



WBC NEW PROJECT PROPOSAL

Project Title:	Identifying Adhesive Bondline Quality to Improve Cross-Laminated Timber Performance				
Expected Duration:	2 years	Start Date:	August 2024	Site:	VT
Investigator(s):	Daniel Hindman, Audrey Zink-Sharp			Submitted by:	Daniel Hindman
Related to Topic/Theme:	C. Adhesive Technology, 1. Wood-Adhesive Interaction, b. Adhesive distribution and penetration C. Adhesive Technology, 3. Performance, a. Methods for evaluating the adhesive bond				

GOALS & OBJECTIVES: Goal for this project is to determine the correlation of adhesive bondline measurements with quality-control tests of CLT materials. Objectives for year 1 are to 1) manufacture *matched* microscopy and quality control test specimens, 2) complete digital image microscopy of bondlines (measure adhesive bondline thickness, penetration, percent of gaps and microbubbles), and 3) begin testing of shear and delamination for quality control assessment. Objectives for year 2 are to 1) complete mechanical testing, 2) evaluate bondline properties where failures have occurred, 3) complete regression and correlation models and provide final WBC report and peer-reviewed research paper.

EXPERIMENTAL PLAN: This research will use a set of controlled wood specimens and a single bondline to create matched specimens for microscopic and quality-control testing. Variables examined in this study will include press pressure, use of primer, and moisture content of substrate. A set of single bond specimens with varying conditions will be produced to control pressure and time of pressing. Specimens will be examined using digital optical microscopy methods to measure the adhesive penetration, adhesive bondline thickness, and percentage of gaps or microbubbles present in the adhesive bondline. The specimens will be tested using the shear (ASTM D905) and delamination (AITC T110) procedures. The resulting test values will then be correlated to the various adhesive bondline properties. After quality-control testing, the specimens will be re-examined for adhesive bondline measurements, with special attention to areas of the bondline where shear failures or delamination occurred. This second set of images will be compared with the initial bondline images to attempt to correlate specific locations of microbubbles, gaps or changes in the bondline thickness as sources of failure.

OUTCOMES & DELIVERABLES:

TASK	DELIVERABLE	MONTH/YEAR	RESPONSIBILITY
Prepare matched test specimens and evaluate shear, delamination, and bondline microscopy	Specimens for shear, delamination, and microscopy	August 2024 – March 2025	Graduate student
Evaluate mechanical and bondline properties	Comparison and analysis of bondline properties where failure occurred	April 2025 – September 2025	Graduate student
Regression and correlation models; preparation of final reports	Correlation of locations with sources of failures; Final report & publication	October 2025 – July 2026	Graduate student and Investigators

EXPECTED PRACTICAL IMPLICATIONS / IMPACTS: **1.** A method will be provided for evaluation of adhesive bonds and quantification of impact of gaps and microbubble formation in CLT materials. **2** Information will be provided on the impact of imperfect control of manufacturing parameters on performance. **3.** Methods and results could be a) expanded to other wood composites as well as different adhesive systems, b) used to compare performance of different substrate species, substrate treatments, use of fillers or other changes to adhesive systems. **4.** Microscopic images could be used to train machine and artificial intelligence learning tools for development of evaluation systems for panel production.

BUDGET JUSTIFICATION: Funding is requested for a graduate student assistantship and tuition for 24 months to complete the laboratory and mechanical testing and to provide data analysis and statistical correlations. Microscopy and testing materials are needed for specimen preparation. Funds for travel to WBC meetings is also requested.

BUDGET (including expected duration):
Year 1 Budget Estimate:
 Student GRA and benefits: \$35,355; 12 months duration
 Tuition and Fees: \$15,680; 12 months
 Travel and Other: \$1,500; one time during year 1
 Materials/Supplies: \$1,500, 12 months **Total Yr. 1:** \$54,035