



Visualizing the Effects of Wood Grain Direction on Stress Concentrations

Madeleine Graham, Eleanor Smith, Michael Wise

AE 3610 – A11 Structures

OBJECTIVES

Displacement and strain data for wood under tensile loads applied at different angles to the wood grain direction was collected to ascertain the relationship between grain direction and strain.

This information can be useful for a number of different applications:

- Wood-based satellites
- Wood-based home improvement projects

MATERIALS & METHODS

Wood sheets were cut into dog bone specimens with their grain direction at 0°, 45°, or 90°, relative to their length-wise axis. This created specimens with vertical, diagonal, and horizontal grain directions in their test section. The test section of these specimens was then painted white and speckled with black spray paint to facilitate the use of the Direct Image Correlation (DIC) system.

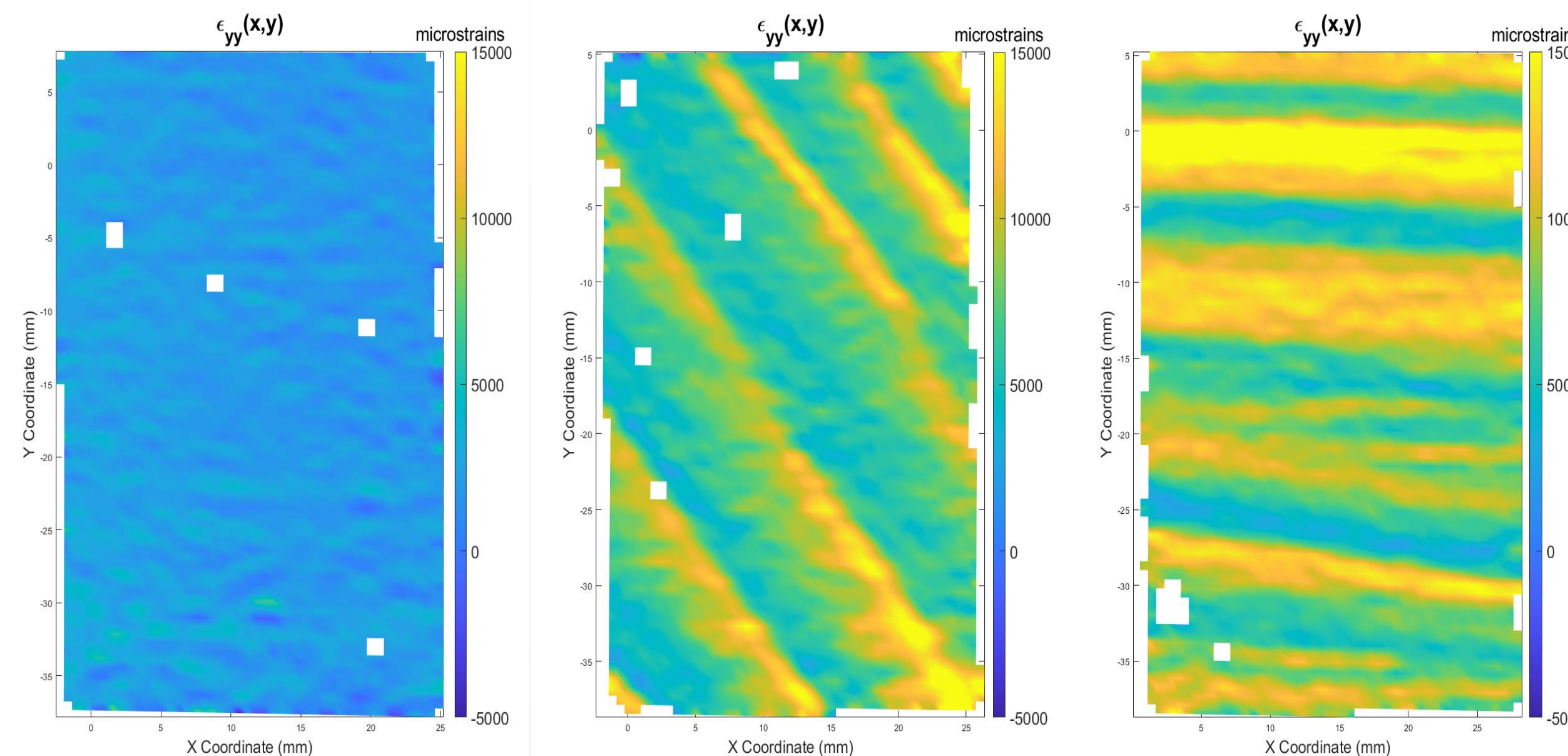
Dimensions of the manufactured specimens' test sections were taken prior to loading.

Tensile loads were applied to these specimens using an INSTRON machine. Each specimen was loaded until failure.*

Collection and synthesis of the DIC data was accomplished through the software Aramis.

*The vertical specimen did not fail before slipping out of the Instron jaws.

RESULTS



Vertical, yield load >3500N

Diagonal, yield load ≈900N

Horizontal, yield load ≈350N

TEST SPECIMENS

DATA REDUCTION

$$\epsilon_x = \frac{\partial u}{\partial x}$$

$$\epsilon_y = \frac{\partial v}{\partial x}$$

$$\sigma_i = E\epsilon_i$$

DISCUSSION

- Grain direction was readily visible in stress and strain concentration fields
- Order of magnitude increase in critical load through change in grain orientation
- Potentially significant contribution of hydration and grain regularity; further analysis using varied species would add clarity
- Vertical grain direction specimen visually similar to DIC images of Aluminum tensile tests
- Further tests necessary to ascertain the relationship between grain spacing or wood density and strain data

CONCLUSIONS

- **Grain direction matters**
- Recommended further areas of experiment include:
 - Hard wood vs. Soft wood
 - Wood hydration and yield stress
 - Ascertaining Elastic modulus change using DIC and a bending rod test

ACKNOWLEDGEMENTS

GTA David Gomez. My goodness, thank you, our good sir.