Top loading during drying

A successful method to reduce deformations


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Research Goals

- Project in Kiln Drying Club
- EU-project STRAIGHT

• Main goal
  • To find the influence of package loading on the degree of deformations of timber during drying

• Other goals
  • Influence of the loading on the stickers marks
  • Influence of sticker distance on the degree of deformations
  • Correlation between fibre angle and twist
Kiln design and test arrangement in laboratory kiln at NTI
(50 mm x 100 / 150 mm spruce)

Load levels

<table>
<thead>
<tr>
<th>Test no.</th>
<th>Loading proced.</th>
<th>Load level (pressure)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Whole package</td>
</tr>
<tr>
<td>1</td>
<td>Increasing load</td>
<td>3 080 – 4 320 kg/m²</td>
</tr>
<tr>
<td>2</td>
<td>Decreasing load</td>
<td>3 080 – 2 460 kg/m²</td>
</tr>
<tr>
<td>3</td>
<td>Constant load</td>
<td>1 350 kg/m²</td>
</tr>
<tr>
<td>4</td>
<td>Constant load</td>
<td>710 kg/m²</td>
</tr>
</tbody>
</table>
Compression strength – various conditions

- Differences clearly significant for all tests
- The yield is highest for the highest load levels, but:
  - Potential for twist deformations is higher for test 3 and 4, and the percentual reduction is almost at the same level for all tests
Twist - specific package loading
(STRAIGHT: NTI-lab.kiln)

Drying schedule

Specific loading [kp/m²]
Twist [mm/100mm/2m]
Temperature [°C]

Spring back

Increasing load: 3 080 - 4 320 kg/m²

Loaded
Non-loaded

Day 0
Day 8
Sticker marks (in the middle of the pith side)

Pressure under stickers [kg/cm²]

Immediate after drying
8 days after drying

Cupping

Location in the longitudinal direction of the planks [cm]
Kiln and test arrangement at Haslestad Sawmill, Norway (50 mm x 100 mm spruce)

The specific package loading is dependant on the MC, the position in kiln and the top loading

Dynamic top loading:

- Test H
- Test G
- Test F
- Test E
- Test D
- Test C
- Test B
- Test A

Top load [kg/m²] vs. Moisture content [%]

- 30% load at start - 100% load at 40% MC (Haslestad)
  (Actual loads at tests)
Specific package load without top loading

Twist – specific package loading (Begna sawmill)
**Twist – specific package loading**
(Haslestad sawmill)

![Graph showing twist vs. specific loading](image)

**Average twist as function of top loading, based on the eight industrial tests**

![Graph showing average twist vs. top loading](image)

\[
\text{Twist} = \frac{344.3}{\text{Top load} + 52.2} + 3.2
\]
Bow and spring is also considerably influenced by the top loading.

Which package do you want to buy (or sell)?
Sticker marks as function of specific sticker pressure (industrial kilns)

The sticker marks were not considered as a problem, even at the highest pressures.

Fibre angle and twisting

Unloaded

Loaded-free end

Loaded-last sticker
The sticker distance has a considerable influence on the twist (data from one test)

\[ y = 0.0434x + 1.7315 \]

\[ R^2 = 0.1203 \]

New kilns with dynamic top loading

The top loading equipment must withstand tilting forces and include flexible air flaps!
Conclusions

- Top loading leads to a considerable reduction in all deformations
- 500-600 kg/m² seems sufficient, and even load levels of 200-300 kg/m² give very good results
- The sticker distance has a great influence on the deformations. Short distances or equal timber lengths in the kiln is recommended
- Sticker (pressure) marks seems to be a minor problem with the top loadings used
- Cup is reduced considerably under stickers by the loading, but negligible between stickers

TOP LOADING

- Reduces all deformations
- Hinders package vault
- Hinders air leakage above the packages

RECOMMENDED!