

Problem Set I

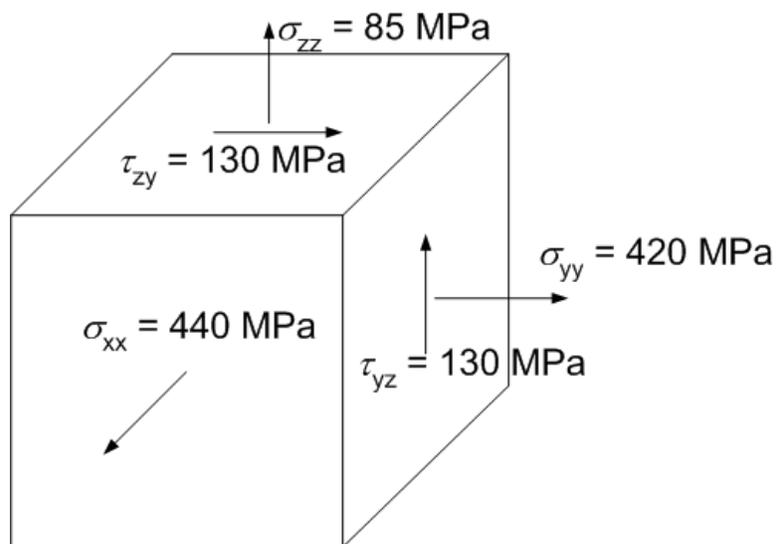
Due 09/19/06

1. A tensile test on 1020 steel gives the following results:

Load (kN)	Diameter (mm)	Length (mm)
0	12.8	50.800
22.2	–	50.848
28.5	–	–(yielding begins)
50.2	12.2	56.1
51.2 (Max.)	10.4	67.3
43.6	–	69.8 (fracture)

- (a) Calculate the elastic modulus.
- (b) Calculate the maximum nominal strain.
- (c) Calculate the tensile strength of this steel.

2. Calculate the maximum normal stress and the maximum shear stress in the cube shown below.



3. This problem illustrates some important stress tensor concepts and some calculation methods for treating a stress tensor.

Consider three stress tensors  $\sigma_a$ ,  $\sigma_b$ , and  $\sigma_c$  defined as follows:

$$\sigma_a = \begin{bmatrix} 55 & -5 & 30 \\ -5 & 55 & 30 \\ 30 & 30 & 20 \end{bmatrix};$$

$$\sigma_b = \begin{bmatrix} -10 & 0 & 0 \\ 0 & -10 & 0 \\ 0 & 0 & -10 \end{bmatrix};$$

$$\sigma_c = \sigma_a + \sigma_b$$

where the stresses are given in MPa units.

- What are the three principal stresses that characterize each of these stress tensors ?
- Draw a 3-D Mohr's circle to represent the three stress states.
- Also place points on your Mohr's circles that give the stresses on planes normal to each of the original coordinate axes (x, y, z).
- What are the unit vectors (direction cosines) that define principal directions for the three stress tensors?
- What is the Tresca Stress for each stress tensor? What is the von Mises Stress for each stress tensor?