Moisture content control by shrinkage behaviour of the wood
- first experimental results -

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Introduction

Why would you like to control a drying process?

- To obtain the final moisture content
- To avoid cracks, distortions and discoloration
Introduction

How do you control a drying process?

- Moisture content measurements
- Moisture evaporation rate (drying rate)
- Strain measurements

Along the cross-section of the timber !!!!!!!!
Introduction

Common inline measurement systems for moisture content in a kiln?

- Electrical resistance probes
- Exceptionally: weighing the stack
- ??????????

Prediction of water evaporation and moisture content by drying models !!!!!!
Introduction

Limitations of electrical resistance measurements?

• Moisture content above fibre saturation
• Temperature above 80°C
Introduction

What about shrinkage?

There is also a relationship between shrinkage and moisture content.
Drying trial

Material

• Sitka Spruce from Scotland/UK
• 2500mm x 100mm x 50mm
• Initial moisture content 40% - 170%
  (50% of all boards higher 90%)
• Final moisture content required 15%±1
• 63 boards per trial
Drying trial

Sensors

6 moisture probes in the timber
2 temperature sensors in the timber
2 relative humidity sensors in the kiln
2 temperature sensors in the kiln
2 shrinkage sensors at the timber stack
2 load cells for weighing the stack
Drying trial

Timber stack

- Top load 500 kg/m², to avoid deformation during drying
- Measuring online the decrease of thickness with a displacement sensor (LVDT)
- Measuring the decrease of the mass with a load cell
Drying trial

Drying schedule

- Pre-drying
- Steam drying
- Cooling
- Conditioning
- Warming up

Time

Temperature:
- T_wet
- T_dry
- r.H.
Results

The graph shows the temperature (T), relative humidity (RH), and moisture content (MC) over time. The legend indicates different lines for each parameter:
- Tair: red line
- RH: black line
- T wet: blue line
- T wood: green line
- MC: orange line
- MC above FSP: dashed line

The graph is labeled with time in hours (0 to 168) on the x-axis and temperature, RH, and MC in percentage on the y-axis. The data points are connected by lines to illustrate the changes over time.
Results

In this period timber is above FSP, but shows linear thickness decrease proportional with mass decrease, due to evaporation.
Results

Shrinkage parameters

- total thickness of the boards 350mm in the beginning of the drying
- total thickness decrease 17.7mm total shrinkage 5.0%
- final moisture content 14.5% (oven dry)
- assumed fibre saturation point 30%
- derived shrinkage coefficient 0.50% per % MC change
Results

Sitka spruce on industrial scale

![Graph showing temperature (T), relative humidity (RH), moisture content (MC), thickness decrease, and time (h) for Sitka spruce on an industrial scale. The graph includes lines for Tair, T wet, T wood, MC wood, MC shrink, and Thickness decrease.](image_url)
Conclusion of the first results

- With a displacement sensor we get information on the drying rate, which is especially in the early drying stages of Sitka very important for the drying quality.

- Displacement measurements are reliable at high temperatures (>100°C).

- There is a direct linear relation between thickness decrease and mass decrease due to drying.
Thank you very much for your attention!