Freres

LUMBER CO., INC.

MPP

MASS PLYWOOD PANELS BY FRERES LUMBER CO.

Freres History

- Founded in 1922 by TG Freres
- Produced lumber until 1959 when we installed a large log veneer plant in Lyons, OR
  - Partnership with Willamette Industries
- Installed small log veneer mill in 1963
- Installed Studmill in 1970- Value added to core stock

Freres History

- First veneer dryer installed in 1990
- Second dryer installed in 1994
  - Supply dry veneer for engineered wood products markets
- Purchased North Santiam Plywood in 1998 out of bankruptcy
  - First move into finished product markets since lumber production
- Installed boiler and Co-gen facility in 2007
  - 100,000 pph boiler
  - 10mW turbine generator powered off of hog fuel and urban wood waste.
  - Offset Natural Gas consumption and provides electricity to 5000 homes

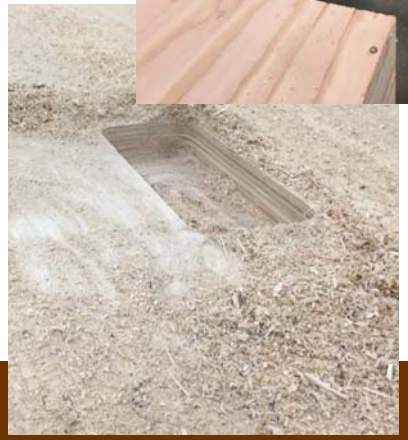
Freres Operations

- One of the largest independent veneer producers on West Coast
  - 400 million square feet of veneer production
  - 200 million feet of plywood production
  - 450 employees with family wage jobs
  - Highly dependent on Federal Timber sales for timber supply
  - Invested over $130 million into our facilities over the last dozen years

- **FLC Operates**
  - Two Veneer plants
  - Veneer Drying Facility
  - Plywood Plant
  - Cogeneration Facility
  - Stud mill
  - Fleet of Log and Highway Trucks
- **MPP Facility**
  - Operational December 2017

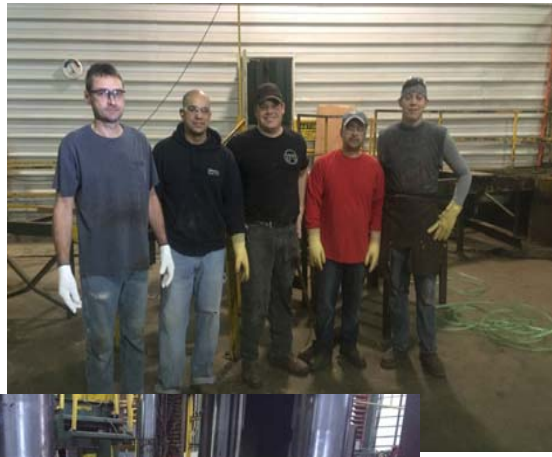
MPP- Main Concepts

- We have experience in density graded wood since 1990
- We have been producing plywood for 20 years
- Engineered Structural Composite Lumber Products meet or exceed performance of conventional lumber products
- Veneer production utilizes fiber available in logs very efficiently
- Plywood and SCL products meet or exceed minimum moisture requirements for CLT- 12%
  - Veneer is dried to 4-6%
  - After panel production moisture content is 8-10%
- Veneer-based panels have predictable falldown
- Potential to produce Mass Timber Panels in increments less than 2-plies of lumber



Product Development Process

- Producing and testing concept panels since April 2015
  - PFS –TECO provided testing lab and initial product verification
- Patent filed October 2015
- OSU receives proof of concept panels January 2016
  - Results received March 2016
- Po's cut for test facility by April 2016
  - Test facility operational February 2017
  - 4'x 17.5' laminating press
  - DET and RF Scarf Press



Equipment Suppliers

- Project requirements
  - Freres to provide equipment up to WIP inventory
  - Equipment required from MPP panel construction through processing
  - 12-month time frame
- Requested quotes from several equipment suppliers.
  - Narrowed quotes down to 3 potential providers
- Homag/ Stiles /Minda
  - Experience in CLT industry
  - Turn-key provider
- CD-Redding- Primary Building Contractor

Freres
LUMBER CO., INC.

HEXION™

WEST COAST
INDUSTRIAL SYSTEMS, INC.

stiles

WEINMANN

MINDA

AikenControls

Member of
APA

ES ICC EVALUATION SERVICE
In Cooperation with Innovation RESEARCH LABS

GP
Georgia-Pacific

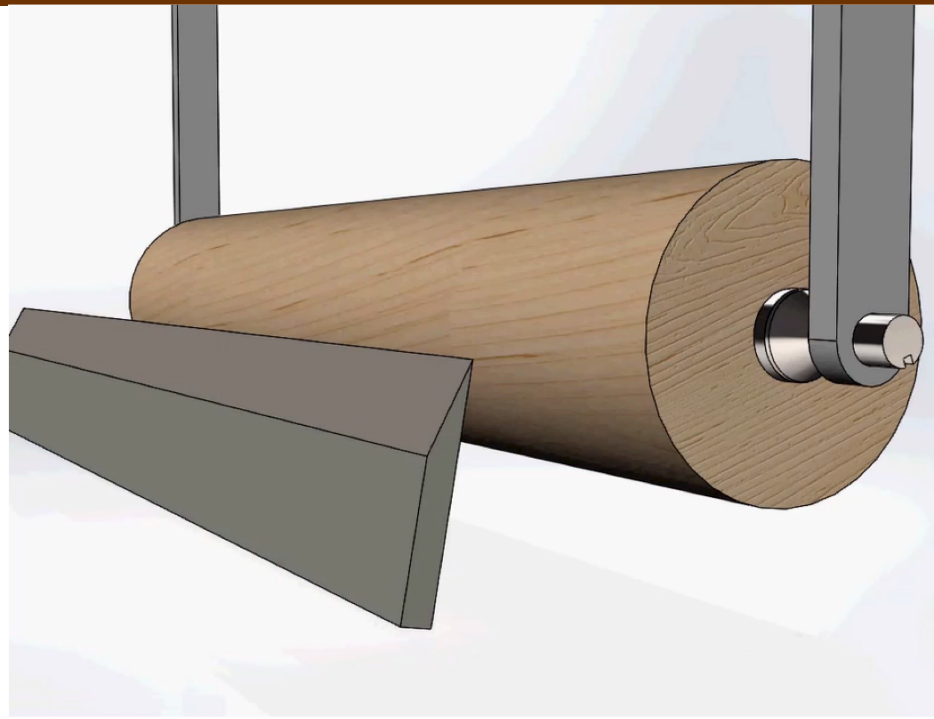
Our Raw Material is Veneer

Veneer is the finest wood format to create engineer wood products

- Higher Recovery of usable fiber than lumber
- Overcomes the problem of producing a square product out of a round tree
- Innumerable potential layups with various thicknesses, density grades, orientations and visual grades

Timber Availability

- Ideal timber for engineered veneer products is suppressed 2nd growth trees
- Average block diameter for our engineered veneer plant is 8.5”
- EVERY sheet of veneer has a definable engineering value



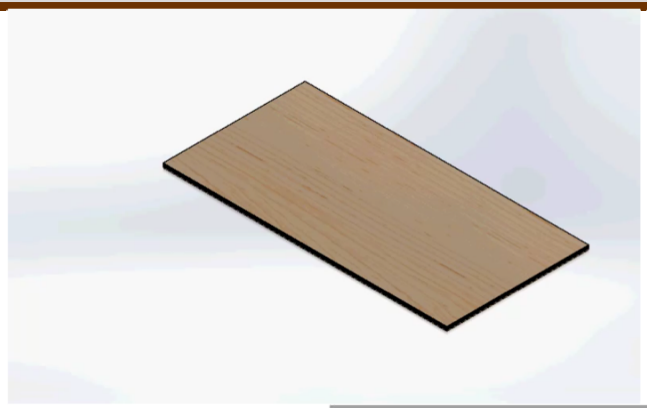
Structural Composite Lumber

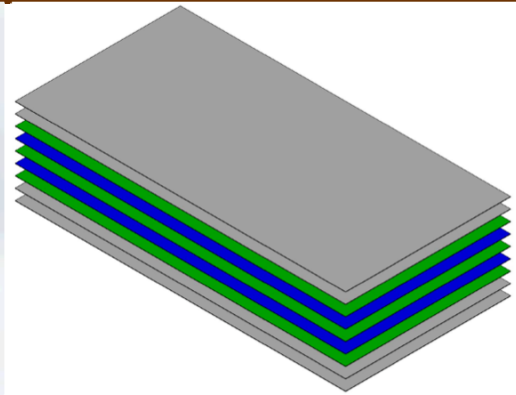
1.8E Lamella Example

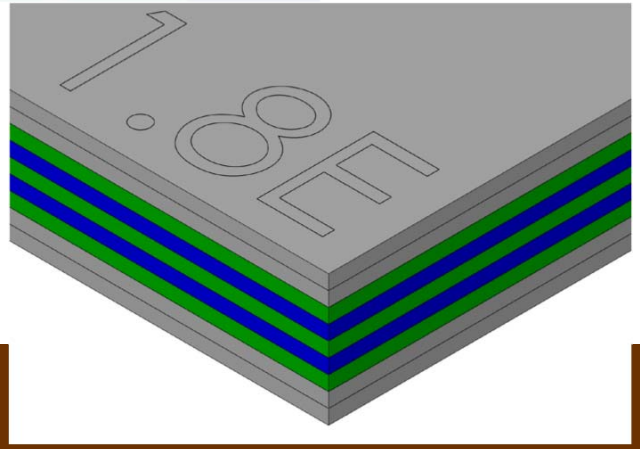
- 9-plies of veneer
- 7 long-grain & 2 cross grain
- Veneer density grades include G1, G2 and G3

Layup Benefits

- Majority of panel is long-grain orientation
  - Span Performance
  - Cross-banding contributes to minor force direction and panel dimensional stability
- Primarily used in Tension and Compression Portions of Mass Timber Panel







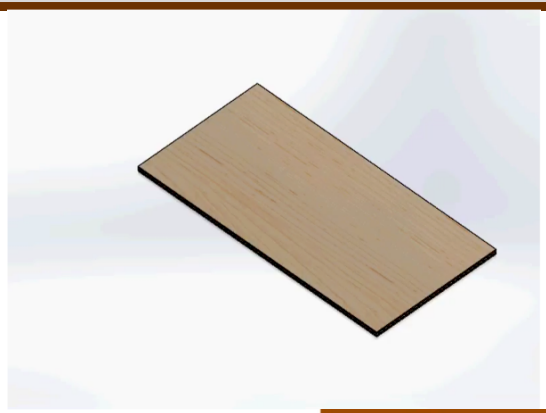
Structural Composite Lumber

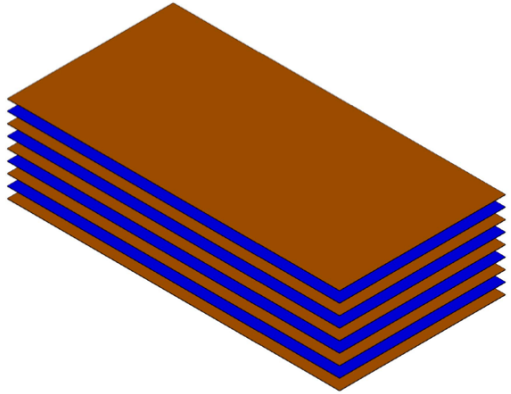
1.0E Lamella Example

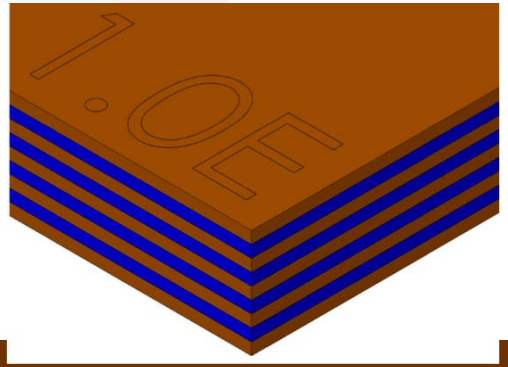
- 9-plies of veneer
- 5 long-grain & 4 cross grain
- Veneer density grades predominantly G3

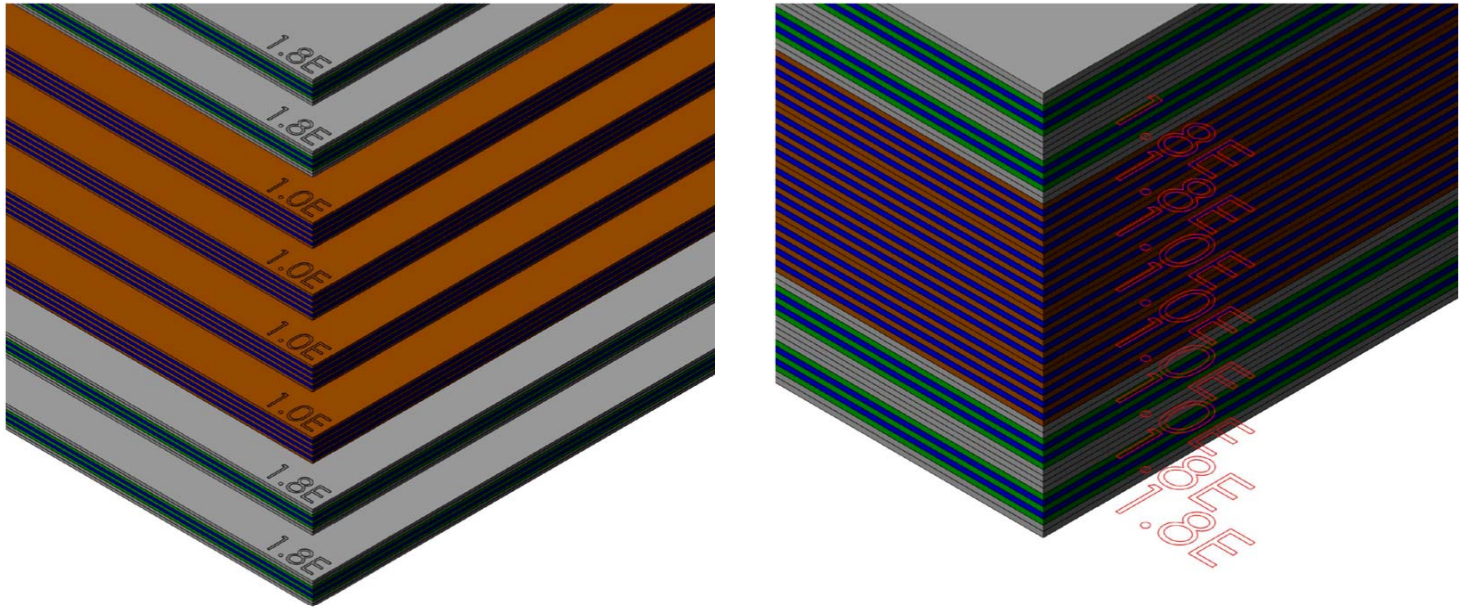
Layup Benefits

- Alternating Long and Cross-grain veneers
  - Major Force & Minor Force Direction Contribution
  - Shear performance & Panel Stability
- Primarily used in Center portion of Mass Timber Panel







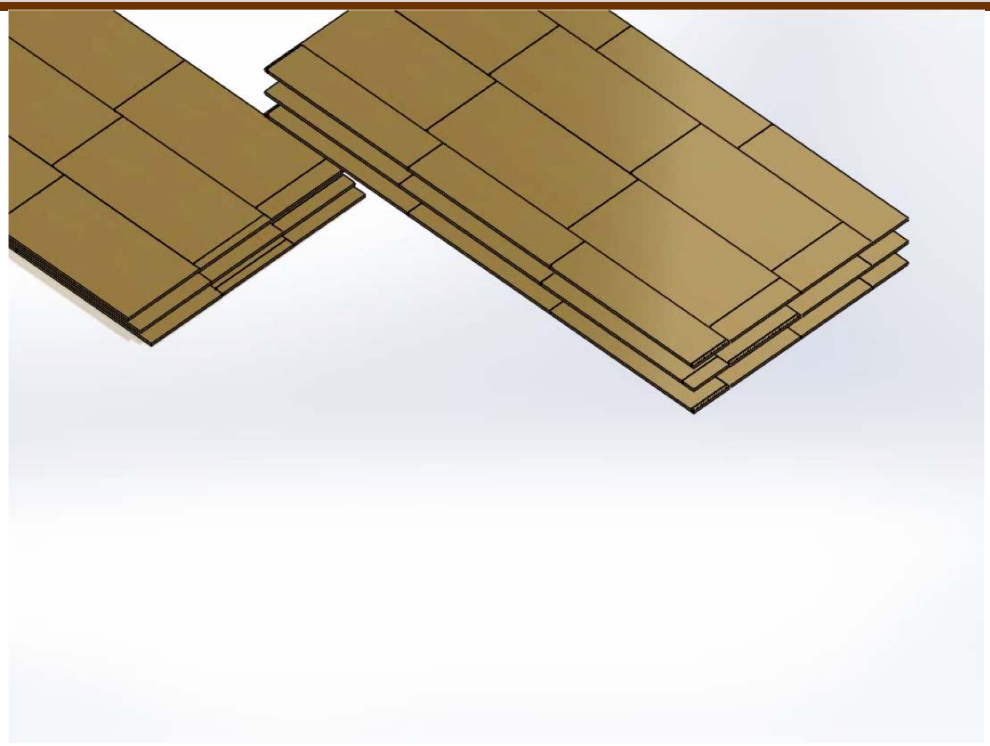

1.8E
1.8E
1.0E
1.0E
1.0E
1.0E
1.8E
1.8E

MPP- Design Values

	Major Strength Axis				
					8" MPP
				7" MPP	F22 SCL
			6" MPP	F22 SCL	F22 SCL
		5" MPP	F22 SCL	F22 SCL	F10 SCL
Lay-up	4" MPP	F22 SCL	F22 SCL	F10 SCL	F10 SCL
	F22 SCL	F22 SCL	F10 SCL	F10 SCL	F10 SCL
	F10 SCL	F10 SCL	F10 SCL	F10 SCL	F10 SCL
	F10 SCL	F22 SCL	F22 SCL	F22 SCL	F22 SCL
	F22 SCL	F22 SCL	F22 SCL	F22 SCL	F22 SCL
Effective Stiffness $(EI)_{eff,f,0}$ ($x10^6$ lbf-in^2/ft of width)	113	233	397	618	902
Shear Modulus $(GA)_{eff,f,0}$ ($x\ 10^5$ lbf/foot of width)	2.66	3.27	3.91	4.10	5.32
Moment Capacity $(F_bS)_{eff,f,0}$ (ft-lbs/ft of width)	4600	7625	10825	14450	18450
Shear Capacity $V_{s,0}$ (lbf/foot of width)	3000	3965	4675	5350	5975
Pounds per Cubic Foot	37	37	37	37	37
Pounds per Lineal Foot/Foot of Width	12.3	15.4	18.5	21.6	24.7

MPP Manufacturing

- Pre-made 4’ wide by 48.5’ long plates- structural composite lumber
- Panels built predominantly in long lamellas- overlapping joints to eliminate weakness across the panel width
- Cross-plies built into the panel per design specifications
- 3 to 4 plates per 12’ wide lamella allowing much easier and quicker construction than 2”x6” or 2”x12”boards
- 54 veneer plies in a 6” thick MPP panel, each engineered for appropriate density, orientation, and visual grade
- Cross-banding built in through the panel- **NO ODD PLY BENEFIT**



Mass Timber Panel Facility Operational December 2017

Product Strengths

Cross-banding in Each 1” Lamella

- Panel Thickness Increased in 1” increments
  - NO ODD-PLY BENEFIT
- Can achieve comparable performance in Major & Minor Force Directions

Density

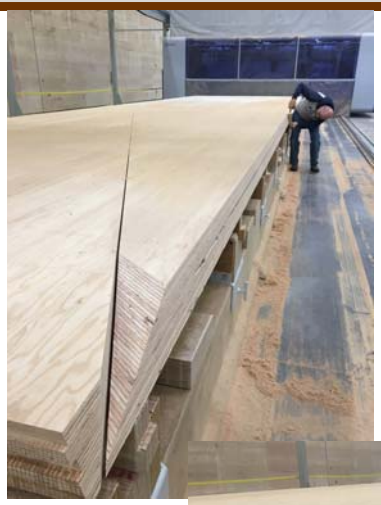
- Potentially Stiffer Performance
- Outperforms in design values where density contributes

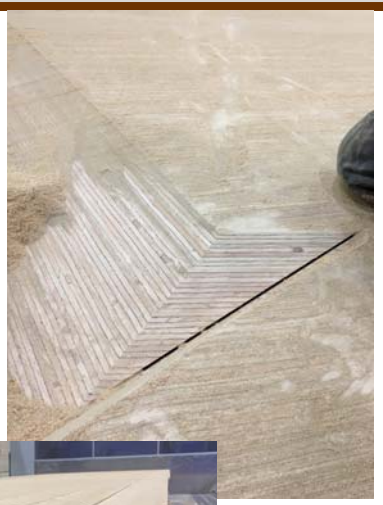
Cost

- Density graded veneers of lower grades widely available
- 95% of full sheet veneer processed at our greenends are G3 or above

Patent Pending

- Product & Process Patent Pending
- PCT Patent Pending for International Application





Product Weaknesses

Glue-lines

- Intense QC to ensure bond-quality
  - Number of glue-lines per cross-section

Wood Loss

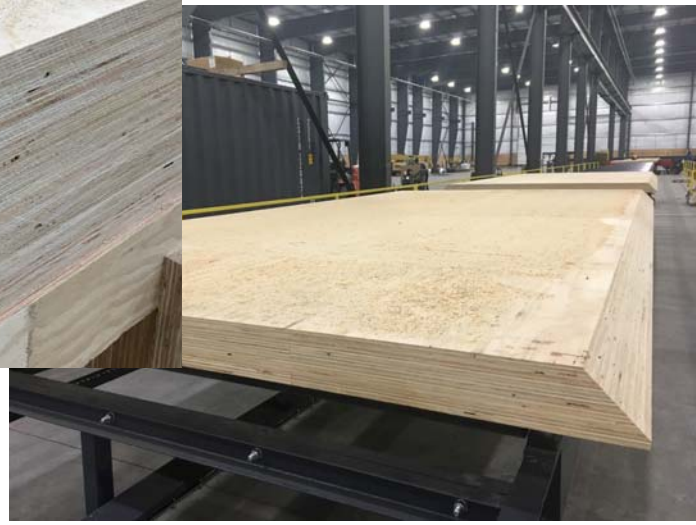
- 10% wood loss in structural joint
- Increased fall-down for SCL lamella

Certification

- Multiple Steps for Certification
  - EXPENSIVE FOR MATERIAL AND TESTING
- ASTM D5456- Creep Testing
  - Long-term testing
- 1st time this testing protocol has been applied for a Mass Timber Panel

Unique

- No template for facility design and application
- No existing tested information for comparable product



Product Certification: APA-EWS and ICC-ES

- Structural Composite Lumber: ASTM D5456
  - ASTM D5456 – 14b “Standard Specification for Evaluation of Structural Composite Lumber Products”
  - ICC-ES AC 47 – “Structural Wood Based Products”.
- Certification of the MPP Products
  - ANSI/APA PRG 320-2012 – “Standard for Performance-Rated Cross-Laminated Timber”
  - ICC-ES AC 455 – “Cross Laminated Timber Panels for use as Components in Floor and Decks”

Product Development Update

- ASTM D5456 & PRG 320
  - Product Certification Timeframe doubles compared to testing solely for PRG 320
  - Product & Plant Certification concurrently
    - Difficult to produce panels for testing while also debugging production facility
  - Creep Test- Not required under PRG-320
    - 30-day required test period- with condition and sample preparation closer to 5 months
    - Limited capacity at test facility to complete this test
  - Witnessing
    - Test specimens must be witnessed at each stage of production, requiring coordination with test facility

Testing Data Completed

APA

OREGON STATE UNIVERSITY

1.8 E Design Values

- *Edge Bending with moisture and volume effects*
- *Flat bending (both strength axis)*
- *Tension with moisture and volume effects*
- *Compression parallel to grain*
- *Creep test completed by month end.*

1.0 E Design Values

- *Flat bending*

2.0 E Beam and Header

- *Completed creep test*

1.55 E Design Values

- In-process

OSU bending and shear test data.

- *Brochures based upon this data.*

MPP Testing

- *2" shear and pre-qualification testing finishing/completed.*

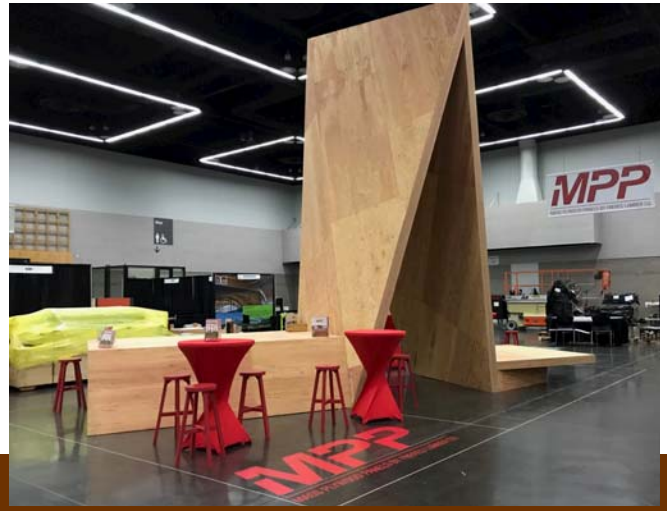
Testing Underway

- Lifecycle Assessment
- Rocking Wall
- Acoustics
- Seismic Structures
- Fastener, Dowel, Component Wall Test

Future Testing

- Large-scale Column & Beam
  - Compression Testing
- Long-term Durability & Weathering
  - MEC-MAC

TALLWOOD DESIGN INSTITUTE



Southwest Research Institute- Fire Compartment Test

- Future Fire Tests
  - ASTM E84- Flame Spread
  - ASTM E119- Char rate
- ARUP is our primary fire contractor
- Additional fire testing is anticipated to be completed in the next 4-6 months

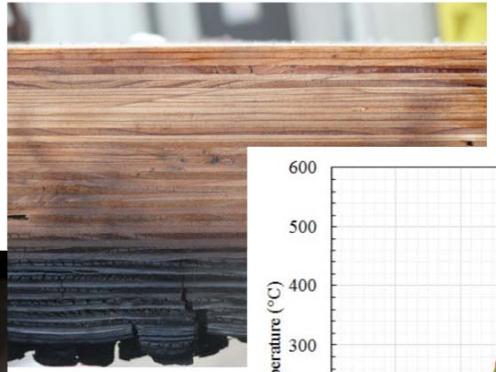


Figure C-23. Post-Test Pictur

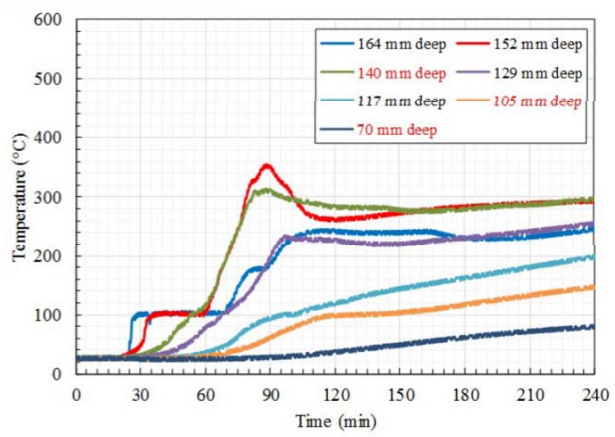


Figure D-9. Embedded TC Temperatures.

Future Developments

- Large-scale Column and Beam
- Industrial Applications
- Engineering Team for multi-story structural applications

www.frereslumber.com