Mechanical Properties of Structural Particleboard and Termite and Decay Resistance

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The mechanical properties and termite and decay resistance performance of wood-based panel used in wooden houses were evaluated. The physical and mechanical properties, along with the resistance levels, of commonly used wood-based panels, including oriented strand board, structural particleboard, and particleboard for use in interior, were compared. The structural particleboard complied with the physical, mechanical, and formaldehyde emission standards of the International Organization for Standardization and Japanese Industrial Standard, surpassing the requirements for oriented strand board. The structural particleboard exhibited excellent water resistance and a consistent performance. Decay tests classified the particleboard and structural particleboard as "Resistant," with mass losses of 7.82 to 12.72% (white rot) and 14.69 to 16.55% (brown rot). Pine (*Pinus densiflora*) and oriented strand board exhibited no decay resistance, with mass losses exceeding 45%. The particleboard and structural particleboard demonstrated superior termite resistance, resulting in 100% termite mortality in three days without chemical treatment. The structural particleboard exhibited excellent water, decay, and termite resistance, which can be an advantage in wooden-house construction in terms of maintenance.

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INTRODUCTION

Due to economic development and lifestyle changes, interior decoration and furniture are being replaced periodically. Particleboard (PB) has become a popular choice for furniture and interior applications owing to its affordability and versatility. PB is formed from a mixture of shredded wood particles and synthetic adhesives, where this mixture is subjected to high pressure at high temperatures to bond the components. PB is one of the most efficient ways to use wood, because low-grade logs such as twigs and bent or twisted trees can be used as raw materials, along with wood by-products and recycled materials. Therefore, PB contributes to a beneficial cycle of resource use, and both its economic importance and production are experiencing continuous growth. Diversification of the raw materials and adhesives used in PB has been investigated to improve its performance (García-Ortuño *et al*. 2011; Altgen *et al*. 2015; Cui *et al*. 2015; Wang *et al*. 2017; Yildirim and Candan 2021; Kuqo *et al*. 2023). Moreover, PB applications have been expanded to structural implementations; for example, structural PB (SPB) has been used to wall, floor, and roof for light-frame wood houses.

In the early 2000s, light-frame wood houses were introduced to Korea from the United States and Canada. These houses have become popular because they are considered eco-friendly; therefore, the yearly number of constructions is steadily increasing (Lee *et al.* 2020). Recently, high-rise buildings using large wooden members made of materials such as cross-laminated timber have attracted attention; however, the domestic wood-construction market in Korea is still dominated by light-frame wood houses. The members used in light-frame wood houses can be divided into lumber for structural frames and wood-based panels for walls, floors, and roofs.

Structural wood-based panels are commonly used in construction as cost-effective and versatile alternatives to solid wood products. Currently, oriented strand board (OSB) is the most commonly used wood-based panel. The performance of wood-based panels used in light-frame wood houses is significantly affected by the adhesives used in their manufacture. Representative wood adhesives include amino-, phenol-, and isocyanate (NCO)-based substances. However, urea-formaldehyde (UF) resin adhesives exhibit poor water resistance and undergo physical decomposition when exposed to moisture or high relative humidity. In contrast, melamine-, phenol-, and NCO-based adhesives have better water resistance. To increase the water resistance of wood-based panels, melamine-urea-formaldehyde (MUF) and phenolic resins, or even superior resins, should be used.

However, a key concern with wood-based panels is their susceptibility to damage due to termites and decay due to prolonged exposure to moisture (Becker 1972; Behr 1972; Gardner *et al.* 2003; Kartal and Green 2003; Kose *et al.* 2011). Although wood-based boards are generally more resistant to such degradation than solid wood boards, they remain susceptible to biological attacks (Curling and Murphy 1999). Chung *et al*. (1999) demonstrated that wood-based composite boards have an equivalent susceptibility to microorganisms as solid wood boards. However, the termite and fungi resistance of the boards were found to be affected by their constituent wood species. Many researchers have found that increasing the proportion of naturally durable wood species in composite boards during their manufacture increases their resistance to biological attacks above that of nondurable wood. In particular, Barnes and Amburgey (1998) reported that furniture made from naturally durable wood species was more resistant to decay fungi and insects than furniture made from naturally weak wood species. Hermawan *et al*. (2012) found that PBs composed of high-density wood were more resistant to termite attacks than those composed of low-density wood. To address this issue, manufacturers often treat boards with chemical preservatives to improve their insect resistance and prevent decay. These preservatives include copper- and boron-based compounds as well as organic biocides.

This study determined the resistance of SPB to decay fungi and termite attacks. This material has improved mechanical properties and water resistance to facilitate its use in construction.

EXPERIMENTAL

Materials

Pine (*Pinus densiflora*) specimens were used as the control group; this material was approximately 35 years old and purchased from the Korea Forestry Association (Yeoju, Gyeonggi-do, Korea). Commercially available PB were obtained from Donghwa Enterprises (Incheon, Korea). The PB specimen dimensions were 1220 mm × 2440 mm × 12 mm, and their formaldehyde emission level was E0 (> 0.5 mg/L). OSB specimens were purchased from a local distributor in Incheon, Korea; their dimensions were 1219 mm × 2438 × 11.1 mm, and their formaldehyde emission level was E0. Average length and width of strand on surface of OSB was 11.3 cm (L) x 1.8 cm (W). Images of each sample are shown in Fig. 1.

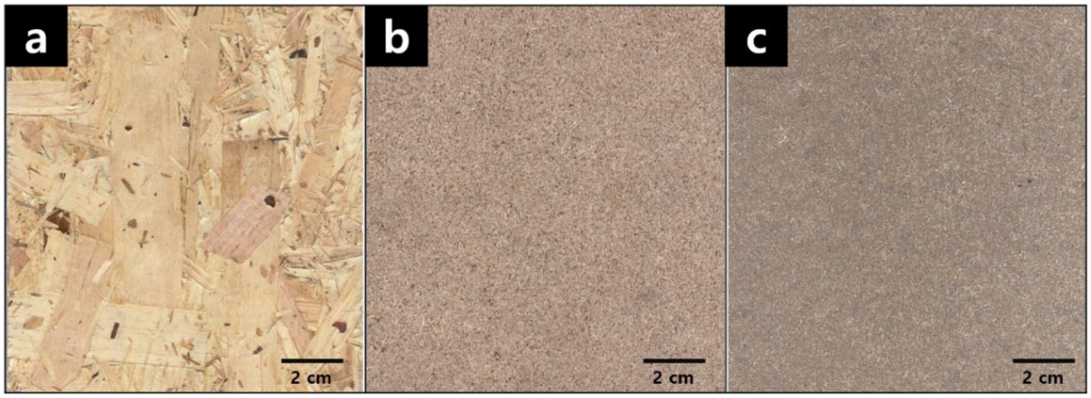

Fig. 1. Images of the wood-based panel samples (a–c: OSB, PB, SPB, respectively)

MUF resin synthesized in a production plant (Donghwa Enterprises, Incheon, Korea) was used; detailed specifications are provided in Table 1. Polymeric methylene diphenyl diisocyanate (pMDI) resin was obtained from Wanhua Chemical Group Co., Ltd. (Yantai, China). Detailed specifications of the resin are presented in Table 2.

Table 1. MUF Resin Specifications

	Solid content (%)	Viscosity (cps)	Gel time (s)	Specific gravity	pH	Water miscibility (%)
MUF	57.9	99	52.5	1.245	9.62	0.39

Table 2. pMDI Resin Specifications

	Color	Viscosity (cps)	NCO content (%)	Specific gravity	Acid content (%)	Hydrolysable chlorin (%)
pMDI	Brown	199	31.08	1.233	0.004	0.04

Methods

Manufacture of SPB

The SPB employed in this study was manufactured at a commercial plant in Incheon, South Korea, using recycled wood chips. Recycled wood chips, including sawn timber, are produced with used wood material from construction sites and offcuts twigs from roadside trees. First, the nails and impurities within the recycled wood chips were removed. Then, the wood particles were pretreated with chemicals (formaldehyde scavenger) for increased productivity. In this study, the SPB specimen dimensions were 2440 mm × 4880 mm × 12 mm. The target density was 0.75 g/m^3. The adhesive was produced by adding 12.0% MUF and 2.0% pMDI to the surface layer and 8.0% MUF and 5% pMDI to the core layer.

The wax-emulsion solid content was 40%, and 1 and 0.75% of the dry particle weight were used for the surface and core layers, respectively. A curing agent was employed at 0.3% of the dry particle weight. The surface-to-core layer composition ratio was 4:6. The thermal pressure conditions for SPB manufacture were as follows:

temperature of 200 °C, pressure of 50 bar, and press time of 8.0 s/mm. The manufactured SPB was cut into 1220 mm × 2440 mm × 12 mm specimens.

Evaluation of mechanical, physical, and chemical properties

To evaluate the mechanical and physical properties of the wood-based panels used for testing, the internal bonding strength, thickness swelling, and bending performance of each were tested according to ISO 16978:2003, 16984:2003, and 16983:2003. Additionally, to evaluate the water resistance of the specimens, their post-boiling internal bonding and wet bending strength were tested according to ISO 16998:2003 and 20585:2005, Method A (ISO 20585 2005). To assess the post-boiling internal bonding strength, the 50 mm × 50 mm specimens were stored at 20 ± 2 °C and 65 ± 5% humidity until a constant weight (error: 0.1%) was reached. The prepared test sample was then immersed in water at a temperature and pH of 20 ± 5 °C and 7 ± 1, respectively. The water was boiled to approximately 100 °C by slowly increasing the temperature for 90 ± 10 min; this temperature was maintained for 120 ± 5 min. After the test was completed, the samples were immersed in water at 20 ± 3 °C for 60 ± 5 min and then removed. The wet samples were wiped with a paper towel and then dried at 70 °C for 16 h. The internal bonding strengths of the dried samples were then measured. To determine the wet bending strength, a test sample was immersed in 70 ± 3 °C water for 2 h and then immersed in room-temperature water for 1 h. A bending strength test was then conducted on the wet samples. The formaldehyde emissions were measured according to KS M 1998 (KS M 1998 2022) using the desiccator method.

Fungal bioassay

Brown (*Fomitopsis palustris*, FRI 21055) and white rot (*Trametes versicolor*, FRI 20251) fungi were used for the decay resistance tests. A culture medium was prepared by dissolving 40 g of glucose, 3 g of peptone, and 15 g of malt extract in distilled water to a final volume of 1000 mL. Approximately 250 g of sand was added to a culture bottle as a reagent. Then, 80 mL of culture medium with the pH adjusted to 5.5 was added to the bottle. Next, the culture bottle was sterilized in a high-pressure steam sterilizer at 121 °C for 30 min. When the fungi in the culture medium were sufficiently grown, 3 mL was aseptically sprayed on the surface of a culture bottle and incubated at a temperature of 26 ± 2 ℃ and a relative humidity of 70% or higher.

Table 3. Block Evaluation Standard for Decay Resistance (ASTM-D 2017) (ASTM-D 2017 2005)

Average weight loss (%)	Classification
0 < *X* ≤ 10	Highly resistant
10 < *X* ≤ 24	Resistant
24 < *X* ≤ 44	Moderately resistant
44 < *X*	Slightly resistant or nonresistant

The test-sample dimensions were 20 mm × 20 mm, with the pine having a thickness of 10 mm and the wood-based panels having 'as-manufactured' thicknesses. Each test sample was sterilized with ethylene oxide gas for more than 5 h in a gas sterilizer, and three samples of each type were placed in direct contact with hyphae for 12 weeks at a temperature of 26 ± 2 ℃ and a relative humidity of 70% or more. In the case of *T. versicolor*, the test samples were placed directly on the culture. However, for *F. palustris*, the test samples were placed on a 1 mm heat-resistant plastic net, which was sterilized using an autoclave. In both cases, the test samples were retrieved after a 12-week exposure to the decay fungi, and the hyphae and other surface attachments were completely removed. The samples were then air-dried for approximately 24 h. The test samples were dried at 60 ± 2 °C for 48 h and then cooled in a desiccator for 30 min. The sample weight was measured, and the mass loss was calculated. A decay-resistance rating was assigned; the decay-resistance evaluation standards are listed in Table 3.

Termite bioassay

First, 150 g of dried sand was placed in a washed glass bottle (80 mm diameter × 100 mm height); then, 27 mL of distilled water (18% of the water holding capacity) was added to the bottle. The bottle was then stored at room temperature for 2 h so that the moisture could sufficiently dissipate through the sand. A series of bottles were prepared, and one test sample was placed in each bottle, along with 396 worker termites and 4 soldier termites (that is, 1 to 3% of the worker termites). The termites were Japanese termites (*Reticulitermes speratus* Kolbe, 1885), which were collected from an experimental forest in Jinju, South Korea. Following the weight measurement, the bottles were stored for four weeks at a temperature of 26 ± 2 °C and a relative humidity of 70% or more. During the test period, the termite conditions were observed and the water was replenished if necessary. After four weeks of breeding, each sample was removed from its breeding bottle, foreign substances attached to the sample surface were removed, and the resistance grade was visually evaluated according to the standard detailed in Table 4. After visual evaluation, the test samples were dried at a temperature of 103 °C for 24 h and left to cool in a desiccator for 30 min. The mass loss was subsequently calculated.

Table 4. Block Evaluation Standard for Termite Resistance (AWPA E1-17) (AWPA E1-17 2020)

Rating system	Description
10	Sound
9.5	Trace, surface nibbles permitted
9	Light attack, up to 3% of cross-sectional area affected
8	Moderate attack, 3–10% of cross-sectional area affected
7	Moderate/severe attack, penetration, 10–30% of cross-sectional area affected
6	Severe attack, 30–50% of cross-sectional area affected
4	Very severe attack, 50–75% of cross-sectional area affected
0	Failure

RESULTS AND DISCUSSION

Mechanical Properties of Wood-Based Panels

Table 5 lists the basic physical properties of the wood-based panels used in this study, along with the ISO and Japanese Industrial Standard (JIS) for wood-based panels for structural use. The general specifications of OSB, PB, and SPB met the ISO and JSA standards. Note that the SPB density exceeded those of OSB and PB. As indicated by its title, SPB was designed for structural use; therefore, its target density exceeds the OSB and PB values, as superior mechanical properties are required. Note that the OSB moisture content exceeded those of the other samples.

Table 5. Basic Specifications of Wood-Based Panels and Relevant Standards

	Standards			OSB 11.1 mm	PB 12 mm	SPB 12 mm
	ISO 16893:2016 (ISO 16893 2016) PB LB-MR1	ISO 16894:2009 (ISO 16894 2009) OSB LB-MR	JIS 5908 (JIS A 5908 2015) SPB			
Thickness (mm)	6–13	10–18	9	11.65	11.98	12.02
Density (g/cm^3)	±10%	±15%	0.71–0.81	0.65	0.64	0.73
Moisture content (%)	5–14	2–12	5–13	7.38	5.03	5.11

Table 6 lists the mechanical and chemical performance results for OSB and SPB, which are mainly used for light-frame wood houses, and for PB, which is typically used for furniture. Both the bending strength and modulus of elasticity (MOE) of the OSB and SPB samples under dry conditions exceeded the ISO and JSA standards. The SPB sample exceeded the ISO standards for OSB (ISO 16894:2009) and exhibited similar bending strength and MOE, regardless of the major and minor axes. Moreover, the SPB bending strength and MOE exceeded those obtained at the OSB minor axis. The bending performance of PB did not exceed the 17.0 MPa standard.

Unlike SPB (0.87 MPa), the internal bond strength of OSB (0.44 MPa) and PB (0.44 MPa) failed to satisfy the ISO standard (> 0.45 MPa). However, all samples satisfied the ISO and JSA OSB standards. The thickness swelling criterion was a thickness increase of 13% or less following immersion of the test piece in water at 20 °C for 24 h. SPB achieved the lowest thickness increase in this test, at 3.2%, which satisfied the standard. However, OSB and PB failed to satisfy the structural standards, with thickness increases of 23.73 and 17.30%, respectively.

Moisture resistance is essential for wood-based panels used for structural purposes. The wet-bending-strength test results indicated that OSB (11.1 and 7.8 MPa, major and minor axes, respectively) and SPB (11.9 MPa) satisfied the standard (> 6.4 MPa); however, PB (3.7 MPa) did not. There was no criterion for the wet flexural modulus; however, SPB exhibited superior performance to OSB. When the post-boiling internal bonding strength was measured, only SPB satisfied the ISO standard of > 0.14 MPa with a value of 0.29 MPa. OSB exhibited a degree of water resistance with an internal bonding strength of 0.09 MPa; however, it did not satisfy the standard. The PB sample decomposed to the extent that measurement was impossible.

For these materials, the bending strength and internal bonding strength are closely related to their density and adhesion. Therefore, to use PB for structural purposes, a density exceeding that required for furniture applications is essential. Moreover, a higher water resistance is required. To achieve this, treatments were performed using MUF resin with a high melamine content and pMDI resin to produce SPB with a relatively high resin content. However, low water resistance was observed with OSB, which is expected because the adhesive used had low water resistance or low resin content. In this study, PB exhibited no water resistance because UF resin was used.

During formaldehyde emission, PB and SPB achieved E0 grades with emissions of 0.46 and 0.43 mg/L, respectively. OSB achieved an SE0 grade with emissions of 0.04 mg/L. Because UF resin was used for PB and MUF and pMDI resins were used for SPB, their formaldehyde emissions exceeded those of OSB, which was manufactured using pMDI. Formaldehyde emissions affect weatherability and termite resistance (Indrayani *et al*. 2015).

Table 6. Mechanical and Chemical Properties of Wood-Based Panels and Relevant Standards

	Standards						
	ISO 16893:2016 (ISO 16893 2016) PB LB-MR1	ISO 16894:2009 (ISO 16894 2009) OSB LB-MR		JIS 5908 (JIS A 5908 2015) SPB	OSB 11.1 mm	PB 12 mm	SPB 12 mm
Bending strength (MPa)	>17.0	Major	>20.0	>18.0	29.8	16.5	26.1
		Minor	>10.0		17.7		
MOE (MPa)	>2450	Major	>3500	>3000	3953	2709	4083
		Minor	>1400		1878		
Internal bonding strength (MPa)	>0.45	>0.32		>0.30	0.44	0.44	0.87
Thickness swelling (%)	<13	<15		<12	23.83	17.30	3.20
Moisture resistance							
Wet bending strength (MPa)	>6.4	-		>9.0	11.1	3.7	11.9
					7.8		
Wet MOE (MPa)	-	-		-	1216	707	1826
					718		
Boiling test: Internal bonding strength (MPa)	>0.14	>0.13		-	0.09	Unavail able	0.29
Formaldehyde emission (mg/L)	<0.7	<0.7		<0.7	0.04	0.46	0.43

*All values are an average of 10 samples from each 5 replicates.

Fungal Bioassay

The results of the 12-week exposure test for *T. versicolor* and *F. palustris* on wood-based panels (SPB, PB, and OSB) and pine are shown in Figs. 2 to 5. Based on the sample mass losses, the damage caused by *F. palustris* exceeded that of *T. versicolor*. The pine-sample mass losses were 30.5 and 52.7% for *T. versicolor* and *F. palustris*, respectively, indicating good activity of the wood decay fungi used in this experiment. The OSB samples had mass losses of 41.5 and 53.2% for *T. versicolor* and *F. palustris*, respectively, indicating very low or no decay resistance. Note that the OSB samples, which were made from poplar species, exhibited higher mass loss than the pine; this outcome seems to have been due to the differences between the holocellulose and lignin contents of these materials (Skyba *et al.* 2013). Based on the above results, considerable damage due to decay fungi may be expected for pine and OSB directly exposed to external air. When used for construction, appropriate moisture management, such as ventilation and regular inspections are required. The PB-sample mass losses were 7.83 and 14.7% for *T. versicolor* and *F. palustris*, respectively, indicating decay resistance. Finally, the SPB-sample mass losses were 12.7 and 16.6% for *T. versicolor* and *F. palustris*, respectively, indicating decay resistance. PB and SPB, as compared with pine and OSB, exhibited higher resistance to decay fungi and were graded "Resistant" (< 24%, Table 3).

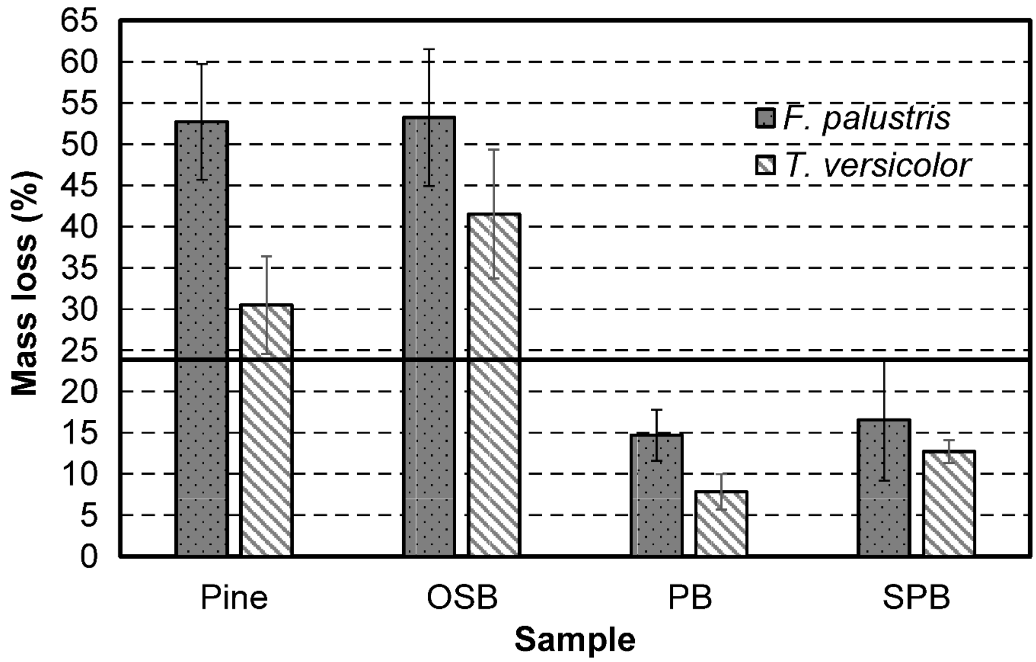

Fig. 2. Mass losses of the pine and wood-based panel samples (OSB, PB, and SPB) following a 12-week exposure to *T. versicolor* and *F. palustris*
[a]Each value represents the mean of 5 replicates. The values in parentheses are standard deviations.

As shown in Figs. 3 and 4, the pine and OSB samples were damaged by the decay fungi; therefore, they failed to maintain their physical shapes and broke or separated into layers. In contrast, the PB and SPB samples maintained their respective shapes. However, their surfaces roughened and darkened owing to the effects of the decay fungi.

Overall, the materials suffered damage due to the decay fungi in the following order: OSB > pine > SPB > PB. The natural decay resistance of wood is strongly influenced by its species. The OSB used in this experiment was mainly formed using poplar species; therefore, it exhibited greater decay than pine and other species. Karimi *et al*. (2013) reported that poplar species have low decay resistance. Additionally, the main adhesive used in OSB production is non-formaldehyde-based pMDI, with a content as low as 5% by mass or lower. Therefore, the OSB samples employed in this study were susceptible to the effects of decay fungi, similar to pine. The superior decay resistance performance of the PB and SPB samples resulted from the differences in their raw materials and adhesives, as compared with the OSB samples, as well as their resin contents. Additionally, recycled wood chips from construction sites were used to produce the PB and SPB samples. These recycled wood chips were first crushed into particles and then treated with acid chemicals and other methods. Therefore, the decay resistance performance of the resulting PB and SPB samples may have been affected by the wood-particle use history and treatment. Notably, the higher formaldehyde emissions of the PB and SPB samples, as compared to those of the pine and OSB samples, may have inhibited the activity of the decay fungi.

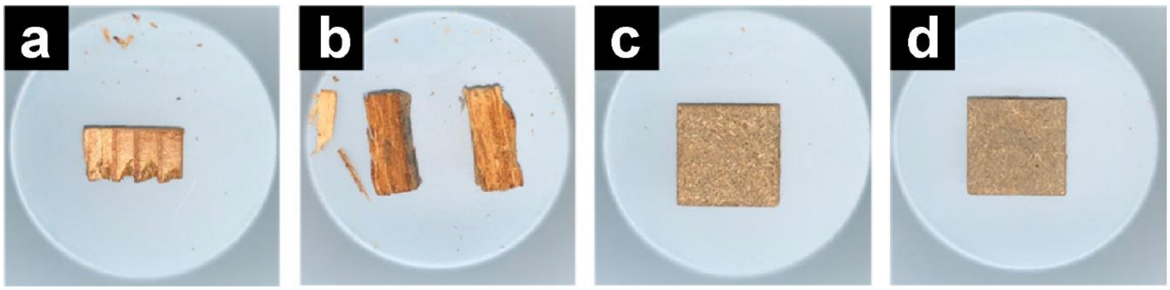

Fig. 3. Images of the pine (a) and wood-based panel samples (b–d: OSB, PB, SPB, respectively) following a 12-week exposure to *T. versicolor*

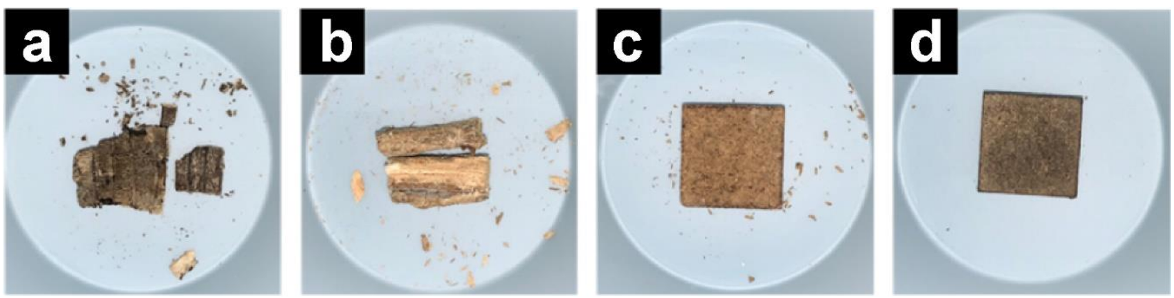

Fig. 4. Images of the pine (a) and wood-based panel samples (b–d: OSB, PB, SPB, respectively) following a 12-week exposure to *F. palustris*

Termite Bioassay

Table 7 lists the weight loss, termite survival rate, and visual grade results for the pine- and wood-based panels (OSB, PB, and SPB) exposed to termites for four weeks.

Table 7. Weight Loss and Termite Survival Results for Pine and Wood-Based Panel Samples (OSB, PB, and SPB) from the Termite Bioassay [a]

Type	Initial Weight (g)	Final Weight (g)	Weight Loss (g)	Termite Survival (%)	Average Visual Rating
Pine	1.45 (0.02)	0.50 (0.05)	0.95 (0.06)	88.16 (6.12)	0
OSB	5.34 (0.04)	4.71 (0.10)	0.63 (0.08)	68.88 (16.05)	4
PB	6.91 (0.03)	6.80 (0.06)	0.11 (0.04)	0 (0)	10
SPB	7.45 (0.05)	7.36 (0.04)	0.09 (0.03)	0 (0)	10

[a]Each value represents the mean of eight replicates. The values in parentheses are standard deviations.

After the termite bioassay, the termite survival rates for pine and OSB were 88.2 and 68.9%, respectively. Therefore, high activity was confirmed for the termites used in this study. A 100% mortality rate was obtained for the termites applied to PB and SPB.

Figure 5 shows front- and side-view photographs of each type of the specimens after the termite bioassay. The termite diet consists of cellulose. Dead wood and wood byproducts, which are mainly composed of cellulose, are optimal foods for termites, and termites penetrate these materials as they feed. In this study, the pine samples were severely damaged by the termites; therefore, a rating of 0, the lowest termite resistance grade, was assigned. For OSB, a termite resistance rating of 4 was assigned. Based on the damage formation observed on the OSB samples, the termites penetrated the OSB interior through the surface or sides during feeding. Consequently, layer separation occurred for the majority of the OSB samples. In the PB and SPB samples, no traces of feeding activity, such as termite nibbling, were found, and their appearance was unchanged. Therefore, maximum termite-resistance ratings of 10 were awarded to PB and SPB.

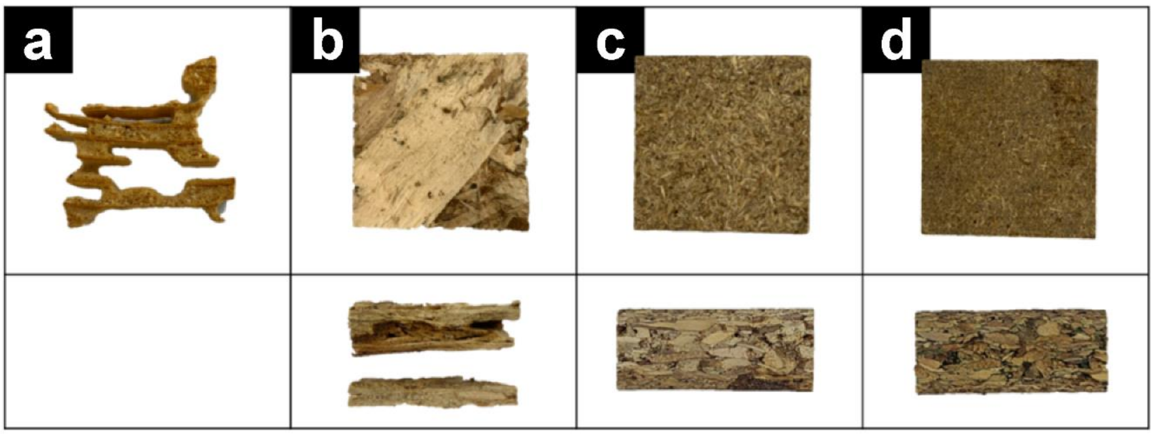

Fig. 5. Images of the pine (a) and wood-based panel samples (b–d: OSB, PB, SPB, respectively) following a four-week exposure to *R. speratus*

Figure 6 shows the mass-loss results for each sample exposed to termites. The mass loss for pine was 65.2%, indicating high activity of the collected termites. The mass loss for OSB was 11.9%, indicating lesser termite damage than that exhibited by pine, which is a softwood. However, as discussed in relation to Fig. 4, in the OSB, the termites fed by tunnelling, which caused layer separation. Therefore, care must be taken when using OSB for construction.

In contrast, the PB and SPB samples exhibited mass loss rates of 1.57 and 1.36%, respectively, indicating outstanding termite resistance. Therefore, no additional anti-termite treatments are required for PB and SPB. In this study, the PB and SPB samples experienced only minimal termite-induced damage because all termites died within 3 d. The rapid mortality of these termites was influenced by a combination of several factors. The factors affecting termite feeding activity include density, moisture content, nutrients, allelochemicals, pH, and fungal decay (Waller 1991). However, the effect of each individual factor varies on a case-by-case basis; therefore, perfectly identifying the mortality factor in the present experiment is difficult.

Wood has a variable pH, but most types of wood are acidic, with pH values ranging from 4.0 to 5.5. The pH values of the PB and SPB surface-layer particles used in this experiment were 4.9 to 5.1, being slightly acidic, whereas those of the core-layer particles were 3.0 to 3.3 because of pretreatment. Waller (1991) performed a termite bioassay using treated paper with pH 2 as food and proposed a weak correlation between low pH and termite mortality due to particle pretreatment. Moreover, Jimenez *et al*. (2022)

demonstrated that the correlation between the termite mortality rate and formaldehyde emission levels is low. However, rapid termite mortality is influenced by the allelochemicals released from recycled wood chips, which are the raw materials of PB and SPB, and by pretreatment and manufacturing processes performed to optimize the post-grinding production process (Jimenez *et al*. 2022).

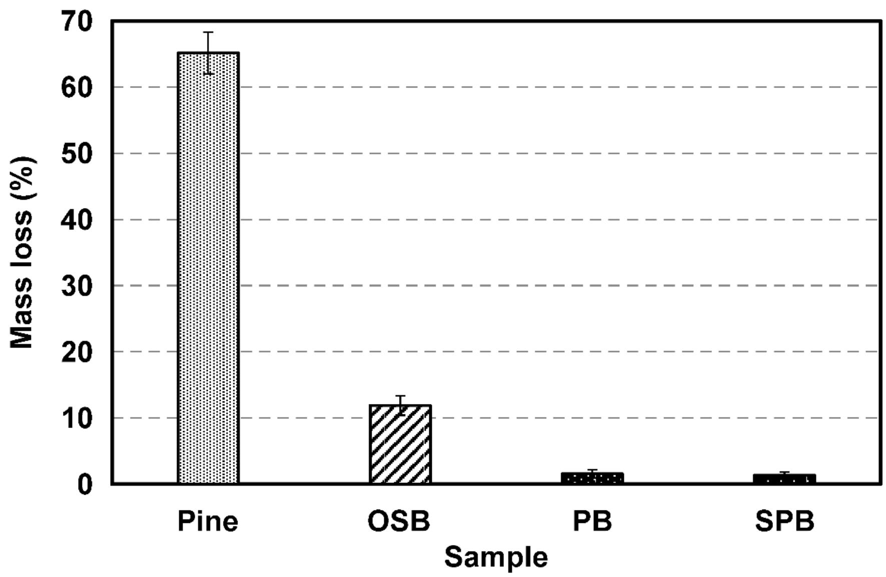

Fig. 6. Mass losses (%) of the pine and wood-based panel samples (OSB, PB, and SPB) after a four-week exposure to *R. speratus*

Overall, SPB exhibited excellent water resistance and sufficiently satisfied the ISO standards pertaining to mechanical properties; therefore, it can be employed in the construction of wooden buildings. Korea has four distinct seasons, a large daily temperature difference, and a long rainy season; therefore, water resistance is an essential requirement for wooden structures. Additionally, SPB exhibited excellent decay and termite resistance in this study; therefore, wooden buildings constructed with SPB have advantages in terms of maintenance.

CONCLUSIONS

1. Structural particle board (SPB) satisfied all standards and demonstrated a high physical performance that exceeded the relevant ISO and JSA quality standards. In particular, its water-resistance performance was superior to that of the other materials. The SPB formaldehyde emission levels also satisfied the applicable restrictions.
2. The results of a decay resistance test revealed that the default particle board (PB) and the SPB samples had average mass losses below 24%; therefore, they were classified as “Resistant” based on ASTM-D 2017 (ASTM-D 2017 2005). However, the pine used as a control and the oriented strand board (OSB) samples were “Nonresistant,” with weight losses exceeding 44%. The decay resistance varied considerably with species, but OSB exhibited lower decay resistance because poplar species were used as its raw material.

3. The PB and SPB samples exhibited outstanding resistance to termites, whereas the pine and OSB samples exhibited severe damage. Therefore, no additional anti-termite chemical treatment is required for PB and SPB. Although the OSB mass loss due to termites was approximately 11%, its termite-resistance performance was determined to be poor because considerable physical destruction occurred because of the termite feeding pattern.

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