Determination of Resistance of Woods against Subterranean Termites by Laboratory Tests Using Indonesian and Japanese Standards

by

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Abstract

Standard testing of wood wood-based products against subterranean termite in Indonesia SNI 01.7207-2006 has no requirements of control (reference) wood species. The present research is related to the selection of a control (reference) wood species from the Indonesian community woods, although Indonesian community woods is known to be perishable to subterranean termites. Comparative laboratory evaluation was conducted by two methods, SNI 01.7207-2006 and JIS K 1571-2004 using *Coptotermes formosanus*. Species of community woods were *Acacia mangium*, *Hevea brasiliensis*, *Paraserianthes falcataia* and *Pinus merkusii*. *Cryptomeria japonica* which is a reference wood species in JIS standard, was included in the test for comparison. Percentage mass loss, termite mortality, and wood feeding rates were measured to discuss relative termite-resistance of 5 wood species. The highest mean percentage mass losses were recorded with *P. merkusii* at 25.4% and 16.8%, respectively in SNI and JIS tests, whereas those of *C. japonica* were 42.1% and 21.8%. The lowest mortalities were also recorded with *P. merkusii* ie, 9% and 7%. Feeding rates determined with *P. merkusii* were 79 and 95 µg/termite/day, respectively in SNI and JIS tests. These results strongly suggested that *P. merkusii* was most suitable for a control (reference) wood species in Indonesian standard SNI 01.7207-2006.

Key words: percent mass loss, termite mortality, wood feeding rate, *Coptotermes formosanus*, SNI 01.7207-2006, JIS K 1571-2004

Introduction

Indonesia has huge community forests which produce a variety of wood species. Following species are abundant in quantity with potential constant supply: *Acacia mangium*, *Paraserianthes falcataria*, *Hevea brasiliensis*, and *Pinus merkusii*. However, most of wood species from community forests are highly vulnerable to wood-attacking organisms. Although there are over 4,000 wood species in Indonesia, most of them (80-85%) are regarded as low-quality woods due to low-durability, lack of knowledge on their characteristic and uses (Mandang & Pandit 1997)

The success in determining the termite-resistance of wood materials is largely dependent on termite activities in laboratory conditions. This means that control (reference) wood specimens sustain a certain level of attack which supports the reliability of relative comparison of results. Test results are always influenced by environmental conditions such as temperature, humidity and population of airborne spores during the test. Some failures might be caused by high termite mortality. percentage. Therefore, it seems important to choose an appropriate wood species as

control (reference) for comparison of the termite-resistance of untreated and chemically-treated woods.

Unfortunately, the Indonesia standard SNI 01.7207-2006 does not designate a selected control wood species so that we need to carefully compare the results obtained by different researchers. Since the 4 wood species used in this research are graded as durability class III-IV, they are thought to be a candidate of a control in SNI 01.7207-2006.

Materials and methods

Wood species

Wood species that we were used in this research were *Acacia mangium, Paraserianthes falcataria, Hevea brasiliensis,* and *Pinus merkusii*. We used *Cryptomeria japonica* (wood control in JIS) for reference material.

Testing method according to SNI 01. 7202-2006

The standard refers to a forced-feeding test using 200 g sand media, 50 ml aquadestilata, and 200 worker termites of *Coptotermes formosanus* for four weeks in the dark. The wood samples were placed inside the jar with standing position and was leaned on so that one of the widest side was leaned on to the jar wall. Details should be referred to the previous article (Hadi and Tsunoda 2010). Figure 1 shows an assembled test jar.

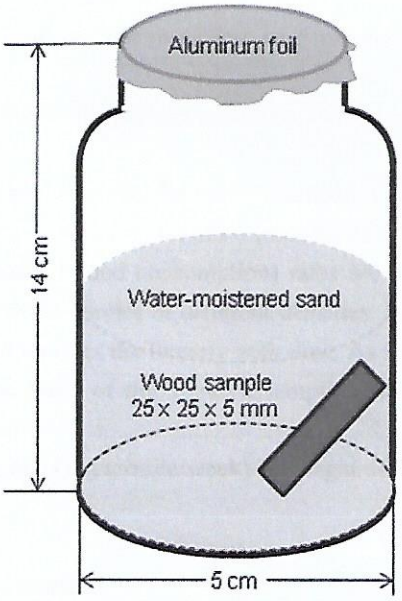

Figure 1 Termite test assembly used in the Indonesian standard SNI 01.7202-2006

Testing method according to JIS K1571-2004* (*recently revised as JIS K1571-2010)

The principle of the test method is the same as the above-mentioned Indonesian standard (forced-feeding test). Sugi (*Cryptomeria japonica*) sapwood samples are used as reference untreated materials. As shown in Figure 2, a wood sample is a sole food source for termites. An individual wood sample is placed on a plastic net to avoid direct contact of wood sample with moist plaster bottom in an acrylic cylindrical yest container with 150 worker termites and 15 soldiers. The assembled test container is maintained at 28 ± 2°C and ca. 80% R H for three weeks in the dark.

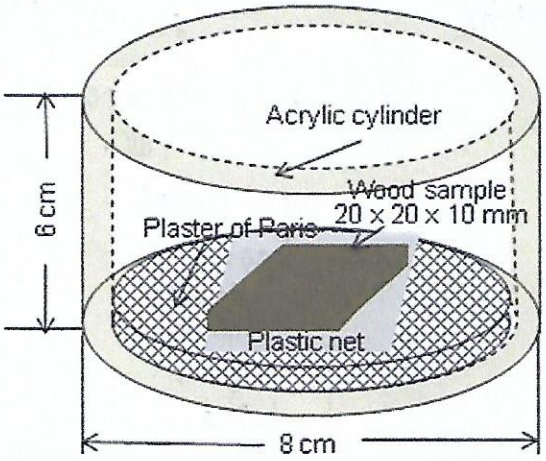

Figure 2 Termite test assembly used in the Japanese standard JIS K 1571-2004

Evaluation of results

Percent mass loss of the individual wood sample is calculated by the difference in weights before and after test according to the following equation:

Percent mass loss = $(W_1 - W_2)/W_1 \times 100$, where

W_1 = weight of oven-dried wood before test (g),

W_2 = weight of oven-dried wood after test (g).

When mean percent mass loss of 5 untreated wood samples is < 15%, the test should be redone.

In addition to the percent mass loss, termite mortality is calculated according to the following equation:

Termite mortality (%) for SNI = (number of dead workers)/200 x 100

Termite mortality (%) for JIS = (number of dead workers)/150 x 100

The feeding (wood consumption) rates are thought to be helpful for comparing test results obtained with wood species of different densities. In order to calculate the feeding rate, we need an assumption that termites die linearly with time. As shown in Figure 3.

On the basis of the above assumption, feeding rates can be calculated according to the following equation:

Feeding rate (mg/termite/week) = (weight of wood eaten by termites)/termite·test period (weeks)

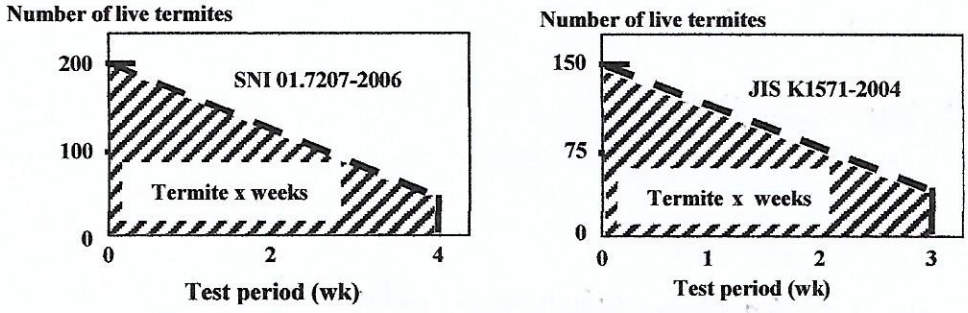

Figure 3 Theoretical linearly decrease in the number of live termites

Results and discussion

Results of SNI 01. 7202-2006

The average of mass loss percentage, mortality percentage, and wood consumption of SNI were presented in Table 1. The average mass loss percentage ranged from 11.6% to 42.1%. The lowest mass loss percentage was *A. mangium* and the highest one was *C. japonica*. According to JIS, that the control mass loss percentage must be greater than 15%. Because of this, three species were potentially be used as a control. They were *H. brasiliensis, P. falcataria*, and *P. merkusii* with a mass loss percentage of 21.0%, 24.5%, and 25.4% respectively. Only *A. mangium* colud not meet this requirement. It was assumed because the relatively high extractive content in *A. mangium*, so that *C. formosanus* was less preferable.

Table 1 Mean mass loss, mortality, and wood consumption rates determined by SNI

Wood Species	Mass Loss (%)	Mortality (%)	Wood Consumption (µg/termite/day)
Acacia mangium	11.6 ± 1.24	27 ± 4.0	43 ± 4.5
Hevea brasiliensis	21.0 ± 1.05	22 ± 5.0	79 ± 4.8
Paraserianthe falcataria	24.5 ± 1.76	23 ± 3.5	49 ± 4.0
Pinus merkusii	25.4 ± 3.35	9 ± 4.8	79 ± 9.9
Cryptomeria japonica	42.1 ± 1.91	19 ± 5.2	82 ± 5.6

The average of mortality percentage ranged from 9% to 27%. The lowest one was *P. merkusii* while the highest one was *A. mangium*. Only *P. merkusii* had mortality percentage less than 10% , while others more than 20%. They were 22%, 23%, and 27% for *H. brasiliensis*, *P. falcataria*, and *A. mangium* respectively.

Mean wood consumption per termite per day ranged between 43 µg to 82 µg. The highest one was *C. japonica* (82 µg). *H. brasiliensis* and *P. merkusii* had the same value of mean wood consumption (79 ug). This was presumably because *H. brasiliensis* has a sap (Pandit & Kurniawan, 2008) so that *C. formosanus* was preferable. Also the same thing happened with *P. merkusii*, where

it had resin content and turpentine odor (Martawijaya 1989). It could be the main attraction for *C. formosanus* to consume.

Results of JIS K 1571-2004

The average of mass loss percentage, mortality percentage, and wood consumption of JIS were presented in Table 2. The Average mass loss percentage ranged from 6.1% to 21.8%. The lowest one was *A. mangium* and the highest one was *C. japonica*. According to JIS, that the control mass loss percentage must be greater than 15%. Because of this, two species were potentially be used as a control. They were *H. brasiliensis* and *P. merkusii* with a mass loss percentage of 15.8% and 16.8% respectively respectively. The average mass loss of *A. mangium* is very low (6.1%) so it could not meet the requirement. This was equivalent with SNI, where *A. mangium* could not meet the mass loss percentage requirement

The average value of mortality ranged from 7% to 32%. The lowest one was *P. merkusii* while the highest one was *A. mangium*. The average mortality percentage of two wood species was less than 10%. They were *P. merkusii* (7%), and *H. brasiliensis* (8%). The same with SNI results, *P. merkusii* had the lowest mortality percentage value.

Table 2 Mean mass loss, mortality, and wood consumption rates determined by JIS

Wood Species	Mass Loss (%)	Mortality (%)	Wood Consumption (µg/termite/day)
Acacia mangium	6.1±1.19	32±6.1	55±8.7
Hevea brasiliensis	15.8±1.29	8±3.8	129±10.0
Paraserianthe falcataria	14.2±2.23	11±3.6	66±6.5
Pinus merkusii	16.8±3.29	7±1.9	95±21.1
Cryptomeria japonica	21.8±2.33	12±4.0	98±10.6

Mean wood consumption per termite per day ranged from 55 µg to 129 µg. The highest one was *H. brasiliensis* (129 µg), while the lowest one was *A. mangium* (55 µg). Like SNI results, mean wood consumption of *P. merkusii* was also quite high (95 µg).

If we compared the results between these two methods (SNI and JIS), the mean mass loss of SNI was higher than JIS. This was because the number of worker termites that were used on the SNI test were 200. While JIS, only 150 workers termites. Furthermore SNI test took a longer period (four weeks) while JIS only three weeks. It also implicated that the mean wood consumption per day of JIS test was higher than SNI.

Conclusions

Based on this research we could conclude that *P. merkusii* was potentially used as a wood control on the durability test of wood and wood products against subterranean termites in Indonesia. This conclusion was taken based on consideration of three criteria. They were ie mass loss percentage, mortality percentage and wood consumption. Furthermore, *H. brasiliensis* could become a second choice.

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