NPRE 332
Fall 2003

Lab 3: Tensile Stress-Strain Relations

Analysis of Results

1. On a single chart, plot engineering stress-strain curves for: 1018 steel (as received and annealed), 2024 aluminum, 304 stainless steel, and 1045 steel (from lab 1). Plot PMMA on a separate plot. Be sure the curves are distinct and labeled.

2. From the above plots, compute the following; elastic modulus, appropriate measure of yield strength, ultimate tensile strength, percent elongation, and modulus of resilience. Prepare a table with each of these values and include a column for the Rockwell hardness (be sure to correct properly).

3. Plot elastic modulus, yield strength, ultimate tensile strength, percent elongation, and modulus of resilience versus hardness (Rockwell B scale) on separate plots (yield strength and UTS can go on one plot if desired) for all metals tested in labs 1 and 2 (exclude brass). Which property (or properties) correlate to hardness?

4. Compute the true-stress/true-strain curve for the 304 stainless steel, (using the engineering equations given in the lab manual to estimate true stress and true strain until necking and the failure point). Plot this on a graph with the engineering stress-strain curve for the same material.

5. Using log-log paper or graphics packages (Excel or Kaleidagraph are simple), calculate the values of K and *n* that best fit your true-stress/true-plastic-strain data with a power-law model, $\sigma_t = K\left(\varepsilon_{tp}\right)^n$.
6. Plot the stress-strain curve from the brass demo. From this plot, determine the elastic modulus and the yield strength for the initial material, and for the first two reloadings. Present these data in tabular form, showing modulus and yield strength as a function of plastic strain at the beginning of the cycle.

Points for discussion

1. Comment on the relative values of the measured properties. For example, which properties of the steel are affected by annealing? Which materials are strongest? Hardest? Stiffest? Most ductile? Absorb most elastic energy?

2. Discuss the issues with specifying "steel" or "aluminum" when designing structures.

3. Compare the true and engineering stress-strain curves for the 304 stainless steel. Is the absolute value of the true stress larger or smaller than that of engineering stress? Why?

4. Comment on the accuracy your true stress-strain curve fit, and compare your values of K and *n* to published values. (Be sure to cite your source.)

5. Discuss changes in elastic modulus, yield stress, and ductility as the brass specimen is strained beyond the elastic limit. Be quantitative. How does the experiment match with what you expect? What might cause any deviations from your theory?