

## Termite Resistant Properties of Sisal Board

by

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### Abstract

Sisal fibers have been used as board-manufacturing raw material. In order to improve sisal board's mechanical properties, rubber wood veneer, betung bamboo matting or formica have been used as overlaid materials on sisal board. For use as building materials in long term, it is necessary to conduct durability test properties of sisal board. Therefore, to understand the properties of the sisal board resistance against termite attack, we conducted a test of board resistance against *Coptotermes gestroi*. Testing for termite attack resistance refers to the standard of the Japan Wood Preserving Association (JWPA) No. 12-1992 and conducted on sisal board with and without overlaid materials. Based on the research results, it was found that sisal board with formica overlaid has a better resistance to *Coptotermes gestroi* compared to those of sisal board with rubber wood veneer overlaid or betung bamboo matting overlaid.

**Key words;** sisal board, termite resistance, *Coptotermes gestroi*, Japan Wood Preserving Association (JWPA) No. 12-1992

### Introduction

Boards of sisal fibers bonded by UF, MUF or PF adhesives fulfilled the requirements of JIS A5908-1994 for particle board on mechanical properties. However, the physical properties of the board failed to fulfill the standard, especially board thickness swelling properties (Syamani *et al.* 2008). To overcome that problem, sisal fibers have been processed in a ring flaker prior to produce sisal boards using isocyanate adhesive, then various overlaid materials have been used on the upper and lower part of the boards (Syamani 2009). Sisal fibers that has been processed in a ring flaker improved thickness swelling properties of sisal board significantly. While the use of overlaid materials improved the mechanical properties significantly. For use as building materials in long term, it is necessary to conduct durability test properties on sisal board.

One way to determine the durability properties of the board is to test sisal board resistance against termites. Tropical climate is suitable for breeding termites. Termites habitat is originally located in nature. However, nowadays the development of human settlements threaten termites habitat. As a result, termites begin to attack residential areas, especially in parts of the building made of wood or other material containing lignocellulose.

Subterranean termites are one of the most extensive attacking-termites in Indonesia. Genus *Coptotermes* is the most harmful among other genera because they can damage the wood in a short time (Tambunan and Nandika 1989). *Coptotermes* behavior on attacking timber is to nest in the

wood, although the wood has no contact with the soil. They were only need to be provided water occasionally, such as rain water droplets from a leaky roof (Tarumingkeng 2001). *Coptotermes gestroi* is considered as a pest species that cause severe damage in areas of Southeast Asia and Brazil. As the most aggressive species, *Coptotermes gestroi* caused damage to 63-90% structures and buildings in Malaysia, Thailand and Singapore. Doors, window frames and parquet floors were found as termite attack object (Gurbel 2008). Therefore, to understand the properties of the sisal<sup>board</sup> resistance against termite attack, we conducted a test on sisal board resistance against *Coptotermes gestroi*.

### **Materials and methods**

There were two types of sisal boards were produced in this research, namely bare sisal board and overlaid sisal board. The information regarding sisal board production are as follows :

1. Bare sisal board; Material that were tested for resistance to termite attack were boards made of sisal fibers bonded with 8%, 10%, and 12% of isocyanate resin based on sisal fibers oven dry weight. Sisal fibers and isocyanate were mixed in drum mixer, then sisal fibers glued with isocyanate were hand-formed before hot-pressed at 0,8 N/mm<sup>2</sup> for 10 minutes at 140°C. Board density target was 0,6 g/cm<sup>3</sup> with 1 cm thickness.
2. Overlaid sisal boards; Materials that were used to overlaid sisal boards were rubber wood veneer, betung bamboo matting or formica. The sisal raw material used in the overlaid sisal board production is the same as the bare sisal board. The amount of isocyanate used in overlaid sisal board were 10% based on board component's oven dry weight. 75% of total isocyanate were used to bond sisal fibers that were in the middle of board and 25% of total isocyanate were spreaded on overlaid materials before adhered on the upper and lower part of the sisal fibers mat. A single-stage board-hot-pressing were conducted at 0,8 N/mm<sup>2</sup> for 10 minutes at 140°C.

Testing for termite attack resistance refers to the standard of the Japan Wood Preserving Association (JWPA) No. 12-1992, by using forced-feeding test. Observations were carried out for 3 weeks. Each properties were measured in 3 replications. Species of termites that used in testing was *Coptotermes gestroi*. The sisal board specimens (20 by 20 by 10 mm) were placed in the center of a hard plaster breeding container (80 mm in diameter, 60 mm high); 150 workers and 15 soldiers of *Coptotermes gestroi* were introduced into each container. The assembled containers were put on dampened cotton pads to supply water to the specimens and kept at 28°C and 80 % relative humidity for 3 weeks in a dark conditioning room. Termite mortality was determined regularly. Weight loss after termite attack was determined based on the difference between initial and final dry weights of specimen after debris of the termite attack had been removed. Three replications were made for each board type.

### **Results and discussion**

The observation of sisal board's weight loss due to termite attack showed that among bare sisal boards, sisal board with adhesive level of 8% has the highest weight loss compared to those of sisal boards with adhesive levels of 10% or 12% (Figure 1). Among sisal board with overlaid

material, bamboo-matting overlaid-sisal-board's weight loss was higher than sisal boards with rubber wood veneer or formica overlaid (Figure 2).

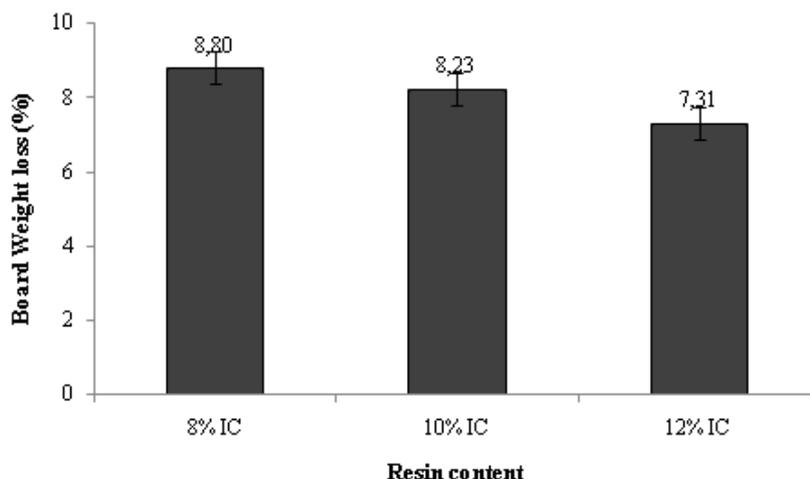


Figure 1. The weight loss average of sisal board with various level of isocyanate

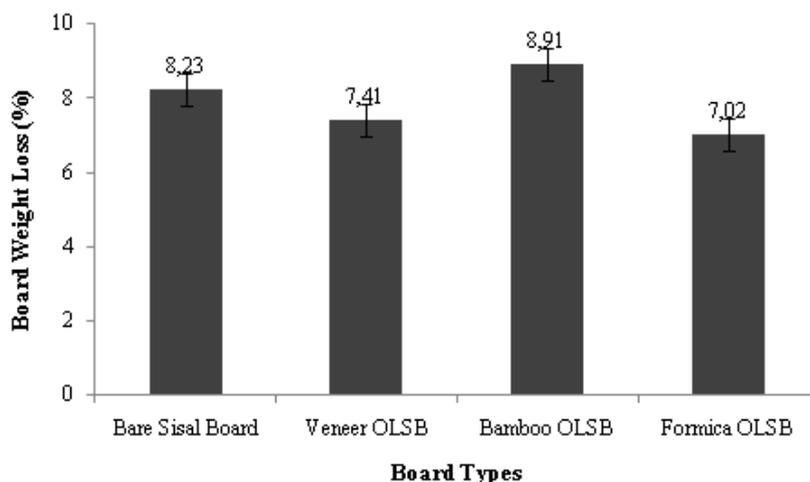


Figure 2. The weight loss average of bare sisal board and overlaid sisal board  
 Note : OLSB means overlaid sisal board

Based on analysis of variety, level of adhesive effected the value of board weight loss due to termite attack. According to Duncan test, it is known that weight loss value of sisal board with 12% adhesive level did not differ from board with adhesive levels of 10%, but differ from board with adhesive levels of adhesive 8%. Types of overlaid materials have no effect on the sisal board weight loss value due to termite attack.

The weight loss of sisal boards with 8% isocyanate adhesive levels (WL = 8.80%), higher than sisal boards with 10% adhesive level (WL = 7.71%) or 12% adhesive level (WL = 7.31%). The more amount of adhesive in the test sample, the less board's weight loss. It was due to termite feeding activity decreased. One of the advantages of using isocyanate as board adhesive is to improve the durability of wood against deterioration due to biological factors.

Visual observation showed that, at first, termite attacked the middle part of boards. The process of

making composite board using hot compression, had already solidified the surface of the board than the middle of the board. Thus the center of the board has a lower density than the surface of the board, consequently termites preferred to attack starting from the center of the board.

Termite attacked sisal board with overlaid materials on the upper and lower surface, at the middle of the board, as well as on sisal board without overlaid materials. It has become common knowledge that the termites attack the wood to consume cellulose. According to Mohanty, *et al.* in Mishra, *et al.* (2004), amount of cellulose in sisal fibers ranged between 67-78%, while the cellulose content in bamboo betung approximately 52.9% (Gusmailina and Sukmadiwangsa in Krisdianto *et al.* 2000). Therefore, termite attacks the middle of the board first to consume sisal cellulose, then attacked betung bamboo matting which was as sisal board overlaid.

Sisal board with betung bamboo matting overlaid experienced greater weight loss (8.91%) compared to sisal board with rubber wood veneer overlaid or formica overlaid. Bamboo has a very low durability, easily attacked by microorganisms and insects, whole bamboo in the dry state can be attacked by *dinoderus* sp borer and dry wood termites (Krisdianto *et al.* 2000). Similar to betung bamboo, although included in class II –III for strength, rubber wood's durability is low, included in class V for durability (Burgess 1966 in Martawijaya 1972). For that reason, sisal board sisal with rubber wood veneer overlaid also experienced significant weight loss, which was 7.41%.

Formica overlaid with a thickness of only 0.76 mm, resulted in higher sisal content than a board with veneer or bamboo matting overlaid. On the other hand, formica as sisal board overlaid material has a higher density than rubber wood veneer or betung bamboo matting, so the termite's attack on sisal board with formica overlaid was lower than on the board with other overlaid materials. Termites attacked the center of the board by making a hole and going down to the inside of the board. This behavior is a manifestation of termite's characteristics that is cryptobiotik, that termites tend to hide themselves and avoid the light (Prasetyo and Yusuf, 2005). Figure 3 shows termite attack on sisal board with various overlaid materials.



Fig.3. Termite attack on sisal board with rubber wood veneer overlaid (A), formica overlaid (B) and betung bamboo woven overlaid (C) (Syamani 2009)

Resistancy sisal composite boards against termite attack was also analyzed by observing the level of mortality of termites for 3 weeks. Based on analysis of variety, level of adhesive has no effect on the percentage of termite mortality, but type of overlaid materials provide a significant effect on the percentage of termite mortality. With Duncan test, it is known that the mortality of termites in the sisal board with formica overlaid is highest and different from mortality on sisal

board with rubber wood veneer or betung bamboo matting overlaid. The level of mortality of termites in sisal board is presented in Figure 4 and the level of cumulative mortality of termites in overlaid sisal boards on each week of observations is presented in Figure 5.

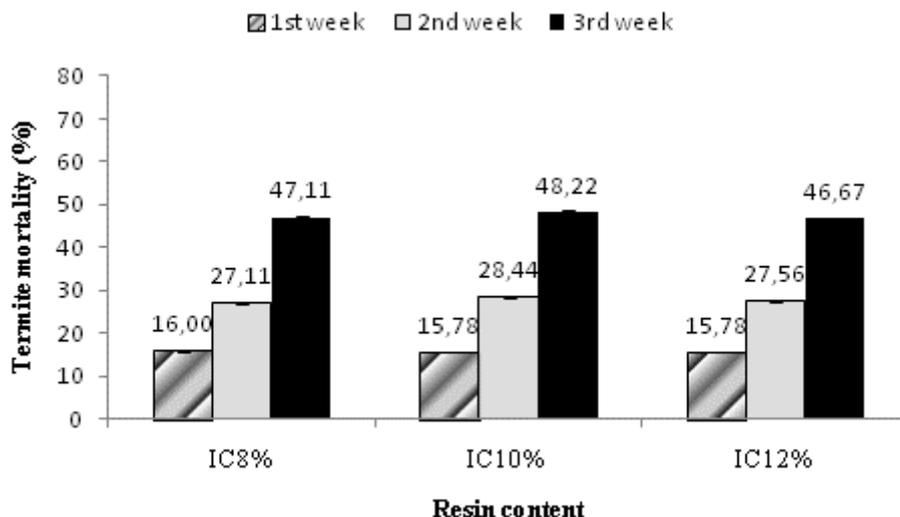


Fig. 4. Termite mortality level (%) on sisal board with various level of isocyanate

From the figure, sisal board with formica overlaid had the highest termite mortality levels ranging from the first week until the third week of observation. Formica consist of several layers of kraft paper impregnated with resin, and protected with melamine, then pressed and cured by using heat to produce a hard surface. The hardness and solid characteristics of formica were not preferred by termites. With limited food sources, there was a strong possibility for termites ate the weak ones to survive. According to Rismayadi and Arinana (2007), in conditions of limited food sources and can not supply sufficient nutrition for the needs of termite colonies, the termites often behave cannibal on non-productive members of their colony.

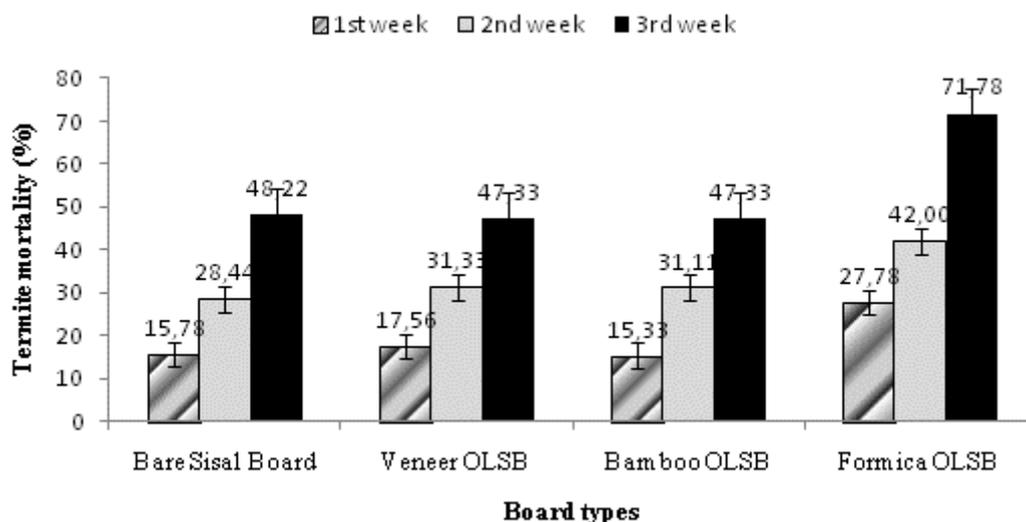


Fig. 5 Termite mortality level (%) of sisal board and overlaid sisal board

Observation of the boards weight loss due to termite attack showed that the sisal board with formica overlaid had the least weight loss. Thus the high mortality of termites in the test sample board with formica overlaid indicating in low termite feeding activity and resulting in low weight loss of the board.

### Conclusions

Sisal board bonded with higher amount of isocyanate showed less board's weight loss. Sisal board with formica overlaid has a better resistance to termites *Coptotermes gestoi* than sisal board with rubber wood veneer overlaid or betung bamboo matting overlaid.

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