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Color Degradation, Hardness and Abrasion Resistance of Coated Black Cherry Lumber

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Abstract: In this study, the coating properties and surface performance of exotic cherry wood (*Prunus serotina*) were estimated, reviewing color difference, hardness and abrasion resistibility in order to evaluate probability as construction interior members such as wall and floor. The reduction effect of color difference was represented in the order of water soluble color stain, water soluble transparent stain, and non-coated lumber. However, the tendency of distinct difference according to wood grain pattern was not found. The wavy grain lumber showed better properties in hardness and resistance to abrasion than quarter grain. In conclusion, it was supposed that the application of wavy grain lumber in wall and floor as interior materials would be acceptable in practicality.

Keywords: *exotic cherry wood (Prunus serotina), coating, color difference, hardness, abrasion resistibility, quarter grain, wavy grain*

1. Introduction

These days the diverse types of felled logs from forest have been occuring because of increased abnormal weather change. These phenomena typically contain the logs injured by forest fire, forest disease and pest and typhoon, etc.

Currently the import of wood amounts to about 89% of domestic wood demand, therefore, an whole utilization of forest products such as thinnings, forest tendering, and residues through sustainable forest management are becoming a very important concept. Therefore, not only waste residues in forest and outdoors but also wood resources injured by weather disaster should to be used efficiently.

Exotic species such as black cherry, Norway spruce, and black locust on KFRI arboretum in KIST district were struck by Kompus typhoon in september, 2010. At this time, much Korean pines were felled in Gwang Neung Experimental Forest, and are being supplied as structural members in Test house(timber post-and-beam construction) which is being constructed by Dept. of Forest Resources Development of Korea Forest Research Institute in 2011. This study was carried out in order to develop such construction interior panels as wall and floor in Test House.

In relation to this study, Kang etc. (2006) reported that the heat-treated wood showed a distinct change of wood color. Kim etc. (2002) mentioned the LPM overlaid-under-floor heating board, and there was also same tendency at abra-

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<Felled site of black cherry logs and cut logs>

<Sawing, high-frequency drying and prepared test specimens(from left)>

<Equipments for light fading test, spectrophotometer, Rockwell hardness test, and Taber abraser (from left)>

Fig. 1. Obtainment of test log, sawing, high-frequency drying, test specimen and testing apparatus.

sion resistance. Kim etc. (2008) reported in medical field that the resistant property is especially required for a liner of artificial articulation, and a hardness is dependent on the irradiation (kGy) of gamma ray on ultra-high molecular polyethylene. Kim etc. (2008) also mentioned that in case of decrease of abrasion resistance micro-particles of joint in human body would be formed and occur a bone fusion phenomenon. So he emphasized that close relation between hardness and abrasion.

Additionally, in an introduction of 「Finishing Eastern Hardwoods」 edited by Roy M. Carter, E. A. Wheeler mentioned "Finishing wood to bring out its most attractive features is an art based upon a through knowledge of both the finishing materials and characteristic properties of the wood."

Generally, the discoloration of wood is influenced by light, alien substance of metal etc., oxygenation and heating, microorganism, chemicals of acid and alkali.

First of all, the sawn lumbers need to be painted for the purpose of protecting surface and decorating appearance. Accordingly, cherry wood (*Prunus serotina*) which is supposed valuable for interior use was coated in 2 types of color stain and transparent stain. Then, surface properties of hardness and abrasion resistance and color change after light irradiation test were evaluated.

2. Experimental Procesure

2.1. Material

Cherry wood (*Prunus serotina*) was sawmilled

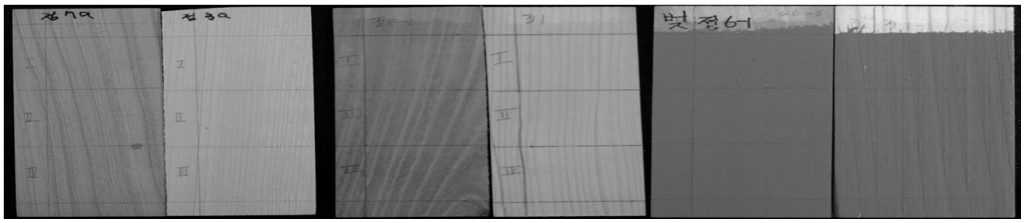

Fig. 2. Non-coated lumber, water soluble transparent stain (type 2), water soluble color stain (type 1).
* The above nominations are applied to both specimens from left.
* For both specimen, the first is wavy grain, the second is quarter grain.

to 2.5 cm (T) × 13.5 cm (W) of sawn lumber, and thereafter dried and planed to 1 cm (T) × 5 cm (W) × 15 cm (L) specimens.

For coating on lumber, two types of paints were used, Type Ⅰ was water soluble color stain (brand name; Noroo) and Type Ⅱ was water soluble transparent stain (brand name; Timber Chem.).

2.2. Methods

Sawn lumber was classified to quarter grain (柾目) and wavy grain (板目), green lumber and dried lumber, and non-coated lumber and coated lumber, respectively. After preparation of specimens, indoor natural light and light fading test was carried out. Then, color difference (ΔE) was measured about the above prepared lumber with spectrophotometer CM-700d, and light resistance was evaluated.

Also, hardness was measured with Rockwell hardness tester, and abrasion resistance was measured with Taber abrasion tester. Taber abrasion rubber was type CS-17, and decreasing amount (wt.) was measured for 10 cm (W) × 10 cm (L) lumber until 1,600 revolution.

As reference, the procedures of this study were illustrated as in Fig. 1.

3. Results and Discussion

In this study, the prepared appearance of test specimens were same as in Fig. 2.

3.1. Color Change by Light Irradiation

For non-coated and coated lumber classified into quarter grain and wavy grain, the color degradation effect after light irradiation as shown in Fig. 3 was estimated.

The color difference was obtained with calculation of below formula.

$$* \text{ Color difference } (\Delta E) = [(\Delta L)^2 + (\Delta a)^2 + (\Delta b)^2]$$

in which, ΔL = change of lightness
Δa = change of color in hue of yellow to blue
Δb = change of color in hue of red to green

As shown in Fig. 3, non-coated lumber (control), transparent stain-coated lumber and color stain-coated lumber showed color difference of steep slope within 24 hrs and thereafter sharply decreased till 48 hrs, and kept up mild declining state till 96 hrs. Also, the color differences were represented in the order of non-coated lumber > water soluble transparent stain > water soluble color stain.

However, there was no significant color difference between quarter grain and wavy grain as shown in Fig. 1, presenting a exceptional differ-

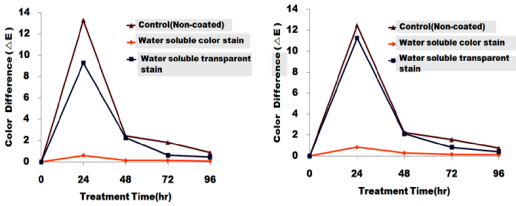

Fig. 3. Color difference (△E) of quarter grain (left) and wavy grain (right) at non-coated and coated lumber by light irradiation test.

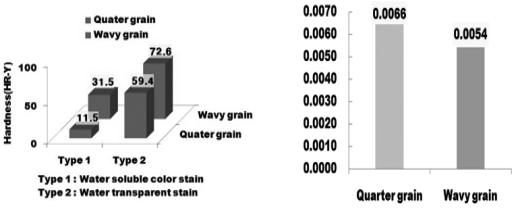

Fig. 4. Hardness (HR-Y) (left) and abrasion amount (wt.) per 100 revolution (right) of cherry lumber.

ence value of the below ΔE 10 in quarter grain and the above ΔE 10 in wavy grain with water soluble transparent stain coat.

The color difference (ΔE) showed 13.27 and 12.48 at the quarter grained lumbers and wavy grained lumber of raw green cherry wood with light treatment for 96 hrs.

Although water soluble color stain is more effective than water soluble transparent stain in terms of decrease of color change, the latter stain could be considered in order to keep up natural wood grain and color.

3.2. Hardness

The hardness of non-coated cherry lumber evaluated as shown in Fig. 4. Regardless of two types of coat, hardness of wavy grain lumber was greater than that of quater grain.

There was a considerable difference at hardness between two types of coat, i.e. water soluble transparent stain and water soluble color stain. It was observed that the hardness of lumber coated

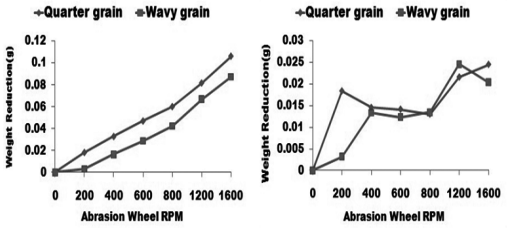

Fig. 5. Accumulative wt. reduction (left) and wt. reduction per 200 revolution (right) by abrasion test according to grain pattern of cherry lumber.

with the former stain was greater than that of lumber coated with the latter stain.

3.3. Resistance to Abrasion

The abrasion value results were represented as in Fig. 4 and Fig. 5. Reviewing the trends, the quarter grained lumber showed greater abrasion amount (wt.) than wavy grained lumber.

Also, the degree of abrasion was different according to wood grain pattern. It was found that the accumulative weight reduction by abrasion up to 1600 revolution of Taber abrasion was greater in the quarter grain lumber than the wavy grain lumber.

Therefore, the application of wavy grain lumber in wall and floor as interior materials would be favorable in terms of upgrading sawing yield, presence of natural cherry color and figure.

4. Summary

Wood has been widely used as interior use because of beautiful wood color and fine grain of wood. But, in case of using raw wood, the wood has also a defect failing to keep original color due to light discoloration etc. Therefore this study was examined to estimate the surface durability and the color change of cherry wood after coating treatment. Commercial paint (type I) for dried- and coated woods showed lower color change

than water soluble stain (type II) at both indoor natural light and light fading test irradiation. Two coatings showed high discoloration up to 24 hrs, and sharply decreased up to 48 hrs, and thereafter was stable to irradiation till 96 hrs. The coated quarter grain lumber was more durable to light than coated wavy grain lumber, and quarter grain lumber using general coating I showed the best durability against light.

In hardness test, it was thought that HR-values of quarter grain lumber and wavy grain lumber were dependent on their location at sapwood or heartwood. In comparison of quarter grain lumber and wavy grain lumber, hardness of the wavy grain lumber was higher than hardness of the quarter grain lumber. Generally the resistance to abrasion of wavy grain lumber was greater than that of quarter grain lumber. The quarter grain lumber kept regular decreasing amount from starting point to ending point at abrasion and figured relatively higher decreasing amount than the wavy grain lumber. But, the wavy grain lumber showed mild-slope decreasing amount at starting point of 0 to 200 revolution, and slowly decreased with medium-level decreasing amount in 200 to 800 revolution, and finally showed the greater decreasing amount at the beyond 800 revolution. In terms of durability, it was thought that the wavy grain lumber would be more favorable than the quarter grain lumber for floor panel.

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