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Author(s)	SUDIYANNI, Yanni; IMAMURA, Yuji; TAKAHASHI, Munezoh
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Preliminary

Weathering Effects on Several Properties of Chemically Modified Wood*[1]

Yanni SUDIYANNI*[2], Yuji IMAMURA*[3] and Munezoh TAKAHASHI*[2]

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Introduction

Wood exposed to weather undergoes degradation due principally to the effect of light and water. The ultra-violet (UV) light component of sun's rays is thought to have the most damaging effect on wood by depolymerizing lignin in the cell wall. Consequently, the decomposed lignin leads to the deterioration of physical, chemical and biological properties of wood. Furthermore, water such as rainfall would accelerate the occurrence of surface checking and roughness of exposed wood[1,2].

Although biodegradability and dimensional instability of wood have been improved by chemical modification, weathering effects on the modified wood has been less studied.

The objective of this study is to evaluate the weathering effects on several properties of chemically modified wood of albizzia and sugi by several methods. We described here the surface appearance of weatherd specimens and their decay resistance after weathering.

Materials and Methods

Wood specimens, measuring 45 (T)×3 (R)×145 (L) (mm), of albizzia (*Paraserianthes falcata* Becker) and sugi (*Cryptomeria japonica* D. Don) were prepared and oven-dried at 60°C for 3 days. They were chemically modified by acetic anhydride, propylene oxide, paraformaldehyde, dimethyrol dihydroxy ethylene urea (DMDHEU), and phenol-formaldehyde resins. Half numbers of modified and untreated control specimens were then subjected to surface coating with lacquer type of polyurethane resin (Dainippon Toryo, Co., Ltd.) to form the film-forming transparent finishes. The lacquer was diluted with toluene and applied by brushing at 100 g/m^2 in double coatings. Half of all specimens were

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*[2] Laboratory of Deterioration Control.

*[3] Laboratory of Wood Composites.

exposed to natural weathering with rainfall facing to the south at an angle of 45 degrees for one year, at the Wood Research Institute, Kyoto University, Uji, Kyoto, Japan. Another half of specimens were subjected to artificial weathering for total 1,080 hours which was combined with UV-irradiation and water spray, by using a commercial weathering chamber (Sunshine Super Long-life Weather Meter, WEL-SUN-HC, Suga Shikenki, Co., Ltd.). A carbon arc light of 3 Kwh was used as UV source at 50°C and 50% RH. A distilled water spray was made for 12 minutes in every hour. Evaluation of weathering effects was made mainly for surface appearance and decay resistance after exposure.

Table 1. Surface performance and weight loss of chemically modefied sugi wood after natural and artificial weatherings.

Treatment		Surface coating	Natural[a]		Artificial[b]	
Chemicals	WG (%)		Weathering index[c]	Weight loss (%)	Weathering index[c]	Weight loss (%)
Untreated	0	Yes	8	14.2	9	14.5
		No	8	16.1	10	18.4
Acetic anhydride	17.1	Yes	6	6.8	7	10.1
		No	6	8.4	9	13.6
	22.6	Yes	4	4.6	6	9.0
		No	4	6.1	8	10.1
	24.8	Yes	3	3.7	3	5.8
		No	4	5.1	6	9.2
Propylene oxide	7.1	Yes	6	8.1	4	11.7
		No	5	9.7	7	14.1
DMDHEU	12.5	Yes	5	10.1	5	11.4
		No	5	11.4	7	14.0
	22.6	Yes	5	7.9	4	10.0
		No	5	9.9	7	13.1
Paraformaldehyde	4.5	Yes	6	9.9	6	13.4
		No	6	10.7	7	14.5
	5.1	Yes	5	8.5	6	10.1
		No	5	8.7	7	13.3
PF-resin	10.4	Yes	4	6.9	6	9.3
		No	4	8.9	7	13.8
	16.7	Yes	3	5.7	4	9.5
		No	4	7.4	6	11.4
	20.6	Yes	3	3.8	4	6.9
		No	4	4.5	6	8.9

[a] After 1 year. [b] After 1080 hours. [c] Sum of cracking and hangnail ratings: 0=No cracking or hangnail, 1=Occurred at 10–20% of surface area, 2=at 20–40%, 3=at 40–60%, 4=at 60–70%, 5=at more than 70%.

Results and Discussion

Surface performance

For sugi wood, all modified specimens kept better surface performance and lesser weight loss after natural and artificial weatherings than that of untreated controls (Table 1). Artificial weathering caused severer deterioration of wood than did natural weathering, although 1,080 hours of artificial weathering was generally assumpted to be equivalent to one year of natural exposure in temperate zone. Effect of surface coating was recognized more clearly in artificial weathering than was in narural weathering. Evaluation of the

Table 2. Decay resistance of chemically modified sugi wood after weathering in 8-week laboratory test.

Treatment		Surface coating	Weight loss (%) by decay					
			Before weathering		Natural[a]		Artificial[b]	
Chemicals	WG (%)		TYP[c]	COV[d]	TYP[c]	COV[d]	TYP[c]	COV[d]
Untreated	0	Yes	45.8	45.3	52.0	54.9	55.7	55.9
		No	48.5	45.7	55.9	50.1	59.0	56.7
Acetic anhydride	17.1	Yes	0.6	0.1	4.3	2.5	13.2	8.9
		No	0	0	5.4	3.7	13.6	10.3
	22.6	Yes	0	0	1.6	1.7	7.3	4.6
		No	0	0	0	1.7	10.3	6.0
	24.8	Yes	0	0	0.5	0.3	0	5.2
		No	0	0	0	0.5	0	8.0
Propylene oxide	7.1	Yes	9.5	4.1	18.1	12.5	30.0	25.2
		No	10.6	5.3	20.9	11.6	32.1	29.7
DMDHEU	12.5	Yes	4.2	2.9	4.8	4.0	9.3	9.0
		No	4.6	3.1	5.2	4.0	11.2	9.3
	22.6	Yes	2.5	1.9	4.0	2.6	6.2	5.2
		No	2.9	2.1	4.2	2.9	6.2	7.4
Paraformaldehyde	4.5	Yes	7.4	4.4	15.9	11.2	22.3	19.2
		No	8.1	4.9	17.0	11.5	23.2	20.2
	5.1	Yes	7.0	2.5	12.4	6.2	21.6	18.8
		No	7.3	2.4	14.8	7.8	22.3	20.4
PF-resin	10.4	Yes	0.3	1.6	2.1	2.3	2.6	2.3
		No	0	0.8	2.4	1.9	2.9	2.9
	16.7	Yes	0.4	0	0	0.6	1.6	1.8
		No	0	0	0	0.8	1.7	2.0
	20.6	Yes	0	0	0	0	1.2	0.8
		No	0	0	0	0.3	1.9	0.9

[a] After 1 year. [b] After 1,080 hours. [c] *Tyromyces palustris*. [d] *Coliolus versicolor*.

treatments tested was not clearly established in achieving good surface performance and low weight loss. However, treatments with acetic anhydride and PF-resin seemed better than other treatments in these aspects. These results were approximately similar to those with albizzia wood.

Decay resistance

Decay test was made in laboratory using blocks with 22.5 mm×24.0 mm cross area which were prepared from weathered specimens. Decay resistance of modified sugi wood reduced in all treatments after weathering, particularly by artificial weathering (Table 2). However, PF-resin treated blocks were most resistant after weathering, followed by the acetylated blocks which had equally strong decay resistance before weathering. While in albizzia wood, acetylated blocks were ranked best in yielding the highest resistance after weathering and DMDHEU-treated blocks were ranked the next. These rankings were approximately derived from the original resistance before weathering. Acetylation achieved higher decay resistance for both wood species, but the treatments with PF-resin and DMDHEU resulted in different effects between sugi and albizzia. Treatments with propylene oxide and paraformaldehyde could not yield a good decay resistance for both wood species in the present experiment and it might caused the subsequent poor resistance after weathering. Different effects among wood species or between softwood and hardwood have been often recognized in any chemical treatment. Therefore, assessment of chemical modification should be made in consideration of these variance, and should be conducted using several wood species.

Among the various methods to evaluate the weathering properties of chemically modified wood, bio-assay of treated wood after weathering is considered simple but useful tool for this purpose.

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