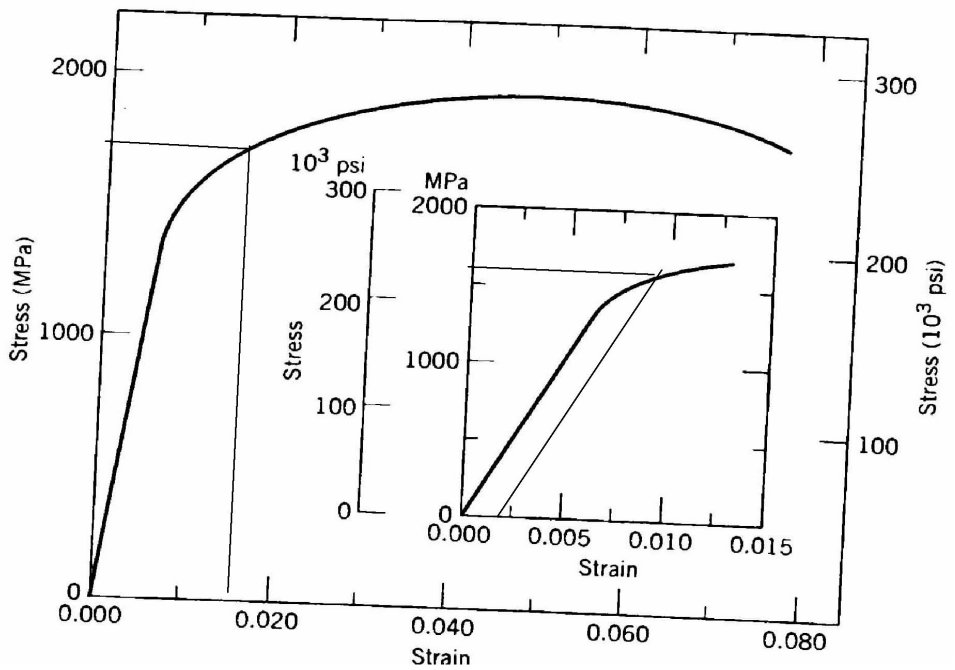
p6-47



Equations

Problem 6-47

We have a steel alloy with the stress strain behavior given in the figure. It has cross section dimensions:

$$w = 19.2 \ [\text{mm}] \tag{1}$$

$$t = 3.2 \ [\text{mm}] \tag{2}$$

The original cross sectional area is

$$A_0 = w \cdot t \tag{3}$$

The specimen is subjected to a tensile force of...

$$F = 110000 \ [\text{N}] \tag{4}$$

(a) determine the elastic and plastic strain values

Calculate the stress

$$\sigma = F/A_0 \tag{5}$$

This value is above yield, which from the inset looks to be 1600 MPa. So we expect both elastic and plastic behavior

See from the diagram that the total strain is about...

$$\epsilon = 0.018 \tag{6}$$

To get the elastic strain we need E. Look it up in the back of the text.

$$E = 207000 \tag{7}$$

Now we can calculate the elastic strain

$$\epsilon_{el} = \sigma / E \tag{8}$$

The plastic strain is the total minus the elastic

$$\epsilon_{pl} = \epsilon - \epsilon_{el} \tag{9}$$

(b) The original length is 610 mm. Find the final length after the load is released

$$L_0 = 610 \tag{10}$$

$$\Delta L = \epsilon_{pl} \cdot L_0 \tag{11}$$

$$L_{final} = L_0 + \Delta L \tag{12}$$

(c)

$$F_c = 7500 \cdot \left| 4.44822 \ \frac{N}{lbf} \right| \tag{13}$$

Get the stress at this new load

$$\sigma_c = F_c / A_0 \tag{14}$$

It's below yield, so all of the energy is elastic

$$\textit{Energy}_{density} = 1/2 \cdot \frac{\sigma_c^2}{E} \tag{15}$$

$$\textit{Volume} = L_0 \cdot A_0 \tag{16}$$

$$\textit{Energy} = \textit{Energy}_{density} \cdot \textit{Volume} \cdot \left| 0.001 \ \frac{J}{N\text{-}mm} \right| \tag{17}$$

(d)

Same as above. All the elastic energy is recoverable.

Solution

$A_0 = 61.44$

$E = 207000$

$\mathit{Energy}_{density} = 0.7122$

$\boxed{\epsilon_{el} = 0.0086}$

$F = 110000$

$L_0 = 610$

$\sigma = 1790$

$t = 3.2$

$w = 19.2$

$\Delta L = 5.704$

$\boxed{\mathit{Energy} = 26.7\,[\mathrm{J}]}$

$\epsilon = 0.018$

$\boxed{\epsilon_{pl} = 0.0094}$

$F_c = 33362$

$\boxed{L_{final} = 615.7\,[\mathrm{mm}]}$

$\sigma_c = 543$

$\mathit{Volume} = 37478$