Pressure Treated Wood for Outdoor Structures

MARVEL WOOD

Technical Data

MARVEL corporation

Contents

1. What is “Marvel Wood”?

“Marvel wood” is the pressure treated wood having the concepts as “Contribute the environmental conservation” and “Change to the better landscapes”.

1.1 Concepts

“Contribute the environmental conservation”

Forests take in Carbon dioxide from the atmosphere in the growth process, and fix the carbon as the tree. Also, there is a property that the emission of carbon dioxide when manufacture the wood products is a little compared with metal products or concrete products. Therefore, using “Marvel wood” can be the effective device for the reduction of carbon dioxide emissions and the measure of global warming.

“Change to the better landscapes”

“Marvel Wood” is same as natural wood regarding appearance, touching and texture. Therefore, discoloring like the treated wood with heavy metal preservatives is not appeared, nor you will not feel the strange feeling like the plastic imitation wood. Also, "Marvel Wood" can provide the warmth of wood to the around, but the metals or concrete cannot do that.

1.2 Demerit of Wood

The wood is the superior material having some properties, but unfortunately having some demerits. A most demerit when use long-term is the low durability.

The wood is the natural resources, so it's included in the food chain. In other words, the wood strength decrease because of be eaten by wood decay fungus and termites.

"Marvel Wood" is the treated wood with Japanese wood preservative, and protects the wood from the deterioration by these creatures.

Wood preservative used in "Marvel Wood" is authorized by Japan Wood Protection Association as effective wood preservative. The authorize number is "A-5443"

Wood decay fungi

Termite

Impregnation plant

Wood preservative manufacture plant (Japan)

2. Performance of “Marvel Wood”

“Marvel Wood” is having three characteristics as follows.

Good Appearances

- The appearance, touch and texture are not changed by wood preservative or impregnate process.
- Includes fungicide, therefore treated wood surface are decreased the black discolorations caused by mold.

Environmentally Friendly

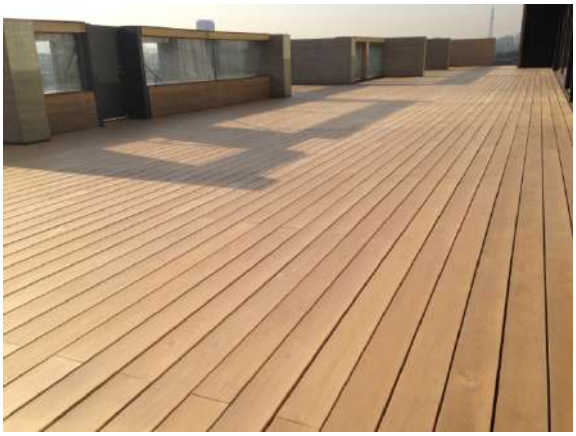
- Not included the heavy metal compounds
- Not included the chlorine-based compounds
- A overwhelmingly low fish toxicity compared with the conventional treated wood.
- The leaching of the active compunds caused by water like rainwater is little.

High Durability

- Regarding the wood decays and termites, as a result of evaluated by laboratory tests and field tests based on Japanese Industrial Standard, "Marvel Wood" conformed to the performance standard in all tests.
- Also regarding the iron corrosion, "Marvel Wood" conformed to the performance standard of Japanese Industrial Standard.

2.1 Good Appearances

“Marvel Wood” is not influenced the woody appearance, touch and texture by the impregnate. Therefore, it can make use of the warmly and naturally wood characteristics to around landscape.



Deck made of "Marvel Wood"

“Marvel Wood” includes the fungicide, therefore the black discolorations caused by mold will be reduced. A below photo is the results of the outdoor weathering test, “Marvel Wood” and Non-treated wood were exposed in one year. “Marvel Wood” was keeping the appearance of wood, but Non-treated wood had the black discolorations caused by mold.

Results of the outdoor weathering test in one year

Top : Marvel Wood

Bottom : Non-treated wood

2.2 Environmentally Friendly

2.2.1 Fish toxicity of treated wood

As a result of fish toxicity test for the treated wood, “Marvel Wood” was low toxicity compare with some treated wood impregnated the conventional wood preservatives.

Materials and Methods

After acclimated 10 killifishes to 4L dechlorination water in the test tanks, the test was started by put the treated wood with 3 type wood preservatives written on table 1 under the test water. The treated wood is Japanese cedar sapwood, the size of 20mm x 20mm x 10mm, and used three pieces(=total volume 12cm^3) each the test tanks. The dilution rates of each wood preservatives were adopted the recommended dilution rates for exterior use. The toxicity was assessed with the dead number at the time of an exposure endpoint of 96 hours.

Test Organization

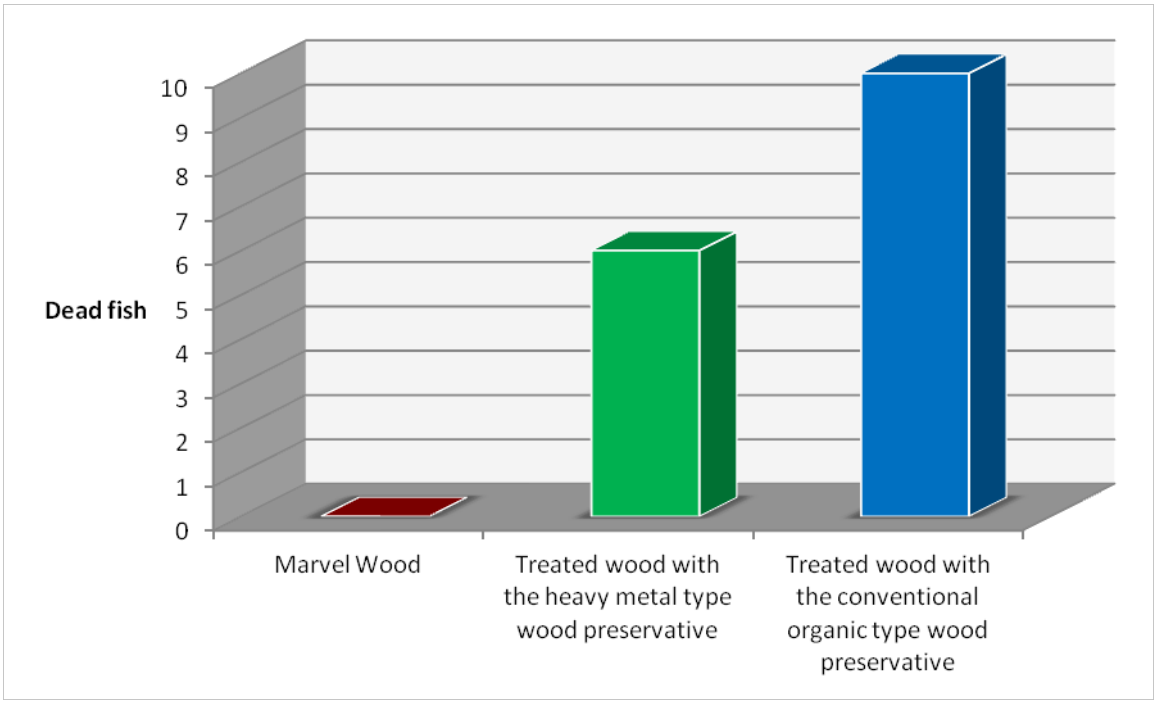
Japan Food Research Laboratories

Results

The test results are given below in Table 1. No dead fish was in the test group of “Marvel Wood”. But, 6 of 10 fishes dead in the test group of the treated wood with the heavy metal type wood preservative. Also, in the test group of the treated wood with the conventional organic type wood preservative, all fishes dead. These results suggested that “Marvel Wood” is low toxicity compare with the other treated wood.

Table 1: Results of Fish Toxicity test

	Amount of impregnate (kg/m^3)	Total volume of treated wood (cm^3)	Dead / All (number of fish)
Marvel Wood	819	12	0 / 10
Treated wood with the heavy metal type wood preservative	843		6 / 10
Treated wood with the conventional organic type wood preservative	828		10 / 10



Numbers of the Dead killifish after 96h exposure

2.2.2 Leachability test of active ingredient

The active ingredient leachability from the treated wood caused to water were assessed the leaching test method based on JIS K 1571. The leachability of “Marvel Wood” was very low level compare with the other wood preservatives. This suggests that “Marvel Wood” is low toxicity and low environmental load.

Materials and Methods

By the quantitative analysis of active ingredients in the leaching liquid after conducted the leaching operation based on JIS K 1571, the active ingredient leachability from the treated wood caused to water were assessed. After conducted the leaching operation (Dipping 8 hours under 10 times the volume of running water to the test wood volume) to the treated wood (Japanese cedar sapwood, the size of 20mm x 20mm x 10mm, 5 pieces) with 3 type wood preservatives written on table 2, the leaching liquids were collected. Also, each wood preservatives were impregnated with diluted to the recommended dilution rates for exterior use. Regarding the quantitative analysis of the leaching liquid, quaternary ammonium compounds were analyzed by absorption spectrophotometry, copper compounds were analyzed by Inductively Coupled Plasma - Atomic Emission Spectrophotometry.

Test Organization

Katayama Chemical, Inc.

Results

The test results are given below in Table 2. The leachability of DMPAP as the main ingredient of “Marvel Wood” was 1.7%. Conversely, the leachabilities of Copper and DDAC as the main ingredients of the conventional wood preservatives were Copper: 16.8%, DDAC: 23.0%. These leachabilities were high compare with DMPAP.

Table2: Results of the leachability test

	Amount of impregnate (kg/m^3)	Analysis ingredient	Leachability (%)※	Analysis method
Marvel Wood	822	DMPAP	1.7	Absorption spectrophotometry
Treated wood with the heavy metal type wood preservative	784	Copper	16.8	Inductively Coupled Plasma - Atomic Emission Spectrophotometry
Treated wood with the conventional organic type wood preservative	824	DDAC	23.0	Absorption spectrophotometry

※Leachability(%)

$$= \frac{\text{Amount of ingredient in the leaching liquid}}{\text{Main ingredient amount include in the test pieces calculated from impregnate amount}} \times 100$$

2.2.3 Safety tests of wood preservative

Regarding the wood preservative impregnated in “Marvel Wood”, the safety was assessed. The safety tests were conducted to conform to OECD test guidelines.

Materials and Methods

Test items written on the below table 5 were conducted with conform to OECD test guidelines. The tests were conducted in the test organization comply with GLP

Test Organization

CiToxLAB Hungary Ltd.

Results

The test results are given below in Table 3&4.

Table3: Results of toxicity tests to humans or animals

Test Items	Experimental Animals	Number of Animals	Results	Test Guideline
Acute Oral Toxicity	Rat	♀3	LD_{50} =300~2000 mg/kg	OECD423
Acute Dermal Toxicity	Rat	♂5 ♀5	LD_{50}＞2000 mg/kg	OECD402
Acute Inhalation Toxicity	Rat	♂5 ♀5	LC_{50}(4h) =0.51~1.05 mg/L	OECD403 (Nose-Only)
Acute Eye Irritation	Rabbit	♂3	Eye Irritant	OECD405
Acute Skin Irritation	Rabbit	♂3	Mild Irritant	OECD404
Skin Sensitization	Guinea Pig	20	Non-sensitizer	OECD406

Table4: Results of toxicity tests to aquatic organism

Test Items	Experimental Animals	Number of Animals	Results	Test Guideline
Acute Fish Toxicity	Common Carp	7	LC_{50}(96h)=4.04 mg/L NOEC(96h)=2.5mg/L	OECD203
Acute Immobilisation	Daphnia	20	EC_{50}(48h)=3.28 mg/L NOEC(96h)=2.5mg/L	OECD202

2.2.4 Quantitative analysis of gases evolved by combustion

Regarding 52 gases evolved by combustion, the amounts of each gas generations between “Marvel Wood” and Non-treated wood were made comparisons. The results showed that there are hardly any differences of the gases composition between “Marvel Wood” and Non-treated wood.

Materials and Methods

“Marvel Wood” and Non-treated wood (Western hemlock) were burned, and the generation gases were collected. The compound quantities in table 5 included in gases were analyzed with using some instrumental analysis methods.

Test Organization

NIPPON STEEL & SUMIKIN TECHNOLOGY Co., Ltd.

Results

The test results are given below in Table 5.

Table5: Results of quantitative analysis of gases evolved by combustion

Compounds	Non-treated wood (mg/g)	Treated wood (mg/g)	Compounds	Non-treated wood (mg/g)	Treated wood (mg/g)
Carbon monoxide	210	210	Toluene	0.46	0.46
Carbon dioxide	680	720	Xylene	0.48	0.45
Tetrachloroethylene	<0.02	<0.02	Styrene	0.17	0.17
Trichloroethylene	<0.02	<0.02	Carbon disulfide	<0.001	<0.001
Acrylonitrile	<0.5	<0.5	Hydrogen sulfide	<0.001	<0.001
Vinyl chloride monomer	<0.01	<0.01	Methyl mercaptan	<0.001	<0.001
Chloroform	<0.02	<0.02	Dimethyl sulfide	<0.001	<0.001
1,2-Dichloroethane	<0.02	<0.02	Dimethyl disulfide	<0.001	<0.001
Dichloroethane	<0.01	<0.01	Benzo[a]pyrene	<0.001	<0.001
1,3-Butadiene	2.1	2.4	Formaldehyde	1.2	1.1
Carbon tetrachloride	<0.02	<0.02	Acetaldehyde	1.7	1.7
1,1-Dichloroethene	<0.01	<0.01	Acrolein	0.32	0.25
cis-1,2-Dichloroethene	<0.01	<0.01	Propionaldehyde	0.39	0.41
1,1,1-Trichloroethane	<0.02	<0.02	n-Butyraldehyde	0.11	0.10
1,1,2-Trichloroethane	<0.02	<0.02	Isobutyraldehyde	<0.05	<0.05
1,3-Dichloropropene	<0.02	<0.02	n-Valeraldehyde	<0.1	<0.1
Chlorobenzene	<0.02	0.07	Isovaleraldehyde	<0.1	<0.1
Methanol	1.8	1.8	Hydrogen chloride	0.032	<0.001
Pyridine	<0.01	<0.01	Hydrogen bromide	<0.001	<0.001
Phenol	<0.01	<0.01	Sulfur oxide	<0.05	<0.05
Ethylene oxide	<0.02	0.03	Ammonia	<0.01	<0.01
Trimethylamine	<0.01	<0.01	Nitrogen oxides	<0.01	0.03
Isobutyl alcohol	<0.01	0.01	Hydrogen cyanide	0.007	0.018
Ethyl acetate	0.06	0.07	Phosgene	<0.1	<0.1
Methyl isobutyl ketone	<0.01	<0.01	Benzene	1.1	1.2
Chloromethyl methyl ether	<0.01	<0.01	Organophosphorus compound	<0.005	<0.005

2.3 High Durability

2.3.1 Laboratory test to wood decay fungi (JIS K 1571)

A resistance of “Marvel Wood” to wood decay fungi was evaluated with the laboratory test in accordance with Japanese Industrial Standard. The results showed that a resistance ability of “Marvel Wood” to wood decay conformed to the performance standard.

Materials and Methods

This test had been performed in accordance with the standard, JIS K 1571.

Test Organization

Katayama Chemical, Inc.

Results

The test results are given below in Table 6. “Marvel Wood” was under 3% concerning the weight decrease rates and conformed to the performance standard in JIS K 1571.

Table6: Results of the laboratory test for evaluate resistance to wood decay fungi.

	Experimental fungus	Weight decrease rates (%)	
		Average	Standard deviation
Marvel Wood	*Fomitopsis palustris*	−1.4	0.0
	Trametes versicolor	−1.3	0.1
Non-treated Wood	*Fomitopsis palustris*	54.8	6.0
	Trametes versicolor	49.0	4.5

The test pieces after the test. (Left: Marvel Wood, Right: Non-treated wood)

2.3.2 Laboratory test to subterranean termites (JIS K 1571)

A resistance of “Marvel Wood” to subterranean termites was evaluated with the laboratory test in accordance with Japanese Industrial Standard. The results showed that a resistance ability of “Marvel Wood” to termites conformed to the performance standard.

Materials and Methods

This test had been performed in accordance with the standard, JIS K 1571.

Test Organization

Architectural Research Association

Results

The test results are given below in Table 7. “Marvel Wood” was under 3% concerning the weight decrease rates and conformed to the performance standard in JIS K 1571.

Table7: Results of the laboratory test for evaluate resistance to termites.

	Mortality rates (%)		Weight decrease rates (%)	
	Average	Min－Max	Average	Min－Max
Marvel Wood	100	100－100	1.3	1.2－1.5
Non-treated wood	8	7－9	31.8	29.4－36.0

The test pieces after the test. (Top: Marvel Wood, Bottom: Non-treated wood)

2.3.3 Field test with stakes (JIS K 1571)

“Marvel Wood” was evaluated with the field test in accordance with Japanese Industrial Standard. The results showed that “Marvel Wood” conformed to the performance standard.

Materials and Methods

This test had been performed in accordance with the standard, JIS K 1571.

Test Organization

Architectural Research Association

Test Location

Architectural Research Association Field Test Site
(Kinpou-chou, Minami-satuma-shi, Kagoshima Pref., Japan)

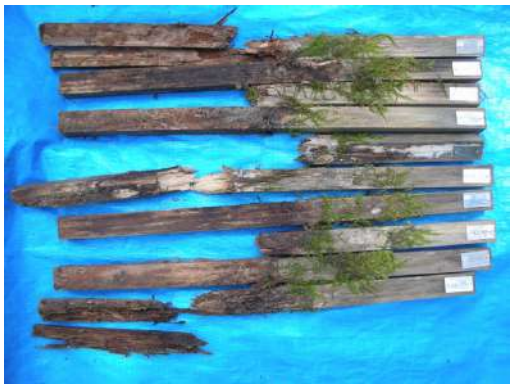
Results

The test results are given below in Table 8. As of 6 years from the test start, “Marvel Wood” was not observed the noticeable fungal decays or termite damages in all portions above ground, ground contact and underground. Conversely, Non-treated wood was observed many serious fungal decays and termite damages, greeted the useful life provided JIS K 1571 in 19 months from the test start. The useful life of “Marvel Wood” was more than 3 times as much than Non-treated wood and conformed to the performance standard in JIS K 1571.

Table: 8 Results of the field test with stakes

	Observation Portions	Degree of Damages		Useful Life	Remarks
		Average	Standard deviation		
Marvel Wood	Above Ground	0	0	–	As of 6 years from the test start
	Ground Contact	0.3	0.5		
	Underground	0.2	0.6		
Non-treated Wood	Above Ground	1.9	1.7	19 months	
	Ground Contact	5.0	0		
	Underground	4.4	1.1		

Marvel Wood
(As of 10 years from the test start)



Non-treated Wood
(As of 3 years from the test start)

A look of the field test with stakes

2.3.4 Field test with posts

As the results of field test with posts, “Marvel Wood” had nothing decays or termite damages, but all of non-treated wood had mild to severe decays and termite attacks.

Materials and Methods

This test had been conducted with using Japanese cedar and Japanese cypress posts (diameter 100mm x length 1500mm). “Marvel Wood” and Non-treated wood were prepared, and the test was started by buried the half (750mm) of these in the ground. The damage conditions were observed regularly.

Test Organization

Katayama Chemical, Inc.

Test Location

Architectural Research Association Field Test Site
(Kinpou-chou, Minami-satuma-shi, Kagoshima Pref., Japan)

Results

The test results as of 4 years from the test start are given below in Table 9. “Marvel Wood” had nothing decays or termite attacks in both of Japanese cedar and Japanese cypress posts. On the other hand, in non-treated wood posts, many damages including posts destroyed caused by decays and termites were observed in Japanese cypress posts, many damages were observed also in Japanese cedar posts.

Table: 9 Distributions of damage degree

	Wood Species	Degree of Damage				
		Sound	Slight Attack	Moderate Attack	Severe Attack	Failure
Marvel Wood	Cedar	100%	0%	0%	0%	0%
	Cypress	100%	0%	0%	0%	0%
Non-treated	Cedar	0%	33.3%	33.3%	33.3%	0%
	Cypress	0%	0%	33.3%	50.0%	16.7%

Wood						

A look of the posts as of 2 years from the test start

Top: Non-treated wood (broken) Bottom: Marvel Wood

Magnified photo of the broken portion on posts

Left: Non-treated wood (broken) Right: Marvel Wood

A look of the field test with posts

2.3.5 Field test to subterranean termites (JIS K 1571)

“Marvel Wood” was evaluated with the field test focused on termites in accordance with Japanese Industrial Standard. The results showed that “Marvel Wood” conformed to the performance standard.

Materials and Methods

This test had been performed in accordance with the standard, JIS K 1571.

Test Organization

Architectural Research Association

Test Location

Architectural Research Association Field Test Site
(Kinpou-chou, Minami-satuma-shi, Kagoshima Pref., Japan)

Results

The test results are given below in Table 10. As of 2 years from the test start, “Marvel Wood” was under 10 concerning the termite damage indexes and conformed to the performance standard in JIS K 1571.

Table: 10 Results of the field test focused on termites

	Specimen Number	Termite Rating		Remarks
		1st year	2nd year	
Marvel Wood	1	0	0	
	2	0	10	
	3	0	0	
	4	0	0	
	5	0	0	
	Termite Damage Index	0	0	
Non-treated Wood	1	10	30	
	2	50	100	
	3	30	30	
	4	30	50	
	5	50	100	
	Termite Damage Index	34	62	

The test stakes after the test. (Left: Marvel Wood, Right: Non-treated wood)

A look of the field test for termites

2.3.6 Field test to subterranean termites in Okinawa

Okinawa prefecture is the most activation area in Japan regarding termites activity. “Marvel Wood” was evaluated with the field test focused on termites in Okinawa, but “Marvel Wood” had nothing termite attacks. In contrast, all of non-treated wood were observed severe termite attacks.

Materials and Methods

This test had been conducted with using Japanese cedar and Western hemlock (105mm x 105mm x length 150mm, 3 for each wood specie). Hollow concrete blocks (100mm x 190mm x390mm) were prepared, and a bait wood (pine) for induce termites were drove in each three holes. Test wood were putted on the concrete block, and the test was started by covered with rain cover. The damage conditions were observed regularly.

Test Organization

Katayama Chemical, Inc.

Test Location

Field Test Site of Faculty of Agriculture, University of the Ryukyus (Nishihara-chou, Nakagami-gun, Okinawa Pref., Japan)

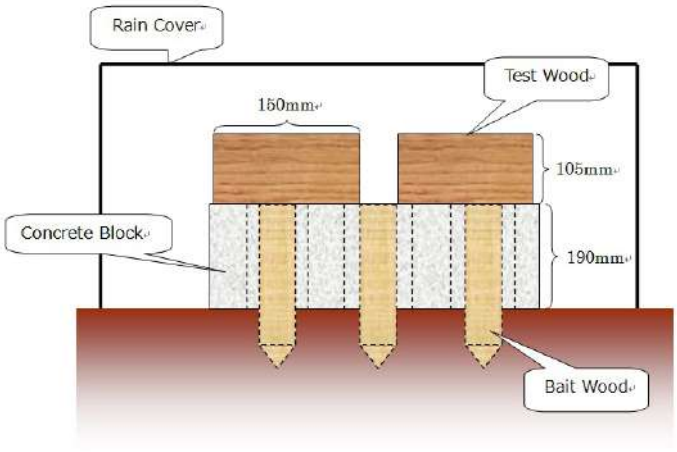
Results

The test results as of 6 years from the test start are given below in Table 11. “Marvel Wood” had nothing termite attacks in both of Japanese cedar and Western hemlock. On the other hand, all of non-treated wood in both of Japanese cedar and Western hemlock had severe termite attacks.

Table: 11 Distributions of damage degree

	Wood Species	Degree of damage			
		Sound	Slight Attack	Severe Attack	Failure
Marvel Wood	Cedar	100%	0%	0%	0%
	W.Hemlock	100%	0%	0%	0%
Non-treated	Cedar	0%	0%	100%	0%

Wood	W.Hemlack	0%	0%	0%	100%



Schematic diagram of the field test in Okinawa

The test wood of Japanese cedar
Left: Marvel Wood
Right: Non-treated Wood

The test wood of Western hemlock
Left: Marvel Wood
Right: Non-treated Wood

Damage example of non-treated western hemlock

2.3.7 Corrosion test of metal (JIS K 1571)

The iron corrosion of “Marvel Wood” was evaluated with the iron corrosion test in accordance with Japanese Industrial Standard. The results showed that “Marvel Wood” has the equality iron corrosion with non-treated wood and it conformed to the performance standard. The iron corrosion of “Marvel Wood” has nothing to get worse by influence of wood preservative.

Materials and Methods

This test had been performed in accordance with the standard, JIS K 1571.

Test Organization

Faculty of Agriculture, Utsunomiya University

Results

The test results are given below in Table 12. “Marvel Wood” was under 2.0 concerning the ratio of iron corrosion and it conformed to the performance standard in JIS K 1571.

Table: 12 Results of iron corrosion test

	Weight decrease rates (%)		Ratio of iron corrosion
	Average	Standard deviation	
Marvel Wood	0.8	0.1	0.9
Non-treated Wood	0.9	0.2	–

Marvel Corporation

・Head Office

4-30 Harame-cho, Fukui-shi, Fukui Pref., 910-0825, Japan
TEL : +81-776-53-7715 FAX : +81-776-63-5485

・Tokyo Office

#203 Riburi-Marvel, 3-39-8 Miyoshi-cho, Fuchu-shi, Tokyo, 183-0045, Japan
TEL : +81-42-310-9681 FAX : +81-42-310-9682