MAE 212: Spring 1999

HW 5

Due Tuesday, March 27

1. A cable is made of two parallel strands of different materials, A and B, having cross-sections as follows:
   Material A: K = 100,000 psi; n=0.5; $A_o = 0.2$ in^2.
   Material B: K = 50,000 psi; n=0.5; $A_o = 0.1$ in^2.

   - Calculate the maximum tensile force that this cable can withstand prior to necking.
   - How would you arrive at an answer if the n values of the two strands were different?

2. A circle of 0.250 in diameter was printed on a thin sheet of metal prior to a complex stamping operation. After the stamping is completed, the circle has changed into an ellipse whose major and minor axes are 0.325 and 0.275 in, respectively. Determine the effective strain, $\bar{\epsilon}$, in the region of the ellipse (Use an expression for $\bar{\epsilon}$ similar to that for $d\bar{\epsilon}$ given in class but in terms of total strains).

3. A tensile test specimen is made of a material represented by $\sigma = K(\epsilon + n)^n$. (a) Determine the true strain at which necking will begin (b) Show that it is possible for an engineering material to exhibit this behavior.

4. Consider a plane strain state ($\epsilon_2 = 0$).

   - Calculate an expression for the equivalent stress $\bar{\sigma}$ in terms of σ_1 and σ_3 alone.
   - Calculate an expression for the equivalent plastic strain $d\bar{\epsilon}$ in terms of $d\epsilon_1$ alone.
   - Consider a rigid plastic material (constant yield stress Y, i.e. no hardening). For this material, calculate the plastic work increment dw in terms of Y and $d\epsilon_1$.

5. Repeat problem 4 for an axisymmetric stress/strain state (Note that in principle the solution of Problems 4 and 5 was given in Lecture 10!).

6. A thin-walled tube, with closed ends, is made whose tensile yield strength is 40,000 psi. The tube has an outer diameter of 3-in and a wall thickness of 0.025-in. The tube is pressurized internally. What pressure, P, would cause yielding according to : (a) Tresca (b) Von-Mises?

7. A cube of metal having a constant yield stress Y of 300 MPa (such behavior is called *rigid-plastic* since Y would not change after initial yielding) experiences a stress state of σ_1, $\sigma_2 = 0.3\,\sigma_1$, and $\sigma_3 = -0.5\,\sigma_1$. If the stresses are gradually increased in these

constant ratios, find σ_1 at yielding: (a) using the von-Mises criterion and (b) using the Tresca criterion.

8. Consider the following stress state (in a matrix form):

$$[\sigma] = \begin{bmatrix} 15 & 3 & 0 \\ 3 & 10 & 0 \\ 0 & 0 & 5 \end{bmatrix} \tag{1}$$

- Find the hydrostatic stress σ_m
- Find the deviatoric stress components
- What is the sum of the deviatoric normal stress components?
- Find the ration $\frac{d\epsilon_1}{d\epsilon_3}$