

# Full-scale Diaphragm Connection Testing of Structural CLT Panels

Kyle Sullivan, MS  
Dr. Rakesh Gupta, WSE, PI  
Dr. Thomas Miller, CE

10:50 AM, MONDAY, APRIL 27, 2015

WESTERN FORESTRY GRADUATE RESEARCH SYMPOSIUM

COLLEGE OF FORESTRY, OREGON STATE UNIVERSITY

CORVALLIS, OR

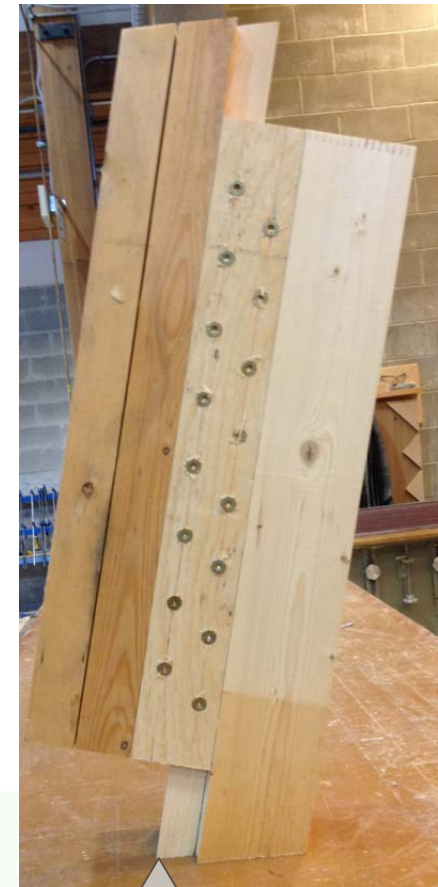
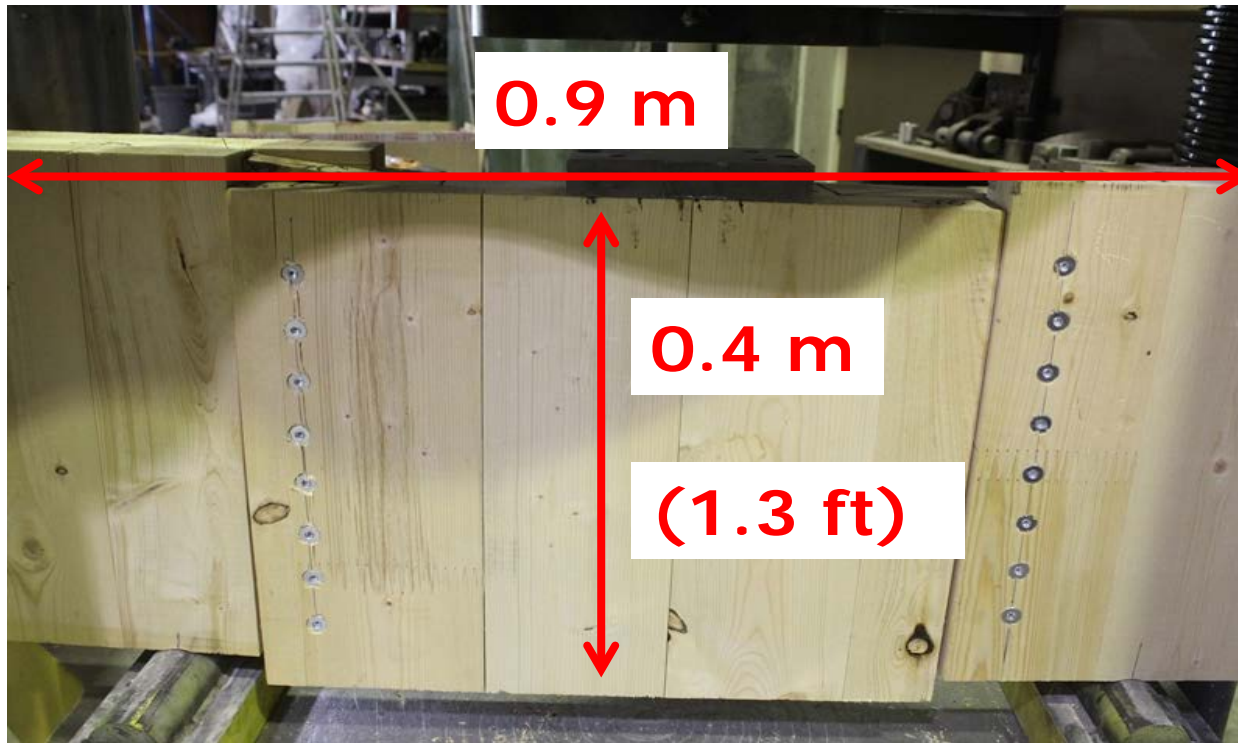
# Outline

- UBC/MyTiCon tests
  - small scale
  - panel-to-panel shear connections
- MS Thesis
  - Full-scale diaphragm tests

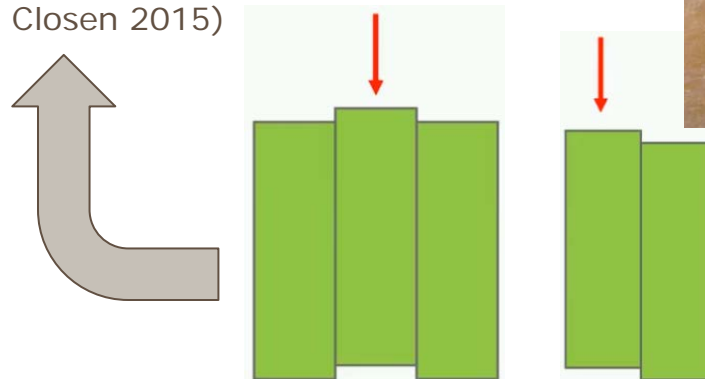


(Styxworks, LLC)

# UBC/MyTiCon Tests



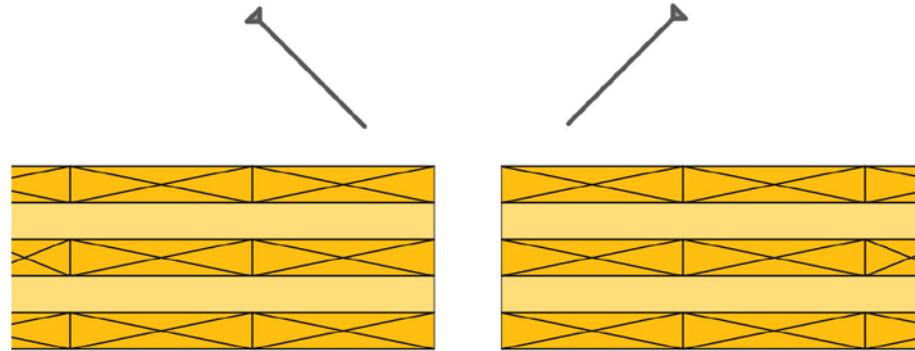
(University of British Columbia and Closten 2015)



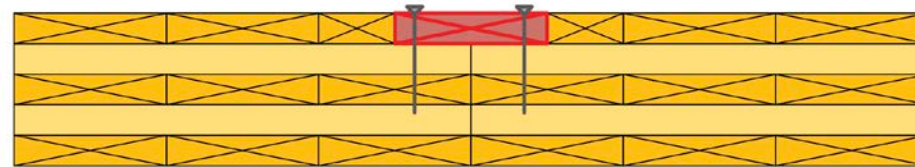
# UBC/MyTiCon Tests

(Elevation View)

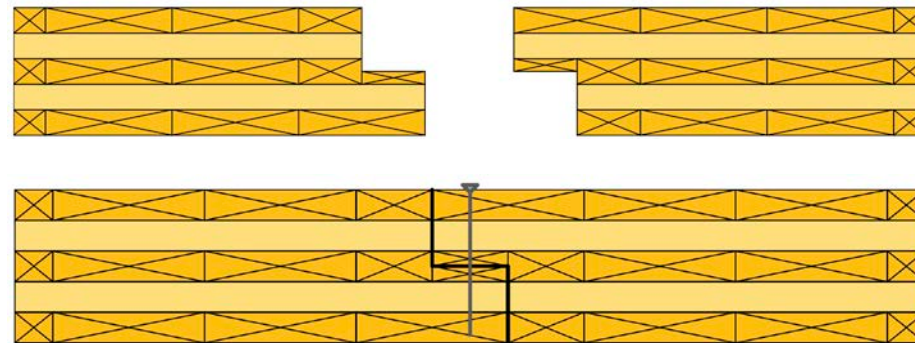
Butt joint



Spline



Half-lap



(FPIInnovations 2013)

# UBC/MyTiCon Tests

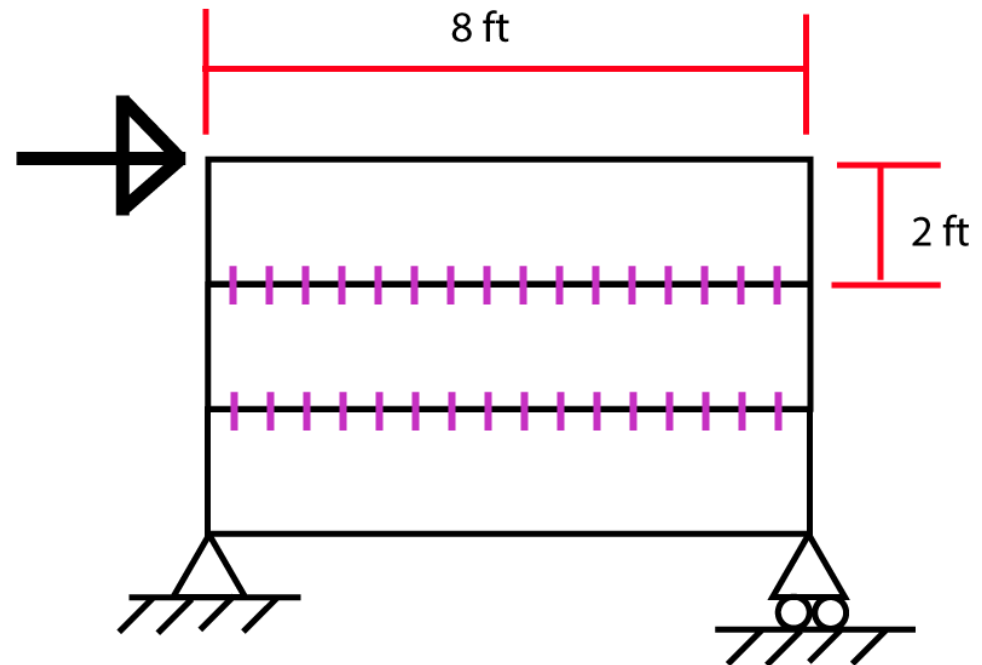
- Wood species: Canadian S-P-F
- Only monotonic loading (no dynamic)
- Variations
  - 3- & 5-ply CLT
  - Screws in tension ( $45^\circ$ ) & shear ( $90^\circ$ )
  - 1-2 rows of screws

## UBC/MyTiCon Tests - Results

- Tension screws ( $45^\circ$ )
  - high stiffness & capacity
  - brittle failure
- Tension/shear ( $45^\circ + 90^\circ$ )
  - high strength & ductility
- Screw yielding w/ spline

# MS Thesis – Full-scale diaphragm tests

- Full-scale diaphragm test
  - 8'x2' panel slices
  - 3 panels per specimen
- Monotonic loading
- CUREE protocol (dynamic load)
- **ASTM E455** – Static Load Test for Diaphragm

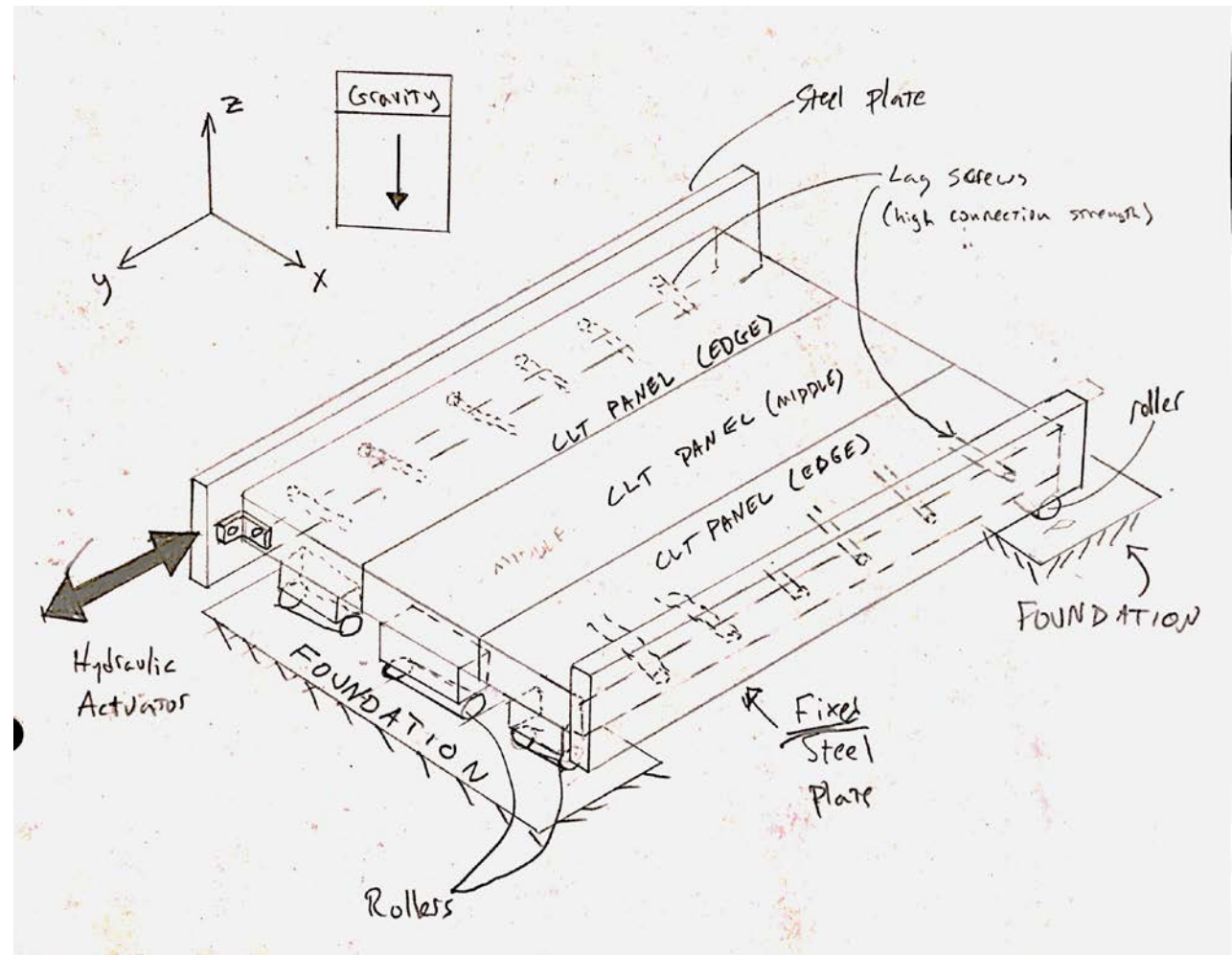


(Sullivan 2015)



# MS Thesis – Full-scale diaphragm tests

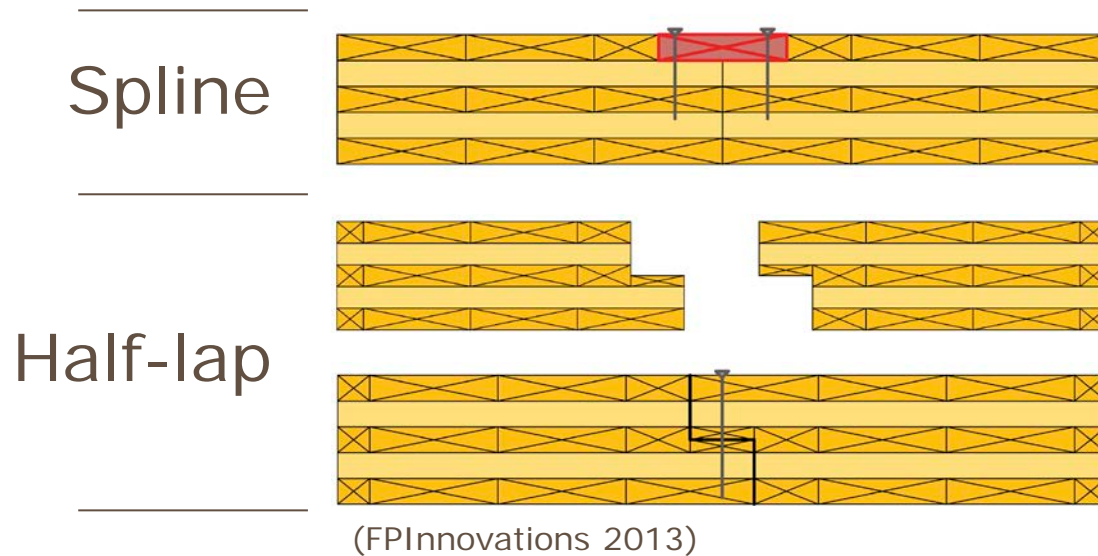
- Ideal setup
- No ASTM Std.



(Sullivan 2015)



# MS Thesis – Full-scale diaphragm tests



- Fastener pattern
  - $90^\circ + 45^\circ$  (shear + withdrawal)
  - Similar spacing to MyTiCon/UBC tests
- 3 layers ONLY of Douglas-fir
  - Pacific NW
  - Higher strength
  - Timber-Concrete-Composite (TCC) diaphragms

## MS Thesis – Full-scale diaphragm tests

Connection System	Test Type	
	Monotonic	CUREE
Half-lap joint	3	3
Single surface spline	3	3

\*If the results of TWO tests are not within 10% of each other then a third test must be carried out.

- 12 test specimen's
- 3 panels per specimen
- NEED (36) 8'x2' panels
  - =576 sq ft of 3-ply CLT
  - =(9) 8'x8' panels

# MS Thesis – Full-scale diaphragm tests

- Strength/stiffness/deflection
- Full-scale vs. small scale results
- Improve CLT diaphragm design methods

Thank you!

# References

- Styxworks, LLC CLT Floor Panels.  
<http://styxworks.com/timber-design/clt-floor-panels>.  
Accessed 20 Apr 2015
- University of British Columbia, Closten M (2015) Structural Screw Technology in Tall Wood Buildings.
- FPInnovations (2013) CLT Handbook (US edition).

# Outline

- UBC/MyTiCon tests
  - small scale
  - panel-to-panel shear connections
- MS Thesis
  - Full-scale diaphragm tests



styxworks.com