture is $T = 25.0^\circ\text{C} - 182^\circ\text{C} = -157^\circ\text{C}$.