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Preliminary Study on Compressed Preservative-treated Wood (CPW) for Outdoor Applications

○ Jinzhen Cao, Jia Mao

Faculty of Materials Science and Engineering

Beijing Forestry University

Qinghua Eastroad 35, Haidian

100083, Beijing, China

Background

- ◆ According to the 6th Chinese Survey of Forest Resources, the area of plantation-grown forests in China was 53 million hectares.
- ◆ wood from plantation-grown forests
 - inferior mechanical properties
 - Inferior decay-resistance
- ◆ It is of great importance to improve both respects.

Objective

- ◆ CPW (compressed preservative-treated wood)
 - Increase surface hardness and wearability;
 - Increase decay resistance by preservative-treatment.



Previous research on wood compression

- ◆ How to fix the compression deformation of wood?
 - Aim: 100 % fixation of deformation.
- ◆ How to improve the liquid permeability of wood?
 - Aim: 100% recovery of deformation.
- ◆ **This study: How to fix the compression deformation of surface area and at the same time improve the liquid permeability?**
 - Aim: selective fixation and recovery

Specimens

- ◆ Wood species: Chinese fir (*Cunninghamia lanceolata* Hook.) sapwood
- ◆ Average air-dried density: 0.355 g/cm³
- ◆ Dimension: 100 (L) × 50(T) × 25 (R)mm

Experiments

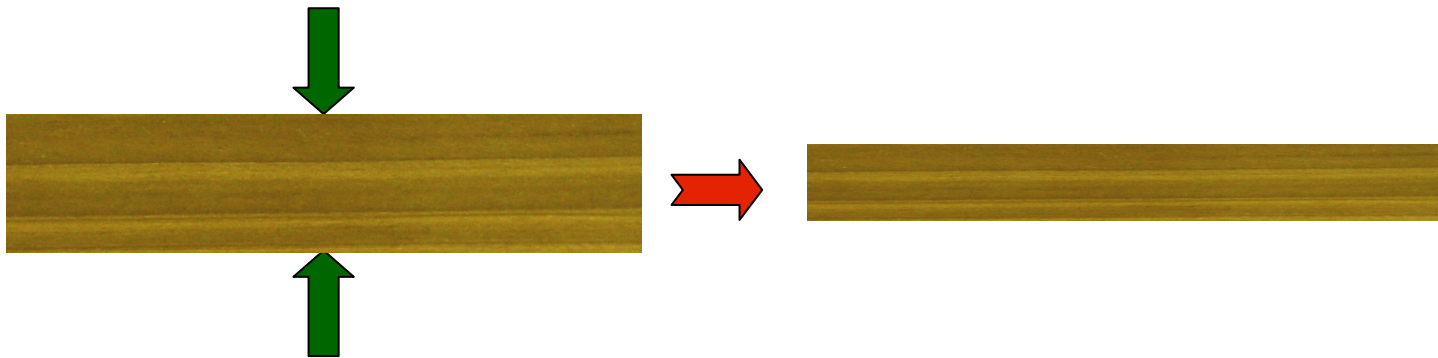
- ◆ Pretreatment
- ◆ Radial compression
- ◆ Preservative treatment
- ◆ Fixation
- ◆ Parameters and property testing

Pretreatment

Sample labelling	Pre-treatment method	Pre-treatment conditions
AD	Air-dried	-
PB50	Partly water bath	Temperature: 50°C
PB80	Partly water bath	Temperature: 80°C
WB50	Wholly water bath	Temperature: 50°C
WB80	Wholly water bath	Temperature: 80°C
SS200	Single surface spraying	Amount of water: 200ml
SS400	Single surface spraying	Amount of water: 400ml
DS200	Double surface spraying	Amount of water: 200ml
DS400	Double surface spraying	Amount of water: 400ml

Radial compression

- ◆ Temperature: 160°C
- ◆ Duration: 20min
- ◆ compression rate: 52%



Preservative treatment and fixation

- ◆ Preservative treatment: impregnated into a tank with 1% ammine copper quat –type D (ACQ-D) for 7 days;
- ◆ Fixation: placed in the conditioning room (25°C, 60%R.H.) for 48 h, and then dried in an oven at 70°C for another 12 h.

Parameters and properties (1)

◆ Liquid absorption (LA)

$$LA = M_2 - M_1$$

- Where, M_1 and M_2 represent the weight of the specimen before and after preservative impregnation, respectively.

◆ Recovery rate of compression stain (R_s)

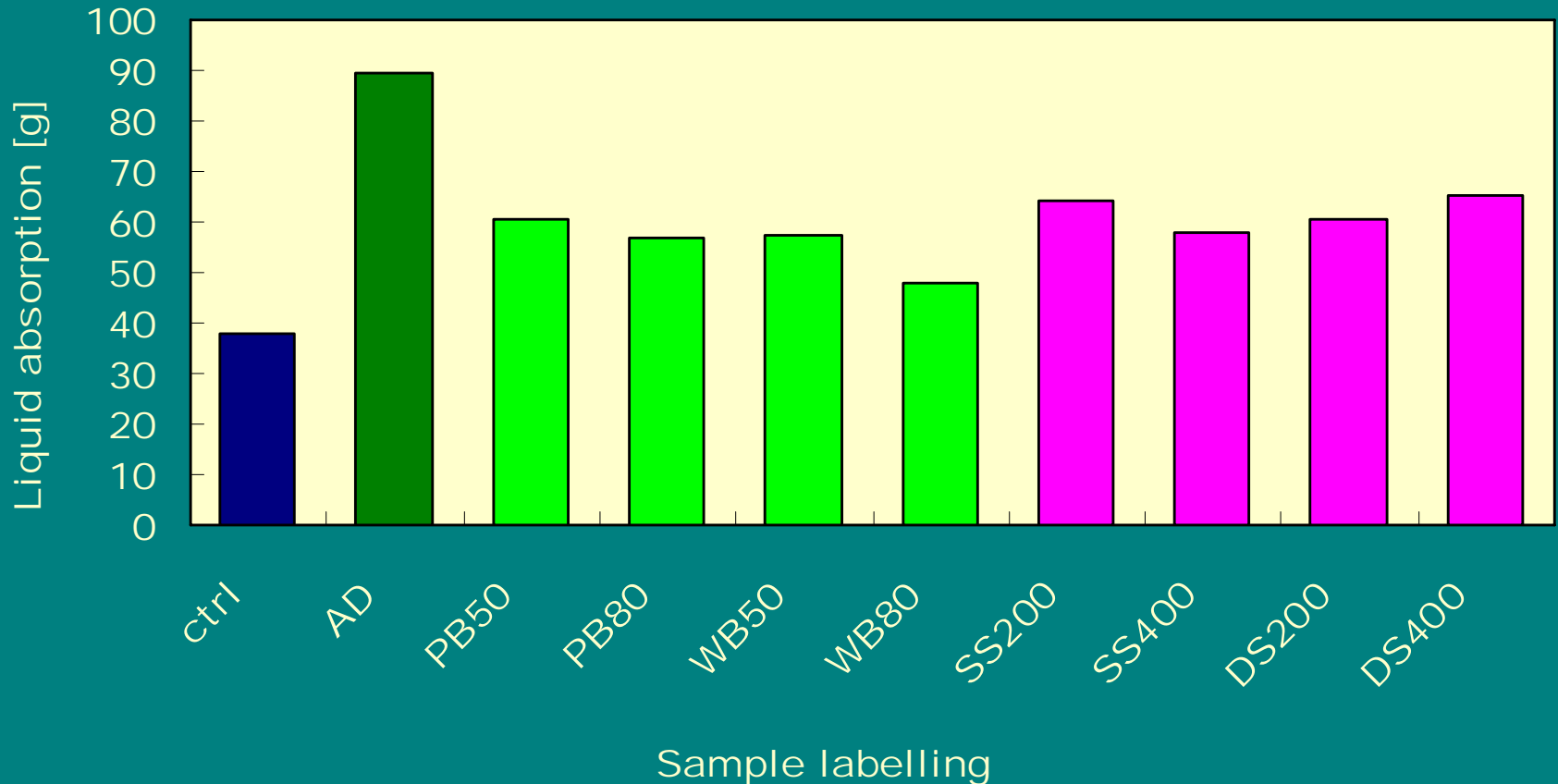
$$R_s = \left[\frac{(L_r - L_c)}{(L_o - L_c)} \right] \times 100\%$$

- Where, L_r is the thickness of the specimen after preservative impregnation, L_o and L_c are the thickness of the specimen before and after compression.

Parameters and properties (2)

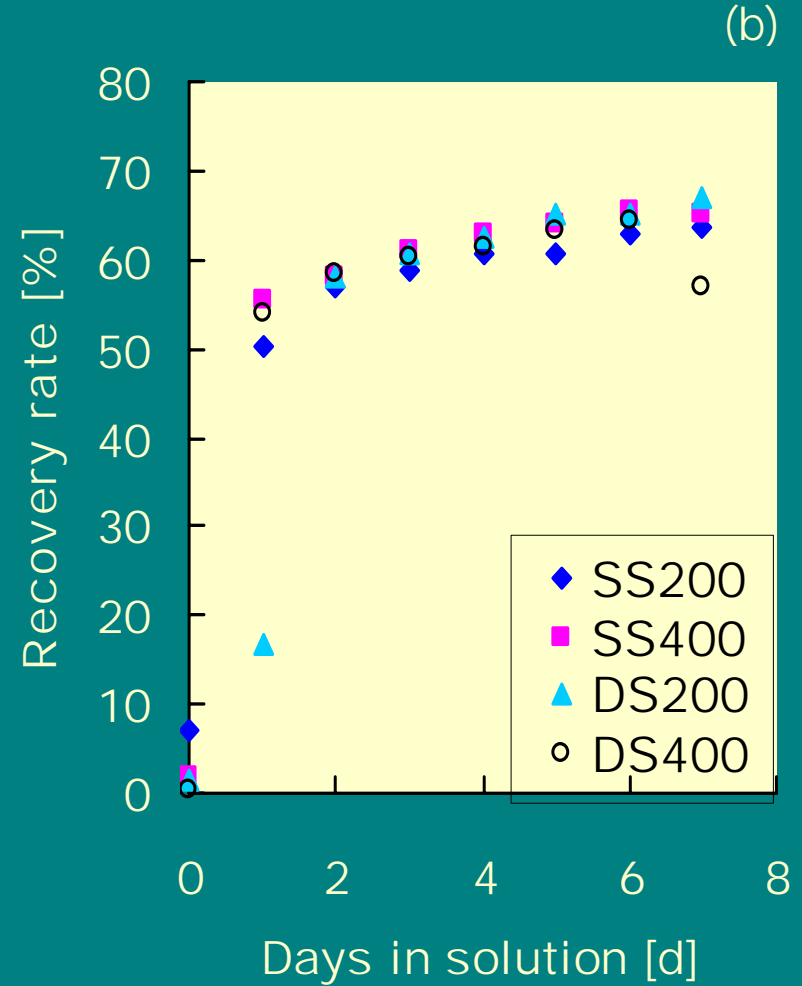
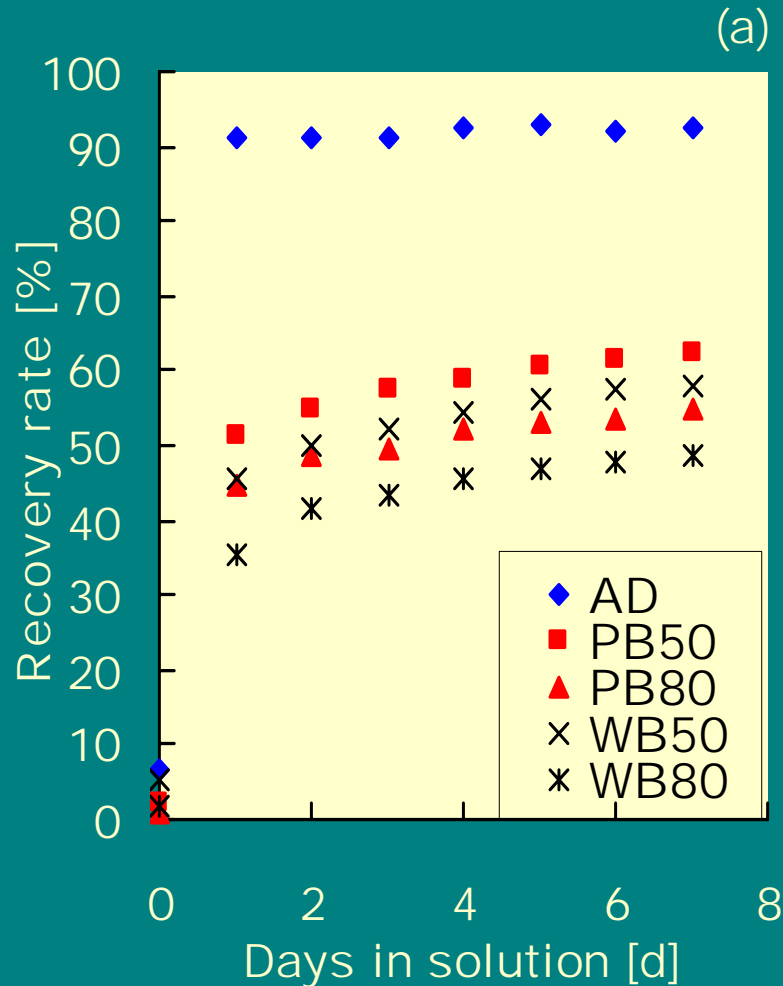
- ◆ Surface hardness: Vickers hardness tester (HMV-2, Shimadzu Co., Japan)
- ◆ Density distribution along thickness direction: Density analyzer (GreCon DA-X, Germany)
- ◆ Copper distribution along thickness direction: dividing the specimen into 5 layers with equal thickness, grounded and analyzed in X-ray fluorescence spectrometer (Spectro Phoenix, Germany).

Liquid adsorption of specimens after different pre-treatments

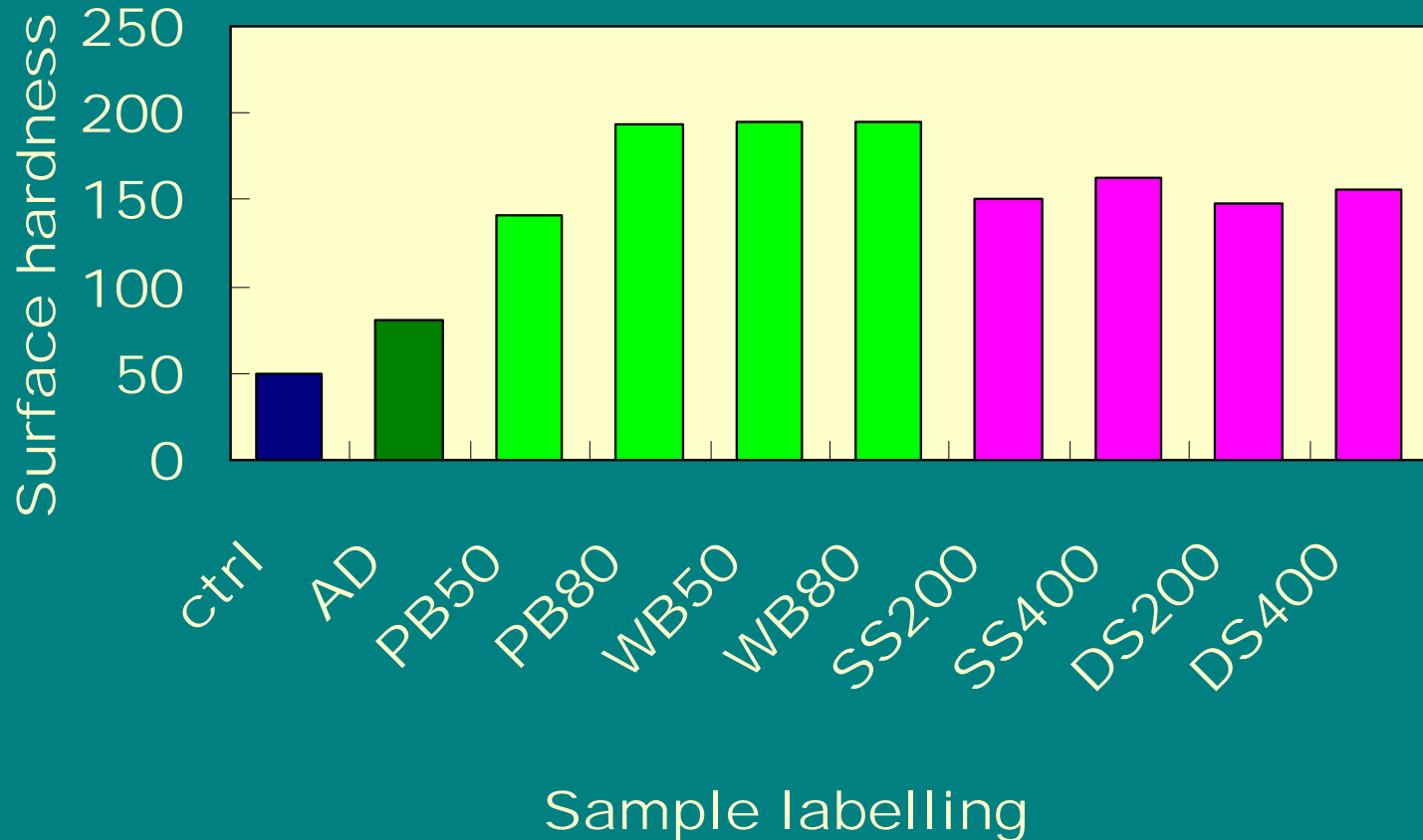


The LA values of all compressed wood samples are higher than that of untreated control (ctrl). The LA value of the specimen compressed directly at air-dry condition (AD) is the highest.

Recovery rate of the compressed specimens after different pre-treatments

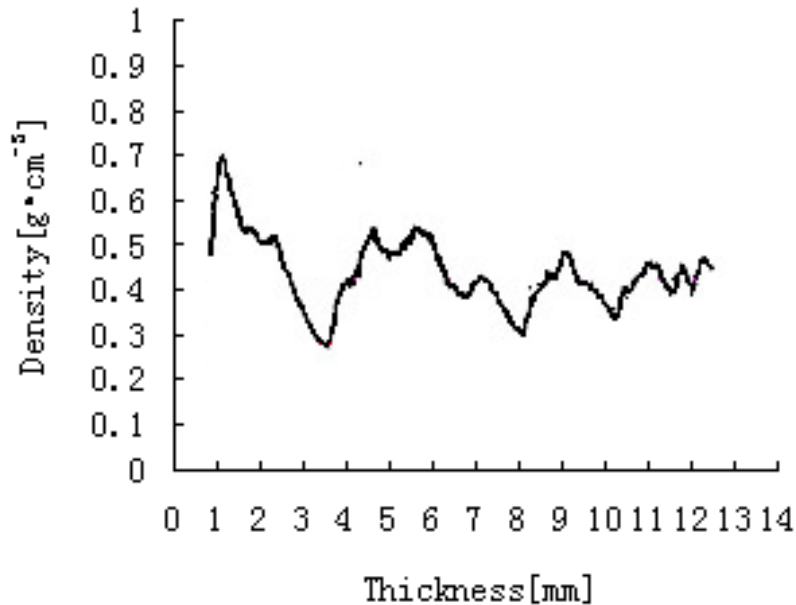


Surface hardness of CPW

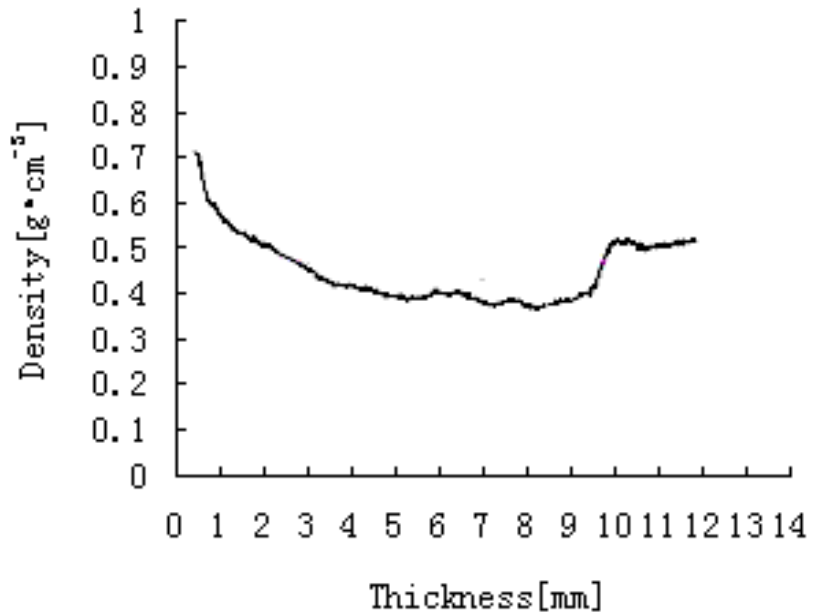


The average Vickers hardness of untreated control is about 50.2, while the value for CPW samples ranges from 140 to 200, which are about 3 to 4 times of untreated control (ctrl).

Density distribution of CPW with different pre-treatments



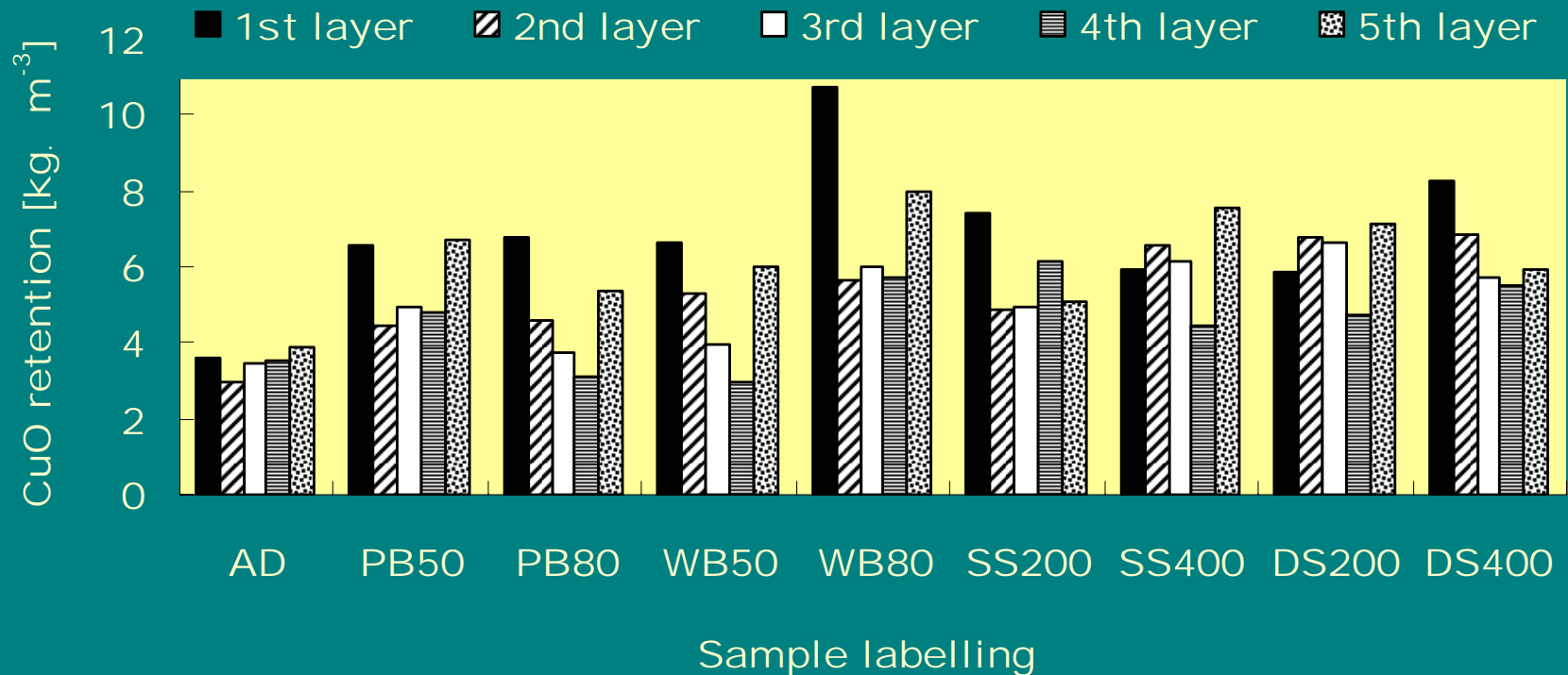
Without pre-treatment (AD)



PB50 pre-treated

- ◆ **AD:** the density waves along the thickness direction since the density of earlywood is much lower than that of latewood.
- ◆ **PB50:** The density distribution is inclined to be even, and the higher density appears on both surfaces.

CuO distribution of CPW with different pre-treatments



The CPW samples with pre-treatments all appear high CuO retention, and have the same trend of distribution, namely, the CuO retention shows the highest value for surface, and then declines inside.

Conclusion

- ◆ The approach of preparing CPW by using the force produced during the recovery of compression deformation is feasible.
- ◆ The pre-treatments prior to compression have great influence on the properties of CPW. By selecting suitable pre-treatments and compression conditions, the surface hardness and density can be improved simultaneously, and also the absorption and distribution of the effective components of wood preservative in wood can be optimized.

More information

- ◆ This approach can not only used in wood preservation, but also in other impregnation treatments such as wood dyeing, fire-retardant treatment, etc.
- ◆ This treatment can obvious improve the permeability of refractory wood.

The End

Thank you

Contact information:

caoj@bjfu.edu.cn

Beijing Forestry University 25#

Qinghua Eastroad 35

Haidian, Beijing, China 100083