Aluminum Rod Tension and Recovery

(a) A 10-mm-diameter rod of 3003-H14 aluminum alloy is subjected to a 6-kN tensile load. Calculate the resulting rod diameter.

(b) Calculate the diameter if this rod is subjected to a 6-kN compressive load.

Note:

(1) 1 kN = 1 x 10^3 N; 1 Pa = 1 N/m^2; 1 MPa = 1 x 10^6 Pa; 1 GPa = 1 x 10^9 Pa

(2) The following information is provided:

$E = \frac{\sigma}{\varepsilon}$; $\sigma = \frac{P}{A_o}$; Elastic Recovery $\Delta\varepsilon = \frac{\sigma}{E}$

0.2% (=0.002) offset strain is used to determine S_y.

Poisson's Ratio $\nu = -\frac{\varepsilon_x}{\varepsilon_z}$ when load is applied in the z-direction

$\varepsilon = \frac{\Delta l}{l_o}$ or $\varepsilon = \frac{\Delta d}{d_o}$

Grading criterion:
Right answer with work shown: 10 pts

(a) $\sigma = \frac{P}{A_o} = \frac{6 \times 10^3 N}{\pi (\frac{10}{2} \times 10^{-3} m)^2} = 76.4 \times 10^6 \frac{N}{m^2} = 76.4\ MPa$

$\epsilon = \frac{\sigma}{E} = \frac{76.4\ MPa}{70 \times 10^3 MPa} = 1.09 \times 10^{-3}$

$\epsilon_{diameter} = -\nu \epsilon_z = -(0.33)(1.09 \times 10^{-3}) = -3.60 \times 10^{-4}$

$\epsilon_{diameter} = \frac{d_f - d_o}{d_o} \Rightarrow d_f = d_o(\epsilon_{diameter} + 1) = 10\ mm(-3.60 \times 10^{-4} + 1) = 9.9964\ mm$

(b) $\epsilon_{diameter} = +3.60 \times 10^{-4} \Rightarrow d_f = d_o(\epsilon_{diameter} + 1) = 10\ mm(+3.60 \times 10^{-4} + 1) = 10.0036\ mm$