Q-12-FR: Simple cross-laminate adhesive durability test
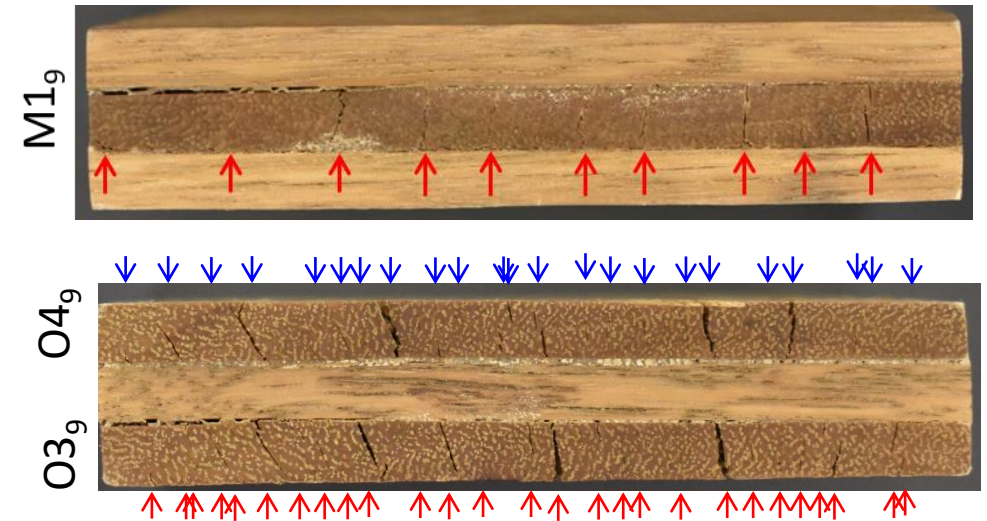
Frazier, Dillard (VT), Peresin & Gururaja (AU), Nairn (OSU)

Matched grain

Crossed grain

3-ply cross-laminated spotted gum
5 x 70 x 70 mm

Anticipated Start Date: *9/2024* | **Expected Duration:** *24 Months, MS project*

Need & Industrial Relevance

The industry needs new wood adhesion testing with a stronger foundation in mechanics, where specimen mechanics are very well understood; this gives greater insight when interpreting results.

Research Roadmap Topics

Hopper topic 2024-11:

- System Effects in Mass Timber Products

WBC research theme:

- Improved Performance and Functionality; Performance Evaluation; b, Improved test methods.

The **critical delam-crack density** varies with :

- mode-II toughness of the adhesive (different adhesives, or wood treatments),
- mode-I wood toughness (different density/porosity woods).

Provides ability to rank:

- **Adhesive durability;**
- **impact of wood density,**
- **impact of surface treatments.**

Long Term Goals

Determine how well Finite Fracture Mechanics (FFM) applies to bonded wood; use results to determine if we should work towards official ASTM certification.

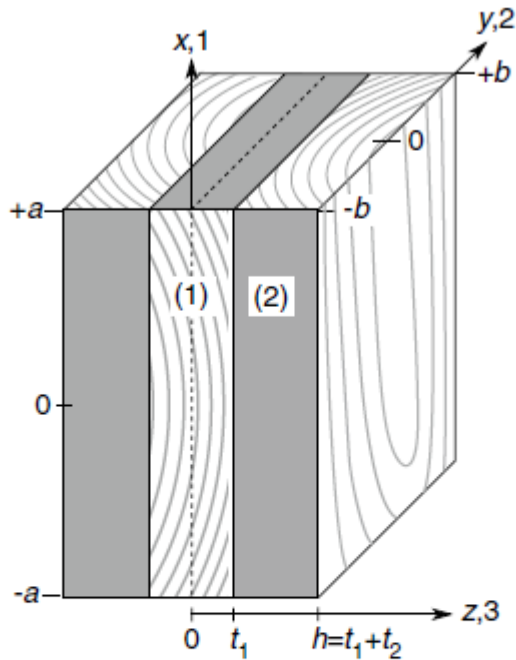x,1   y,2   +b   0   +a   -b   (1)   (2)   0   -a   z,3   0   t₁   h=t₁+t₂

Fig. 1 Unit cell for a CLT panel with orthogonal cracking in all layers. The gray planes mark the crack surfaces (one on each end of each layer) with normals perpendicular to wood grain direction in each layer. Layer 1 is core layer with thickness $2t_1$ and cracks separated by $2a$. Layers 2 are surface layers with thickness t_2 and cracks separated by $2b$. Axes (1, 2, 3) are used to refer to panel properties while (x, y, z) refer to layer properties

ORIGINAL

Predicting layer cracks in cross-laminated timber with evaluations of strategies for suppressing them

John A. Nairn[1]

4x4 inch, 3-ply cross-laminated panel; layer thickness, varied over 2 levels: 0.75 and 0.25 inches.
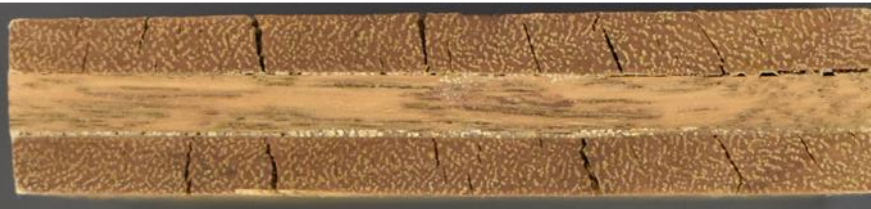
Lumber: high-grade, mature southern pine
Adhesive: Moisture-cure polyurethane

Year 1 goals:
- Machine & sort wood specimens by quality & density.
- Manufacture vacuum/pressure weathering chamber.
  - Cycle from water saturation to dry at 60C w/ vacuum
- Measure wood tensile modulus for FFM model.
- Make panels and start delamination testing.
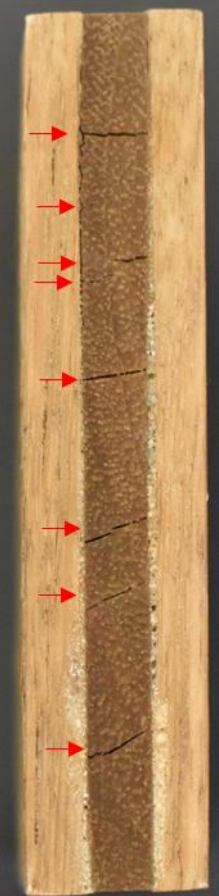
O1$_9$ O2$_9$

O2$_9$

O1$_9$

M1$_9$

M2$_9$

3-ply cross-laminated spotted gum
5 x 70 x 70 mm

- Two middle layer edges
- Four outer-layer edges
- 6 data sets from one panel

O3$_9$

O3$_9$ O4$_9$

O4$_9$

O3$_9$

Insert outcomes and deliverables using table below.
Please focus on <u>first year</u> of your project.

Expected outcome	Deliverable(s)	2024					2025						
		A	S	O	N	D	J	F	M	A	M	J	J
Wood acquisition	Sorted by grade & density												
Manufacture vacuum/pressure weathering chamber.	vacuum/pressure weathering chamber												
Measure wood tensile modulus for FFM model.	FFM model												
Start delamination testing.	Preliminary data												

This project will determine how well Finite Fracture Mechanics applies to bonded wood.

Because the specimen mechanics are so well known, we should achieve more quantitative insight on delamination durability.

BUDGET	AMOUNT
First Year Expenses	
GRA & Benefits	$41,253
Tuition & Fees	$17,500
Materials/Supplies	$7,000
Travel	$1,000
Other (specify):	Not including OSU/VT indirect
YEAR 1 TOTAL:	$66,753
Expected future request amounts: $66,800 for year 2	
	$

Thank You

Questions?