Analysis of Heat and Moisture Transfer in a Center-Bored Timber whose Outer Surface is Sealed

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Introduction
Introduction

large cross-section timber

Using as a structural member for Post & beam construction
Occurrence of drying defects

Especially surface check
Introduction

Manufacture of center-bored timber

The way to reduce drying defects of large cross section timber during drying

To drill a hole along the central longitudinal axis
Comparison of drying time

**Air drying**
- **Round wood**: 12 months
- **Center-bored wood**: 3 months

**Kiln drying**
- **Round wood**: 10 days
- **Center-bored wood**: 2 days
Introduction

Merits of center-bored timber drying

- Less strength reduction
- Restraint of drying defect
- Uniformity of mechanical property
- **Lightening the weight**: convenient to transportation & construction
- **Increment of drying rate**
- **Reduction of energy consumption**
- Uniformity of internal moisture content
Sealing the outer surface of wood

Water emission occurs just only on the inner surface (not on the outer surface)

Enhancing drying rate with applying high temperature drying
Center-bored & (outer) surface- sealed Timber Drying technology was firstly proposed and has been developed by professor Yeo’s team of Seoul National University.

We have reported documents and acquired patents related to this method.
Materials & Methods
Materials & Methods

Analyzing temperature and MC change in woods

Controlling the drying time and energy
center-bored (Pitch pine) timber

Outer DIA 140mm

Inner DIA 80mm

1.2m

Initial MC : about 30%
Materials & Methods

Dry Kiln
Materials & Methods

Drying of center-bored timber
Materials & Methods

**Drying of center-bored timber**

**Control wood**
Materials & Methods

Drying of center-bored timber

Sealing wood
Thermocouples were inserted into the wood. Temperature was measured and recorded using data logger (CR1000, Campbell Scientific Inc.).
Materials & Methods

For determining average moisture content of wood, the weight of the specimens was measured during drying.

For analyzing moisture transfer, outer, center, and inner part of specimens were cut and weighed at 8 hour intervals during drying.
Materials & Methods

Control of drying process

Applying Near-Infrared spectroscopic method
Surface moisture content was measured by NIR spectroscopic method. Time to finish drying process is determined.
Results & Discussion
Drying of center-bored timber

Final moisture contents: about 5%
Results & Discussion

Temperature change

0 hr

Control wood

Sealing wood
Results & Discussion

Temperature change

1 hr

Control wood

Sealing wood

surface

center
Temperature change

Results & Discussion

2 hr

Control wood

Sealing wood

surface

center
Temperature change

3 hr

Control wood

Sealing wood
Results & Discussion

Temperature change

24 hr

Control wood

Sealing wood
Temperatures of surface and center in the sealing wood rose slower than those of control wood.
Wood temperature was increased during approximately 3 hours to reach around the target setting temperature.
Control wood: outer surface was dried rapidly
Sealing wood: drying rate of inner surface was higher than that of outer surface
Results & Discussion

MC variation

0 hr

Control wood

Sealing wood
Results & Discussion

MC variation

2 hr

Control wood

Sealing wood
Results & Discussion

MC variation

4 hr

Control wood

Sealing wood
Results & Discussion

MC variation

16 hr

Control wood

Sealing wood
Results & Discussion

MC variation

24 hr

Control wood

Sealing wood
Results & Discussion

**MC variation**

48 hr

Control wood

Sealing wood
Results & Discussion

Drying energy of center-bored timber

Total energy consumption: 163.14 kWh
Results & Discussion

Comparison of drying energy

- Center-bored timber: outer ø140mm, inner ø80mm
- Lumber: 30X135mm
- Round wood: ø140mm
Control wood: surface checks were occurred during drying
Sealing wood: dried without drying defects

### Results & Discussion

#### Comparison of drying defects

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Control wood: surface checks were occurred during drying
Sealing wood: dried without drying defects
Utilization of center-bored timber

Dried center bored timber

Use as structural timber
Conclusion

1. Reduction of drying time by high temperature drying of center-bored timber

2. Preventing drying defects by sealing pitch pine center-bored timber

3. Reduction of drying energy of large cross section timber by center-boring process
Thank You!