



FPInnovations

Creating forest sector solutions

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Manufacturing of Cross Laminated Timber (CLT)

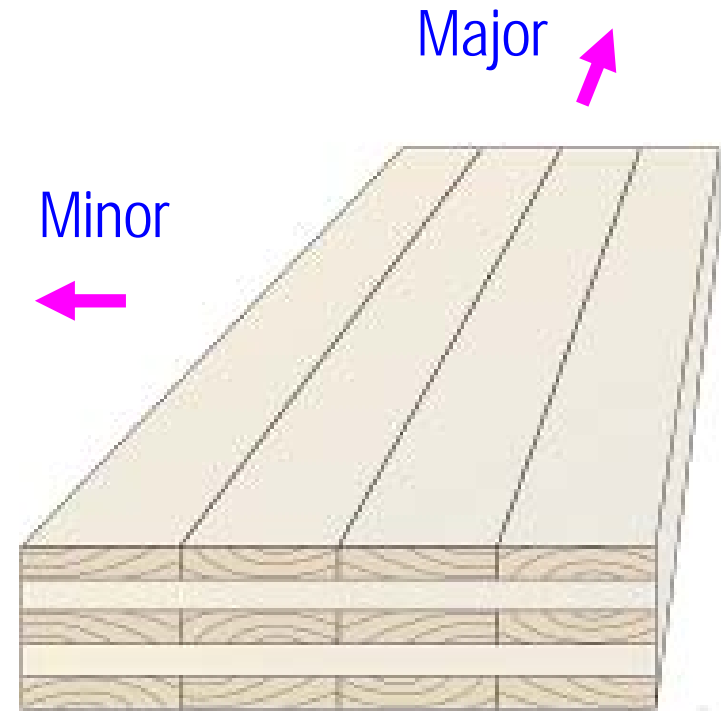
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February 8, 2011

Vancouver, B.C. Canada

Outline

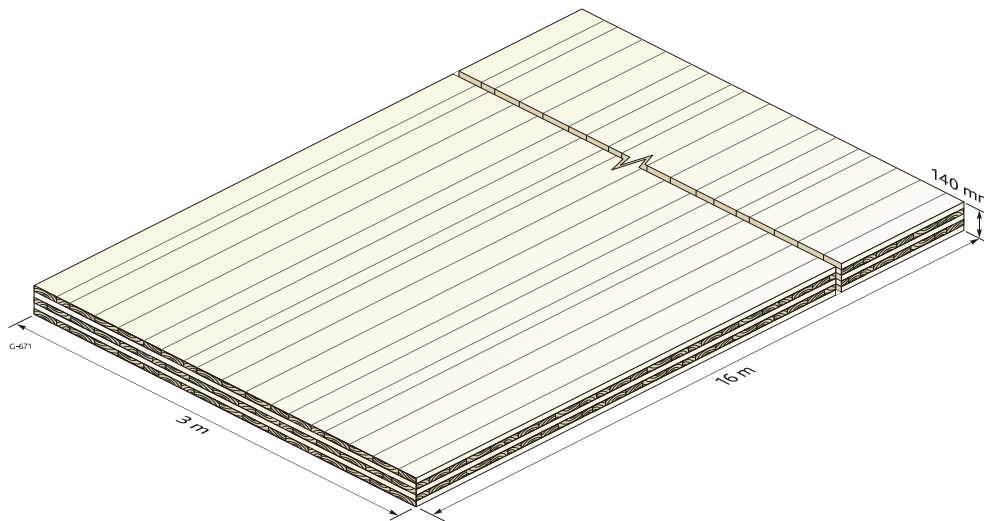
1. CLT manufacturing considerations
2. CLT raw materials
3. Typical steps of CLT manufacturing process
4. CLT bond quality assessment
5. CLT standard development at FPInnovations



CLT - Jumbo Plywood

1. CLT Manufacturing Considerations

- CLT target applications
 - Floor, wall and roof
- CLT panel dimension & lay-ups
- Plant layout, equipment & qualification



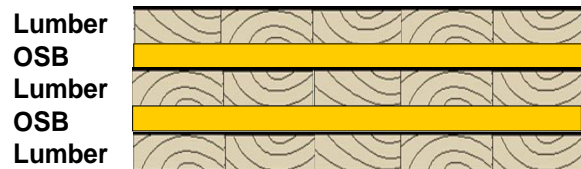
2. CLT Raw Materials

■ Wood

- Structural lumber
 - No.2 &Btr - major direction
 - No.3 &Btr - minor direction
- * Refer to CSA O141 & PS 20(US)
- Wood composites (OSB, LVL...)



Generic CLT



Hybrid CLT

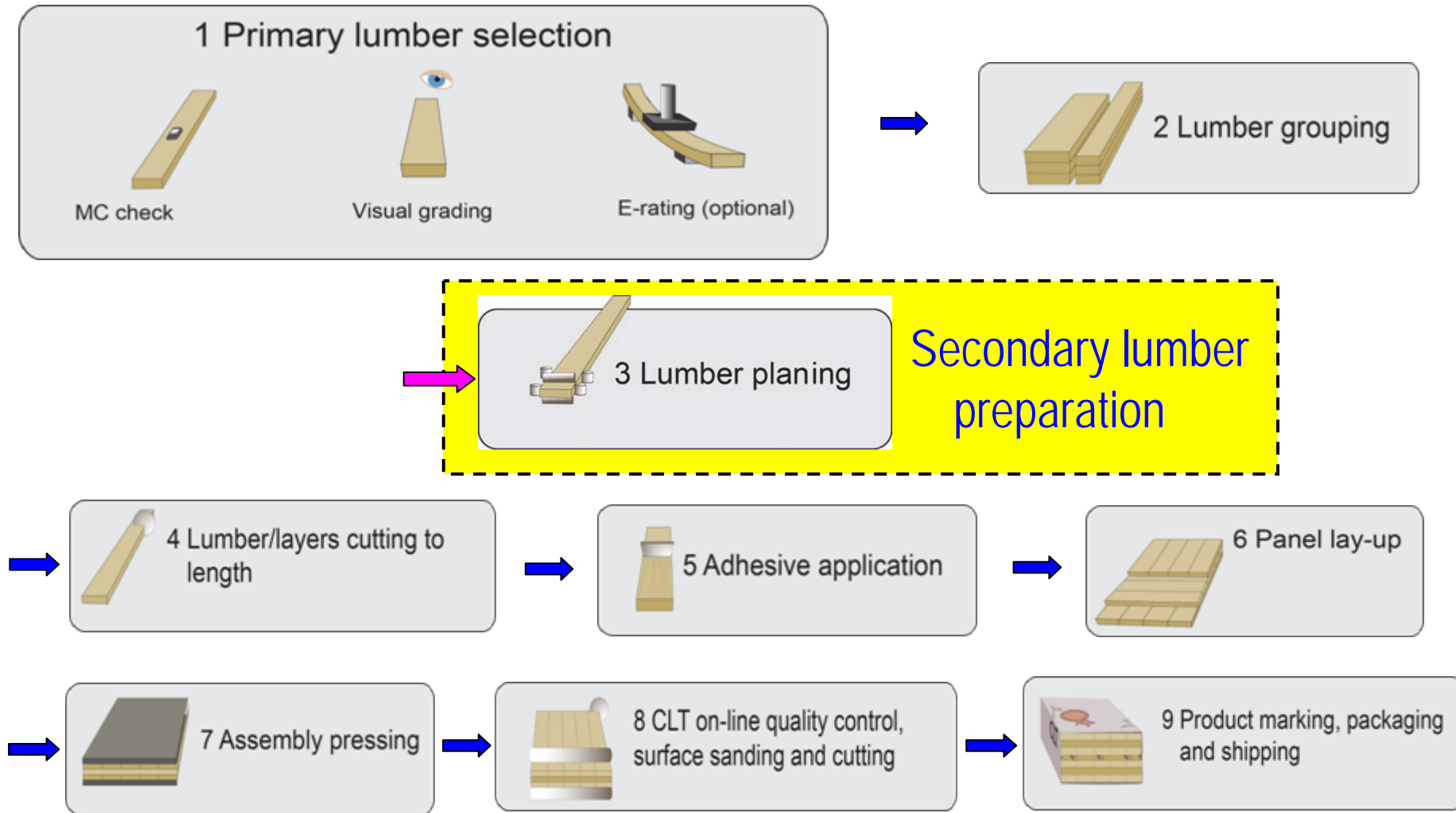
■ Adhesives

- Phenolic type (PRF)
- Emulsion polymer isocyanate (EPI)
- One-component polyurethane (PUR)
- ...

* Meet CSA O112.10

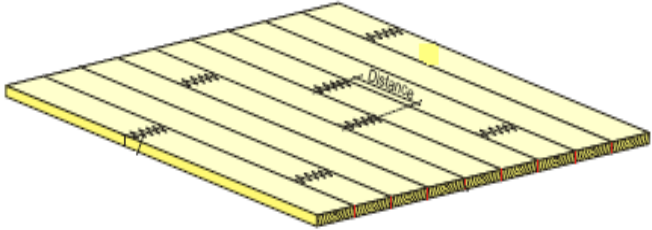
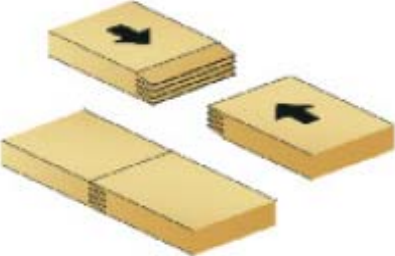
* Refer to manufacturer's specifications

3. Typical Steps of CLT Manufacturing Process



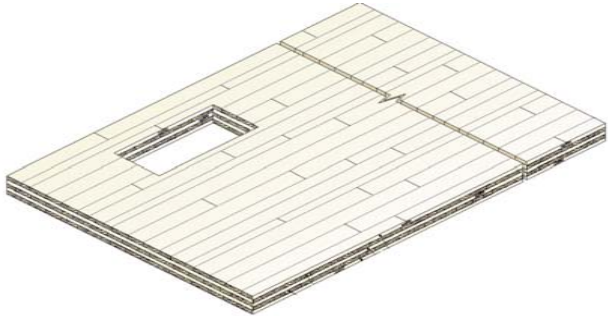
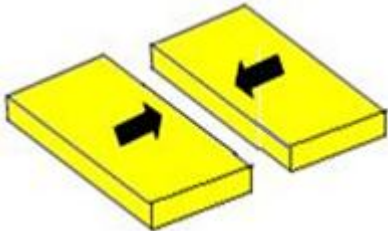
Secondary Lumber Preparation

Option 1: End-joining



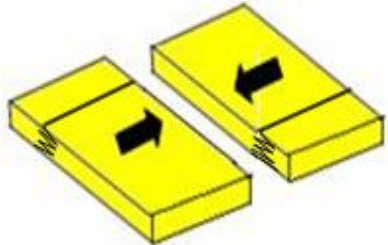
CLT Layer

Option 2: Edge-gluing



CLT Panel

Option 3: End-joining + Edge-gluing



3.1 Lumber Procurement

- 2x lumber / 1x board
- S4S / S1S1E (rough sawn)
- KD - HT (19% MC or less)

- Unpack lumber stocks and sticker lumber



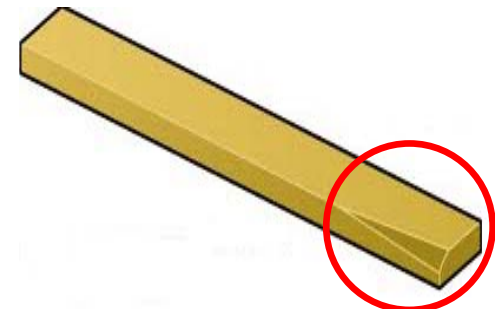
Air-drying



Kiln-drying

3.2 Lumber Quality Control

- MC target: $12 \pm 2\%$
- Visual grading - NLGA rules
 - Limits on wane / shake
 - Restrictions on warp (crook, twist...) and decay...
- E-rating (optional)



Wane



3.3 Lumber Grouping

- Achieve panel design capacity
- Ensure good visual appearance
- Group lumber for major/minor directions based on
 - Lumber MC and visual characteristics
 - In combination of lumber MOE, if E-rating is used



3.4 Lumber Planing

- Activate or refresh wood surfaces to reduce oxidation for effective bonding
 - Reduce thickness variation of laminations
- Remove about
- 0.15 in from the width
 - 0.10 in from the thickness



Surfaced at 4 sides



Surfaced at 2 sides

3.5 Adhesive Applications

- Apply parallel lines of adhesives using a through-feed system
- Application rate and assembly time are adhesive-dependent
 - ✓ Target for PUR:
100-180 g/m² &
45 min maximum

Extruder heads



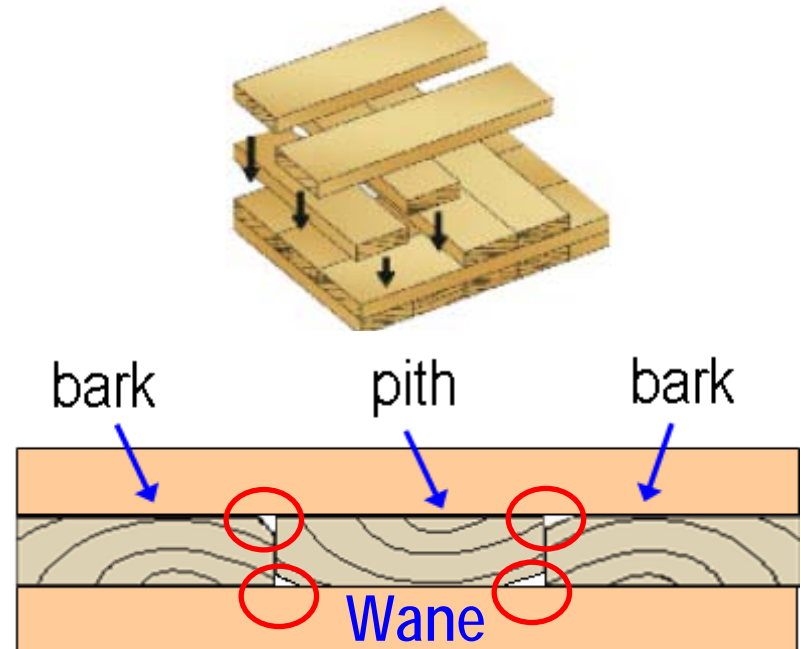
PUR, light color



PRF, dark color

3.6 Panel Lay-up

- Similar to plywood (a crisscross pattern)
- Orient laminations such that bark and pith faces of adjacent pieces alternate
 - disperse wane for a minimum effective bond area (80%)
 - reduce tendency of panel warp



3.7 Assembly Pressing

- Ambient temperature is 15°C or above
- Applied pressure and pressing time are species / adhesive -dependent
- If no edge-gluing, apply a 40-80 psi side pressure to minimize potential gaps in the main layers



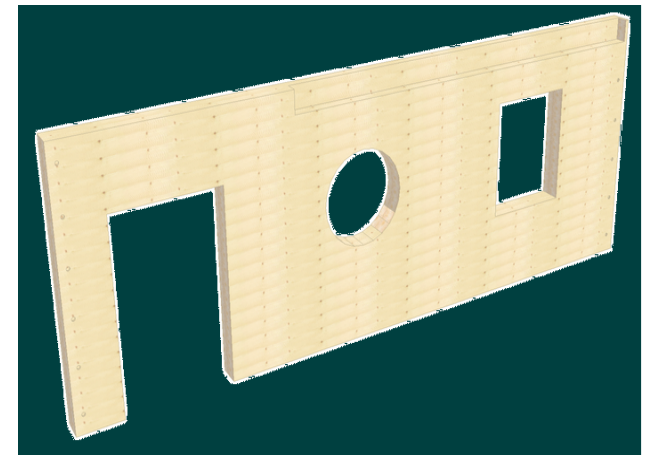
Vertical pressure only



With side pressure

3.8 CLT Quality Control, Cutting & Marking

- Perform visual grading
(optional: surface sanding)
- Cut out openings for
windows /doors with CNC
machine
- Mark CLT panels
 - Plant's logo & code
 - Species, lamination grade
and thickness...

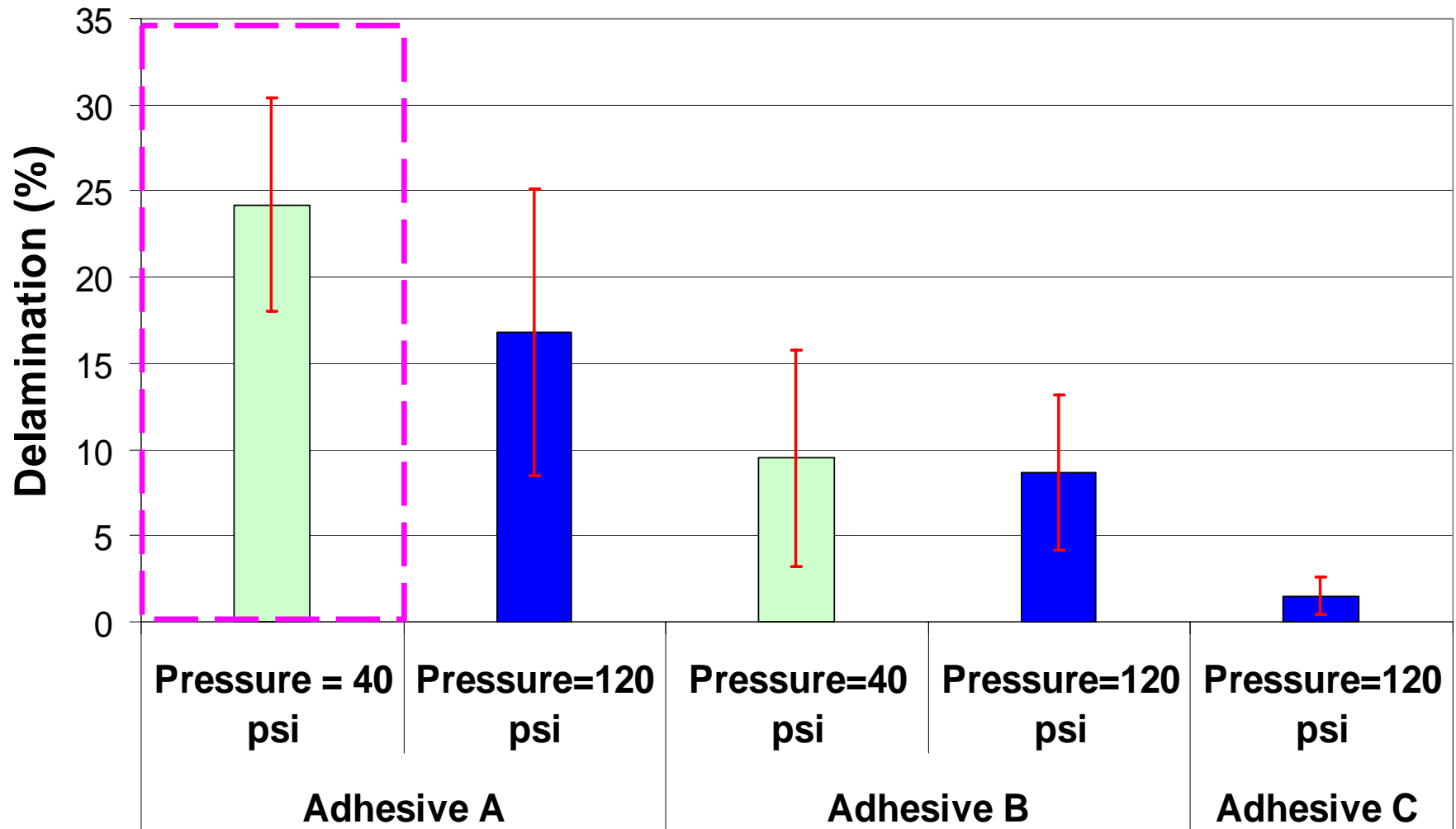


4. CLT Bond Quality Assessment

- Made 2 x 2 -ft CLT
 - 3 lay-ups: 3, 5 and 7-ply
 - 3 adhesives: A, B and C
 - 2 pressures: 40 and 120 psi
- Performed delamination test (similar to that found in CSA O112-06)
 - Cylindrical specimen (d = 3.5 -in)



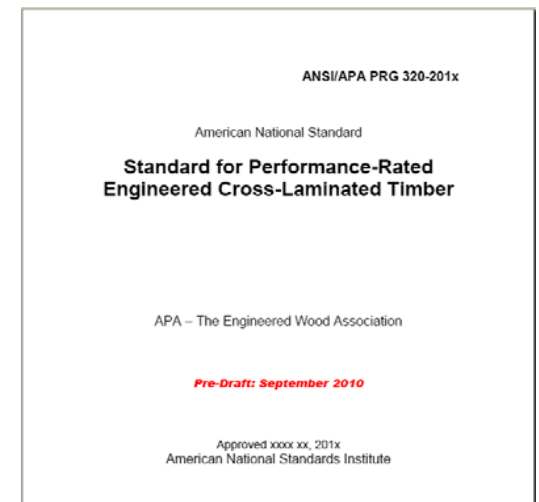
CLT Delamination Resistance



5. CLT Standard Development at FPInnovations

- Developed seed documents for
 - CLT Plant Qualification Standard
 - CLT Product Standard

- CLT North American Standard is under development at APA



Summary

- ✓ CLT manufacturing steps were introduced
- ✓ FPInnovations developed draft CLT plant qualification / product standards based on pilot plant tests
- ✓ FPInnovations passed the standards to APA for a North American CLT standard