

ESc 22 MECHANICS II: MATERIAL SCIENCE

LAB 5: COMPRESSIVE TESTING OF WOOD, BONE, AND FIBERGLASS

INTRODUCTION. We will investigate mechanical properties derived from compressive tests of wood, bone, and fiberglass. The poplar wood specimens will be tested parallel (longitudinally) and perpendicular (transversely) to their grain. The bone specimens are assembled from dense (cortical) and porous (trabecular) bone found in the shafts and inside the ends of long bones. These specimens are intended to be allografts (grafts from one person into another) that assist cervical spine surgical procedures. The fiberglass specimens are comprised of glass fibers in an epoxy matrix. The results of this lab will be reported in a laboratory report due as stated by your Instructor.

FOR YOUR LAB NOTEBOOK

1. Split up into three groups. Each group should select a unique specimen. Your Instructor will conduct all procedures on the allograft.
2. Sketch each specimen in your lab notebook. For the wood specimens, measure the height, width, and depth, and note the grain orientation. For the fiberglass specimen, measure the height and the diameter. The allograft geometry is relatively complicated; its height and "cross sectional" area will be provided to you. Get sketches and/or dimensions from the other groups as required.
3. Take your specimen to the test machine. Now place the sample into the compression testing machine according to the instructions of your Instructor. As for the tensile tests, the computer will record the load and crosshead position, from which you will convert to stress and strain.
4. Observe each sample after testing and describe them in your lab notebook.

FOR YOUR LAB REPORT

Refer to the guidelines that were provided for the tensile testing lab.

Results. Include at least the following:

- Plot the stress-strain curve for each specimen using the collected data.
- Determine the elastic modulus E (and the yield strength σ_Y (at a strain offset of 0.2%) and the ultimate strength σ_U if available) for each specimen. Make a table summarizing these results.
- Determine the resilience of each specimen, and describe your calculations.

Discussion. Include at least the following:

- Predict the elastic modulus of the fiberglass-polyester composite given the following rule of mixtures

$$E = V_f E_f + (1 - V_f) E_m$$

where the fiber modulus $E_f = 69$ GPa, the matrix modulus $E_m = 3.4$ GPa, and the fiber volume fraction $V_f = 40\%$. Compare this prediction to the experimentally determined value.

- For the wood specimens, discuss the differences between longitudinal (with the grain) and transverse (perpendicular to the grain). How do these differences reflect the function of this tissue?