Drying Sorted Lumber
Prior and after drying (re-drying)

by
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- Melbourne/Australia – Nov 27/28
Drying Sorted Lumber

Presentation Outline:

1. Problems / Issues
2. Sorting in western Canada
3. Sorting prior to drying
4. Sorting technologies
5. An industrial scale experiment
6. OASiS® simulation
7. Sorting after drying // re-drying

Typical BC SPF kiln installations

General Characteristics:

- \( W_n \approx 180,000 \text{ kg (\sim 400,000 lbs)} \)
- Energy input: 15 – 25 MMBtu/h (\sim 7,300 kW)
- Drying times: 35 – 45 hours
Drying Sorted Lumber

Industrial Problems/Issues:

1) Longer drying times
2) Energy Consumption
3) Drying degrade (over-drying)
4) Non-uniform final MC (wet lumber)
5) Excessive shrinkage (lumber size)

What do we usually do about those problems?
Drying Sorted Lumber

- Drying schedule
- Equalization
- Variable air velocity
- Longer drying times
- Lower temperatures
- Higher temperatures
- Steam, water spray
- Improve package quality
- Kiln maintenance (heat)
- In-kiln moisture sensors
- Weight restraint
- Training

Factors that influence our results
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Log diameter

Storage Conditions

Sawing
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Kiln Conditions

Lumber Preparation

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and additionally...

- Initial Moisture Content
- Species
- Drying schedule

In Western Canada:

→ main species: SPF

Two Schools of Thought:

Sort by species
Sort by Moisture Content

Also:
by species & by MC
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$ impact

Sorting Before Drying
Available Technologies

Sorting Technologies available in Canada:

- a) MC & Density
- b) Weight
- c) Species
- d) MC
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a) MC & density (NMI)

b) Weight
c) Species

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d) Infrared radiation

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an industrial scale experiment

Approach

Lumber Sample #1
OASIS®
Best Sorting Solution Based on a sorting system

Lumber Sample #2
Sort based on the Solution
Kiln drying
Impact on Grade Recovery
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OASIS® Software (Forintek – Eastern Lab)

Outil d'Analyse et de Simulation du Séchage

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Laboratory Setup
Drying Sorted Lumber

Laboratory Setup

Collecting data before drying

Forintek Canada Corp.
Drying Sorted Lumber

Outil d'Analyse et de Simulation du Séchage

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Drying Sorted Lumber

Optimized Solution

MC/Density - NMI
Drying Sorted Lumber

Results

<table>
<thead>
<tr>
<th>Species</th>
<th>High Sort</th>
<th>Low Sort</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spruce</td>
<td>15</td>
<td>11</td>
</tr>
</tbody>
</table>

Spruce-Pine Measured Unsorted IMC

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Results from OASiS

**Spruce & Pine**
- Unsorted
  - NMI ≤ 29 (Low Sort)
  - NMI > 29 (High Sort)

**Sub-alpine fir**
- Unsorted
  - NMI ≤ 45 (Low Sort)
  - NMI > 45 (High Sort)

Histogram _ Basic Density for spruce-pine combined

Histogram _ Basic Density (sub-alpine fir)
### Spruce - Pine

#### Final Moisture Content Distribution

<table>
<thead>
<tr>
<th>Variable</th>
<th>Unsorted</th>
<th>High Sort</th>
<th>Low Sort</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average</td>
<td>13.5</td>
<td>13.7</td>
<td>12.8</td>
</tr>
<tr>
<td>St Dev.</td>
<td>2.8</td>
<td>2.5</td>
<td>1.9</td>
</tr>
<tr>
<td>Max</td>
<td>33.4</td>
<td>26.7</td>
<td>20.9</td>
</tr>
<tr>
<td>Min</td>
<td>6.9</td>
<td>7.9</td>
<td>7.1</td>
</tr>
</tbody>
</table>

#### Spruce/Pine - Babine Schedule

<table>
<thead>
<tr>
<th>Time (hr/min)</th>
<th>39:00:00</th>
<th>44:00:00</th>
<th>31:00:00</th>
</tr>
</thead>
</table>

### Drying Curves

2x4 Spruce/Pine (Babine Schedule)
**Drying Sorted Lumber**

**Degrade Analysis**

<table>
<thead>
<tr>
<th>Value CAD</th>
<th>Unsorted</th>
<th>High Sort</th>
<th>Low sort</th>
</tr>
</thead>
<tbody>
<tr>
<td>Green Value</td>
<td>1,902.49</td>
<td>1,978.96</td>
<td>1,904.43</td>
</tr>
<tr>
<td>Dry Value</td>
<td>1,851.01</td>
<td>1,923.76</td>
<td>1,837.42</td>
</tr>
<tr>
<td>Diff</td>
<td>51.48</td>
<td>55.20</td>
<td>67.01</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Wet at the of drying</th>
<th>Unsorted</th>
<th>High Sort</th>
<th>Low sort</th>
</tr>
</thead>
<tbody>
<tr>
<td>#</td>
<td>21</td>
<td>17</td>
<td>3</td>
</tr>
<tr>
<td>%</td>
<td>2.9</td>
<td>2.4</td>
<td>0.3</td>
</tr>
</tbody>
</table>

**Results for sub-alpine fir**

**Change in Grade**

<table>
<thead>
<tr>
<th>Change in Grade</th>
<th>Low Sort (NMI &lt; 45)</th>
<th>High Sort (NMI &gt; 45)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0% 20% 40% 60%</td>
<td>0% 20% 40% 60%</td>
<td>0% 20% 40% 60%</td>
</tr>
</tbody>
</table>

Forintek Canada Corp.
Drying Sorted Lumber

Drying times for sub-alpine fir

<table>
<thead>
<tr>
<th></th>
<th>Unsorted</th>
<th>High Sort</th>
<th>Low Sort</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time (hr:min)</td>
<td>75:30:00</td>
<td>83:30:00</td>
<td>48:00:00</td>
</tr>
</tbody>
</table>

In summary (for sub-alpine fir):

in terms of gains:

- Quality (?)
- drying times (significant benefits)

Sorting After Drying – setting up for re-drying
Drying Sorted Lumber

General diagram of lumber sorting strategies

Lumber MC distribution after typical conventional drying
Experimental kiln drying degrade as function of lumber MC

2"x4" Hem-fir lumber dried in conventional kiln

Lumber MC distribution after high-target conventional drying

Over dried
Within MC range
Wets
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General diagram of Q-SIFT® dry-redry strategy

Green lumber

Conventional kiln

RF kiln

Wets

Dry lumber

Cost = $ 2,600,000

75 m³ (27,000 bf) 300 kW solid-state RFV dryer
Solid packs (no stickers) with plastic strapping
Experimental results for conventional drying to different targets

<table>
<thead>
<tr>
<th>Test</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pieces</td>
<td>378</td>
<td>392</td>
<td>393</td>
<td>196</td>
<td>196</td>
<td>392</td>
</tr>
<tr>
<td>Drying time (hr)</td>
<td>68</td>
<td>71</td>
<td>67.8</td>
<td>73.5</td>
<td>60.8</td>
<td>60</td>
</tr>
<tr>
<td>Average MC (%)</td>
<td>16.3</td>
<td>17.9</td>
<td>18.5</td>
<td>19.1</td>
<td>23.9</td>
<td>28.9</td>
</tr>
<tr>
<td>Standard deviation (%)</td>
<td>3.9</td>
<td>4.4</td>
<td>4.4</td>
<td>7.2</td>
<td>5.5</td>
<td>6.7</td>
</tr>
<tr>
<td>Wets (%)</td>
<td>3.7</td>
<td>6.4</td>
<td>13.9</td>
<td>19.9</td>
<td>47.3</td>
<td>62.6</td>
</tr>
<tr>
<td>Drying degrade (%)</td>
<td>10.6</td>
<td>6.9</td>
<td>4.6</td>
<td>9.7</td>
<td>0.5</td>
<td>1.8</td>
</tr>
</tbody>
</table>

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Potential lumber value increase based on re-drying using RF

Target MC for conventional drying (%)

Potential value increase after RF re-drying ($/Mfbm)

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Economic analysis for Q-SIFT® strategy

<table>
<thead>
<tr>
<th>Q-SIFT® economic analysis for 2&quot;x4&quot; Hem-fir lumber</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>First pass MC target</td>
<td>18.4 %</td>
</tr>
<tr>
<td>RF re-drying</td>
<td>16 %</td>
</tr>
<tr>
<td>Lumber production</td>
<td>~130 MMfbm/year</td>
</tr>
<tr>
<td>Drying time reduction</td>
<td>5.4 %</td>
</tr>
<tr>
<td>Kiln drying degrade reduction</td>
<td>3.7 %</td>
</tr>
<tr>
<td>Estimated Potential revenue increase</td>
<td>$17.5/Mfbm</td>
</tr>
<tr>
<td>Expected Payback time for RFV kiln</td>
<td>14.2 months</td>
</tr>
</tbody>
</table>
Making sense of Industrial drying information

The End

Thank you