

1.103 CIVIL ENGINEERING MATERIALS LABORATORY (1-2-3)

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MIT
Spring 2004

LABORATORY ASSIGNMENT NUMBER 6

COMPRESSION TESTING AND ANISOTROPY OF WOOD

Purpose: During this laboratory you will learn about:

- (1) Measurement techniques for compression testing
- (2) Mechanical properties of Wood
- (3) Effects of directional properties on strength and stiffness
- (4) Effects of initial structure on failure mode

Reading:

Read this handout and know what will be done in the lab
Know what to expect for the strength and stiffness of WOOD

Organization:

- Meeting A 30 min. *group* overview
- Meeting B 60 min. *Subgroup* testing specimens
- Meeting C 30 min. *Individual* observation of specimens

Overview:

The compression test is the cornerstone of all materials testing facilities. It is most commonly used to measure the compressive strength of cylindrical specimens but is also used with cubic specimens. Depending on the level of sophistication in the test and measurement equipment, this test method can be used to measure elastic properties, proportional limit, Poisson's ratio, yielding stress, strength, cyclic and fatigue properties, and post peak behavior.

For this laboratory assignment, we will use the compression test to investigate the directional dependence of wood. We have cut cylindrical specimens from a wooden beam that was originally 4 in by 4 in by 8 feet long. Cylinders were machined at different angles to the vertical axis of the tree trunk. For each piece of wood, cylinders are cut every 15 degrees from 0° (aligned with the vertical axis) to 90° (perpendicular to the axis). Each subgroup will test 4 specimens at different angles.

Procedure:

Apparatus Preparation

1. Locate all the transducers and sketch the overall experimental configuration.
2. Record the calibration factors and data acquisition channel numbers.
3. Check the electronics including the input voltage, stability of the signals, and direction of the displacement output signals.
4. Set the reaction cross head to the proper position for the specimen height.
5. Measure the gauge length of the extensometer.

Specimen Preparation

1. Select four specimens from different angles. Choose specimens that are as uniform as possible. In particular, look for specimens having reasonably uniform grain alignment.
2. Measure the height and diameter of each specimen and record this on the data sheet.
3. Measure and record the mass of each specimen.
4. In the 'before' box on the data sheet, sketch the grain geometry of the specimen.

Shear Each Specimen

1. Locate specimen cylinder in load frame
2. Zero the load cell.
3. Raise the actuator until the top cap just touches the specimen.
4. Set the extensometer on the specimen with the rubber bands.
5. Zero the extensometer.
6. Check alignment.
7. Start computer with 1 second reading rate.
8. Load specimen at about 0.5mm/min to start with.
9. For at least one specimen perform an unload/reload cycle.
10. Stop test when specimen fails (load clearly decreased and deformation continues).
11. Describe and sketch failure geometry. Note any failure planes and angles.

Calculations:

Compute the applied vertical force, F_v , as:

$$F_v = (LD_t - LD_0) \times CF_{LD}$$

where LD_0 is the zero reading of the load cell.

Compute the vertical stress, σ_v , as:

$$\sigma_v = F_v / A_i$$

where A_i is the initial area.

Compute the vertical deformation, Δ_Ht , based on the actuator transducer as:

$$\Delta_Ht = (LVDT_t - LVDT_i) * CF_{LVDT}$$

where the subscript i indicates the start of specimen deformation. You must determine this value from the initial portion of the data set to eliminate the bedding and seating errors. In a perfect test this value would correspond to the reading when the applied force is zero.

Compute the axial strain from the actuator, in percent, ϵ_a , as:

$$\epsilon_a = \Delta_Ht / Ht_i \times 100$$

Compute the axial strain from the extensometer, in percent, as:

$$\epsilon_{ext} = (EXT_t - EXT_i) * Cf_{ext} * 100$$

Compute the secant modulus, E_s , as:

$$E_s = (\sigma_v - \sigma_{vi}) / \epsilon_{ext} * 100$$

where the subscript i indicates the starting stress on the specimen. It is essential that the first significant data point corresponds to a strain value of zero but the stress may have a non-zero value.

Report:

Your report should include the following:

- Plot stress-strain curve for one test specimen from each of seven angles using the strain computed from the extensometer. You only need to use the actuator strain when the deformation is beyond the range of the extensometer. You will use data from your four test specimens plus three sets of data from another group.
- Draw a line through the initial portion of the stress strain curve corresponding to the slope of the initial modulus. This is best done by plotting the initial portion of the stress-strain curve on a separate graph and drawing the initial slope by hand. Be aware that wood can have a non-linear initial stress strain curve.
- Plot the initial modulus and the secant modulus at 50% of the failure stress versus the angle of the test specimen.
- Plot the strength (peak stress) versus the angle of the test specimen.
- Plot the failure strain (strain at the peak stress) versus the angle of the test specimen. If the specimen does not have a peak stress point then use the stress at 20% strain.
- Provide a summary table including the specimen angle, density (mass/volume) of the wood, initial modulus, secant modulus, strength, failure strain, and description of failure (including angle of failure plane).
- One page of computer data/results printout
- One set of example calculations

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DATA SHEET (1 of 2)

All dimensions in _____ Group No. _____ Date _____

<u>Measurement Device</u>	<u>Vertical Force</u>	<u>Actuator. LVDT</u>	<u>Extensometer</u>
<i>Calibration. Factor</i>	_____	_____	_____
<i>DAQ Channel</i>	_____	_____	_____
<i>Input Voltage</i>	_____	_____	_____

Test Description _____ File Name _____	Before	After
Specimen Height _____, _____, _____		
Specimen Dia. _____, _____, _____, _____		
Specimen Mass _____ (gm) Zero Load _____		
Zero Extens. _____ Zero Act. LVDT _____		
Failure Angle _____ Failure Mode _____		

Test Description _____ File Name _____	Before	After
Specimen Height _____, _____, _____		
Specimen Dia. _____, _____, _____, _____		
Specimen Mass _____ (gm) Zero Load _____		
Zero Extens. _____ Zero Act. LVDT _____		
Failure Angle _____ Failure Mode _____		

Test Description _____ File Name _____	Before	After
Specimen Height _____, _____, _____		
Specimen Dia. _____, _____, _____, _____		
Specimen Mass _____ (gm) Zero Load _____		
Zero Extens. _____ Zero Act. LVDT _____		
Failure Angle _____ Failure Mode _____		

Test Description _____ File Name _____	Before	After
Specimen Height _____, _____, _____		
Specimen Dia. _____, _____, _____, _____		
Specimen Mass _____ (gm) Zero Load _____		
Zero Extens. _____ Zero Act. LVDT _____		
Failure Angle _____ Failure Mode _____		

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COMPRESSION TESTING AND ANISOTROPY OF WOOD

DATA SHEET (2 of 2)

Test Description _____ File Name _____	Before	After
Specimen Height _____, _____, _____		
Specimen Dia. _____, _____, _____, _____		
Specimen Mass _____ (gm) Zero Load _____		
Zero Extens. _____ Zero Act. LVDT _____		
Failure Angle _____ Failure Mode _____		

Test Description _____ File Name _____	Before	After
Specimen Height _____, _____, _____		
Specimen Dia. _____, _____, _____, _____		
Specimen Mass _____ (gm) Zero Load _____		
Zero Extens. _____ Zero Act. LVDT _____		
Failure Angle _____ Failure Mode _____		

Test Description _____ File Name _____	Before	After
Specimen Height _____, _____, _____		
Specimen Dia. _____, _____, _____, _____		
Specimen Mass _____ (gm) Zero Load _____		
Zero Extens. _____ Zero Act. LVDT _____		
Failure Angle _____ Failure Mode _____		

Test Description _____ File Name _____	Before	After
Specimen Height _____, _____, _____		
Specimen Dia. _____, _____, _____, _____		
Specimen Mass _____ (gm) Zero Load _____		
Zero Extens. _____ Zero Act. LVDT _____		
Failure Angle _____ Failure Mode _____		

Test Description _____ File Name _____	Before	After
Specimen Height _____, _____, _____		
Specimen Dia. _____, _____, _____, _____		
Specimen Mass _____ (gm) Zero Load _____		
Zero Extens. _____ Zero Act. LVDT _____		
Failure Angle _____ Failure Mode _____		
