ME 354 Mechanics of Materials Laboratory

In-class group project 3

Date _____

Group members _____

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1) For the initial portion of a tensile test of a 1100-O aluminum, a plot is shown below of load (P) vs. change in length of the gage section (ΔL). Before the test, the gage length, L_o, was 50 mm and the diameter was d_o=9.07 mm. At fracture, the load was P_f=4000 N and the gage length, L_f, was 58.5 mm. Determine the following:

a) Approximate proportional limit stress, σ_P, if P_P=4500 N and $\sigma_p = \frac{P_p}{A_o} = \frac{P_p}{(\pi d_0^2/4)}$

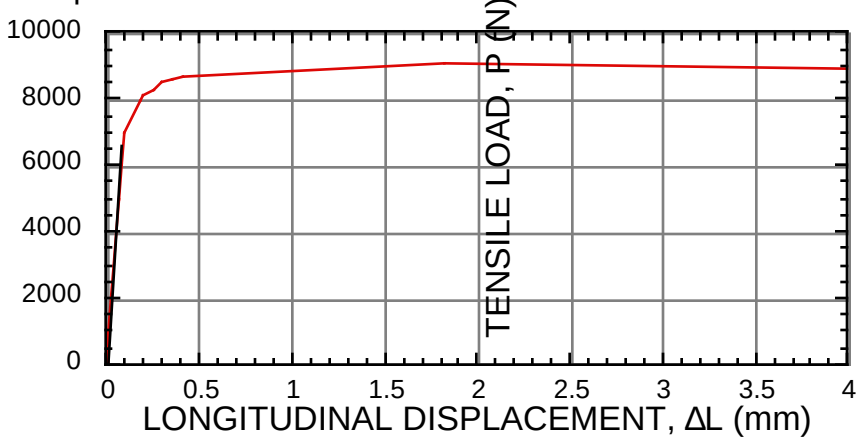
a) Elastic modulus ($E = \frac{d\sigma}{d\varepsilon} \approx \frac{\sigma_p - 0}{\varepsilon_p - 0}$ where $\sigma_p = \frac{P_p}{A_o}$ and $\varepsilon_p = \frac{\Delta L_P}{L_o}$),

c) Ultimate tensile strength ($S_{uts} = \frac{P_{max}}{A_o} = \frac{P_{max}}{(\pi d_0^2/4)}$) if P_{max}=9120 N,

d) %elongation ($\%el = 100\varepsilon_f$),

e) modulus of toughness (estimate $U_T \approx \frac{\sigma_P + S_{uts}}{2}\varepsilon_f$)

f) Is the material ductile or brittle? why? (Note: ductility is often indicated by nonlinear stress-strain response in addition to a rule-of-thumb that states that a material is ductile if %EL ≥ 5)



2) The coordiante stress state at particular time for a component fabricated from this material is shown below. Determine the following:

a) Draw a 3-D incremental element (with coordinate axes) with arrows showing the coordinate stress state.
b) 3-D Mohr's circle.
c) All three principal normal stresses.
d) Maximum shear stress.
e) Apply the appropriate failure criterion (for ductile or brittle materials) to determine a factor of safety. Note for this exercise assume $\sigma_P \approx S_{yp}$.
f) For this state of stress and material, is this design safe? Why or why not?

$$\begin{bmatrix} \sigma_x = 50 & \tau_{xy} = 10 & \tau_{xz} = 0 \\ \tau_{yx} = 10 & \sigma_y = 15 & \tau_{yz} = 0 \\ \tau_{zx} = 0 & \tau_{zy} = 0 & \sigma_z = -5 \end{bmatrix} MPa$$