

## **The Resistance of Laminated Bamboo Boards to the Subterranean Termite (*Coptotermes curvignathus* Holmgreen)**

by

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### **Abstract**

This study investigated the resistance of three-layer laminated bamboo boards (LBB) to subterranean termite (*Coptotermes curvignathus* Holmgreen). The bamboo species used in this study was *Gigantochloa pseudoarundinacea* collected from private gardens in West Java. Prior to LBB fabrication the bamboo strips were divided into four groups *i.e.* untreated (A), cold soaking in 5% boron solution for 2 hours (B), bleached with 17.5% hydrogen peroxide solution (C), and bleached with 20% hydrogen peroxide solution (D). The adhesive used was tannin resorcinol formaldehyde (TRF) and wheat flour (extender) equal to 2.5 % or 5% of TRF weight were added. The assessment of LBB resistance to subterranean termite was carried out on the LBB specimens covering the percentage of LBB-weight loss, percentage of termite mortality, and infestation rate. The results showed that compared with the Indonesian wood resistance class, the LBB made from untreated bamboo strips could be categorized as class IV in their resistance to subterranean termites attack, whereas those laminated bamboo boards made from bamboo strips treated with boron solution or bleached with hydrogen peroxide had comparable resistance to wood resistance class III.

**Key words:** Laminated bamboo board, boron solution, hydrogen peroxide, subterranean termite, tannin resorcinol formaldehyde.

### **Introduction**

The total population of Indonesia in 2005 was 219.2 millions with the growth rate of 1.34 percent per annum (Anonymous, 2006a). According to Supriana *et al.* (2003) the need of housing in Indonesia per year was about 2.9 millions unit and in average every unit of house consumes about 2.97 m<sup>3</sup> of wood, therefore the total wood volume for housing in Indonesia per year was about 8.613 millions m<sup>3</sup> of sawn timber. On the other hand supply of wood raw materials for housing decreased considerably. Therefore research to find wood substitute is urgently needed.

Bamboo can be used as an alternative source of housing and raw materials for wood industry due to its ability to grow in various soils, fast growing, short rotation and desirable properties. People in the village have been using bamboo for construction materials, furniture, household utensils, and handicrafts. However, there are problems associated with the utilization of bamboo for housing materials such as the limitation in shape and dimensions of bamboo. Due to its circular and hollow shape, for timber substitute materials, bamboo must be converted into a flat and a relatively

thick material. By using certain adhesive, it is possible to produce timber-like-materials with the desired dimensions from bamboo strips, called laminated bamboo board.

Laminated bamboo board (LBB) is a product, lumber-like in dimensions, consisting of several plies of bamboo sheets bonded together with the grain in parallel direction. It depends on its thickness and width, the product will be like a plank or a beam. The effort of producing LBB with longer service life can retard the speed of logging activity and at the same time support the natural resource conservation activity. To use LBB as housing materials one should know not only its physical and mechanical properties but also its resistance to subterranean termite. This paper describes the results of an experiment to determine the resistance of three-layer laminated bamboo boards (LBB) glued with tannin resorcinol formaldehyde against subterranean termite (*Coptotermes curvignathus* Holmgreen).

### Materials and methods

**Materials.** Andong bamboo (*Gigantochloa pseudoarundinacea*) was used in the experiment. The bamboo culms were collected from private gardens in Bogor, West Java, Indonesia. The mature bamboo culms were selected from available bamboo stand. The culms used in the experiment were obtained by taking out the first segment at  $\pm 60$  cm in length from the bottom. The remaining culms with approximately 6 m in length of *Gigantochloa pseudoarundinacea* were cross cut into segments. Each segment was 90 cm in length and consists of more or less two internodes. The adhesive used was liquid tannin resorcinol formaldehyde (TRF).

**Preparation of bamboo strips.** Each bamboo segment (90 cm in length) was manually fed into the bamboo splitter machine which resulted in several bamboo strips (5 - 7 strips). The width of bamboo strips was approximately 2 cm, and only straight bamboo strips were collected. The inner and outer parts of the selected bamboo strips were then scraped out and planed smooth using a planer machine. The resulted bamboo strips were stacked and then air dried at room temperature for one week. The bamboo strips were divided into 4 groups. The first group of bamboo strips (A), was intended for control, the second group of bamboo strips (B) was treated with 5% concentration of boron solution, the third group of bamboo strips (C) was bleached with 17.5% concentration of  $H_2O_2$ , and the fourth group of bamboo strip (D) was bleached with 20% concentration of  $H_2O_2$ . Afterwards the bamboo strips were dried by sun light to 12% moisture content.

**Laminated bamboo board (LBB) manufacture.** The laboratory made LBB were constructed of three layers. Each layer (bamboo sheet) consisted of 7 bamboo strips. Laminated bamboo boards were produced by assembling three layers of bamboo sheet with the grain in parallel direction. The bamboo sheets were assembled using liquid tannin resorcinol formaldehyde (TRF). Wheat flour equal to 2.5 % and 5% of TRF weight were added. The glue mix was then hand-spread on the surface of bamboo sheets using a metal spatula and the amount of glue spread was  $170 \text{ g/m}^2$  for a single glue line. The assemblies were cold pressed using a wooden clamp for 4-hour period. Since there was no pressure gauge attached to the clamp, approximately uniform

glue which was squeezed out from the glue lines was taken as the indicator of proper amount of pressure applied to the LBB materials (assembly of bamboo sheets). The laminated bamboo boards produced were conditioned for about 2 weeks before testing.

**LBB resistance against subterranean termites in laboratory test.** Five specimens for each type of LBB measuring 2.5 cm x 2.5 cm x thickness of LBB were prepared. The specimens were dried in the oven at 100°C until constant weight and then placed into the glass bottles, one specimen for one bottle. Inside the bottle, the LBB specimen was placed lengthwise rather vertically such that one of the widest specimen-surface leaned against the inner wall of the bottle. Further, into the bottle was put 200 g moist sand with moisture content of 7% under water-holding capacity. Subsequently, into the bottle were put 200 healthy, active subterranean termites (*Coptotermes curvignathus* Holmgreen). Afterwards, the arrangement test (*i.e.* LBB specimen, wet sand, subterranean termites, and bottle) was stored in dark room and then let for 4 weeks.

After 4 weeks, the assessment was carried out on the LBB specimens covering the percentage of LBB-weight loss, percentage of termite mortality, and infestation rate. The data were used to determine the resistance class of LBB made from various pre-treatment of bamboo strips using the classification of wood resistance against subterranean termites attack as described in Table 1 (Anonymous, 2006). In addition, the infestation rate by termites was determined according to the classification described by Pablo and Garcia (1997).

Table 1. Classification of wood resistance against subterranean termites attack (*Coptotermes curvignathus* Holmgreen)

Class	Resistance criteria	Weight loss (%)
I	Very resistant	< 3.52
II	Resistant	3.52 - < 7.50
III	Moderate	7.50 - < 10.96
IV	Poor	10.96 - < 18.94
V	Very poor	18.94 - 31.89

Source: Anonymous (2006b)

## Results and discussion

Results of the resistance test of LBB against subterranean termites that lasted for 4 weeks are presented in Table 2. Weight loss is one of indicators to determine the resistance of LBB against subterranean termite attack. The LBB made from untreated bamboo strips had average percent weight losses of 14 (extender content 5%) to 15.4 (extender content 2.5%). Compared with the Indonesian wood resistance classification against subterranean termites attack (Anonymous 2006b), those LBB made from untreated bamboo strips had comparable resistance to wood resistance class IV (poor resistance).

Weight loss of the LBB made from bamboo strips treated with 5% boron solution or bleached with either 17.5% or 20% of hydrogen peroxide varied from 7.6% to 10.5%. Compared with the Indonesian wood resistance classification to the subterranean termites attack, these laminated bamboo boards could be categorized as class III in their resistance to subterranean termites attack. This showed that pre-treatment on bamboo strips before LBB fabrication could increased the resistance class of LBB from class IV (poor resistance) to class III (moderate resistance).

Table 2. The resistance of laminated bamboo boards to subterranean termites attack

Bamboo strip treatment	Extender content, %	Weight loss (%)		Mortality (%)	Infestation rate	
		X ± Sd	Resistance class	X ± Sd	Value, %	Severity of attack
A	2.5	15.4 ± 2.70	IV	89.8 ± 13.77	12.5	Slightly attacked
	5	14.0 ± 2.39	IV	97.9 ± 3.68	16.5	Slightly attacked
B	2.5	8.5 ± 0.31	III	100 ± 0	2.0	Slightly attacked
	5	7.6 ± 1.16	III	100 ± 0	1.9	Slightly attacked
C	2.5	10.2 ± 1.79	III	100 ± 0	1.5	Slightly attacked
	5	10.2 ± 2.06	III	100 ± 0	1.1	Slightly attacked
D	2.5	10.3 ± 0.23	III	100 ± 0	1.1	Slightly attacked
	5	10.5 ± 0.37	III	100 ± 0	1.0	Slightly attacked

Remarks:

A = untreated bamboo strips ; B = treated bamboo strips with 5% boron solution ; C = bleached bamboo strips with 17.5% H<sub>2</sub>O<sub>2</sub> solution; D = bleached bamboo strips with 20% H<sub>2</sub>O<sub>2</sub> solution ; X = mean value; Sd = standard deviation.

The termite mortality of LBB made from untreated bamboo strips were 89.8% (extender content of 2.5%) and 97.9% (extender content of 5%). Whereas LBB made from bamboo strips treated with 5% boron solution or bleached with either 17.5% or 20% of hydrogen peroxide had the same termite mortality of 100%. From this information it can be seen that all LBB samples had high termite mortality even though on LBB made from untreated bamboo strips. This phenomenon might be resulted from the use of tannin resorcinol formaldehyde in LBB fabrication which able to resist termite attack. According to Pizzi (1994) tannins are phenolic in nature, while Woworoentoe *et al* (1971) stated that phenol could emit a typical smell and produce strong antiseptic characteristics, thereby functioning as activity regulator of particular enzymes as well as being toxic to the insects. Jasni and Supriana (1992) stated that the efficacy test of certain preservative was considered successful when the termite mortality of the specimens not less than 55%.

The LBB resistance to subterranean termite can be assessed from the value and severity of termite attack (infestation rate) on the LBB samples. As shown in Table 2 that the infestation rate values of laminated bamboo boards vary from 1% to 16.5%, while the severity of attack on all LBB samples can be categorized as slightly attacked.

### Conclusions

The resistance of laminated bamboo boards against subterranean termites attack in laboratory test was affected by bamboo strips treatment. The resistance to subterranean termite of three-layer thick LBB made from untreated bamboo strips had comparable resistance to wood resistance class IV, whereas those laminated bamboo boards made from bamboo strips treated with boron solution or bleached with hydrogen peroxide had comparable resistance to wood resistance class III. The pre-treatment on bamboo strips before LBB fabrication could increased the resistance class of LBB from class IV (poor resistance) to class III (moderate resistance).

## References

- Anonymous 2006a. Statistic of Indonesia 2005/2006. Catalog No : 1401. National Standardization Agency. Jakarta.
- Anonymous 2006b. Wood and wood products resistance test to wood destroying organism. Indonesian National Standard - SNI 01.7207-2006. National Standardization Agency. Jakarta. (in Indonesian)
- Jasni dan N. Supriana 1992. Use of insecticides containing phoxim and cyfluthrin active ingredients to prevent termite and powder post beetle attack on wood . Entomology Congress IV. Yogyakarta. (in Indonesian)
- Pablo. M.R.S. and C.M. Garcia 1997. Natural durability of anahua (*Livistona rotundifolia* Lam.Mart.). Forest Products Research and Development Industries Journal 23: 69-76.
- Pizzi, A 1994. Advanced Wood Adhesives Technology. Marcel Dekker. New York.
- Supriana. N., S. Abdurrohim., Barly, Jasni, Djarwanto., J. Malik., M. Muslich., D. Martono dan P. Permadi 2003. Study on the function of wood preservation for building in relation to sustainable forest management. Research Report. Research and Development Centre for Forest Products Technology . Bogor. (in Indonesian)
- Woworoentoe. S.A., I. Sianturi dan M. Patimah 1971. Properties of chemical substances. Tarate Press. Bandung. (in Indonesian)