Effect of bamboo strand length on oriented strand board

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Abstract. Utilization of non-wood material containing lignocellulose like bamboo Tali could be used for material in the manufacturing of oriented strand board (OSB). This research aimed to evaluate the effect of strand length on OSB quality made from Bamboo Tali. Strand length that used in this research was 5, 10, 15, 20, and 25 cm. The size of the boards. thickness and density target were 25 x 25 cm^2, 1 cm, and 0.7 $g.cm^{-3}$ respectively. OSB was made in three layers with perpendicular strand direction for every layer. The ratio of face/core/back was 1:2:1. The resin used in this research was Isocyanate resin (H3M type) with 5% resin content and 98% solid content to bind the board. After mat-forming. Mat was pressed using hot pressing in 160°C for 5 minutes and 25 $kg.cm^{-2}$ pressure. The results showed that almost all parameter of physical properties had fulfilled standard except moisture content. Furthermore, overall the parameter of mechanical properties had fulfilled JIS A 5908 standard. The trend of MOR and MOE showed that increasing of strand length caused of increasing those parameters, but the contrary trend occurred on internal bond.

1. Introduction

Forest industry of Indonesia is currently facing complex problems that are lack of annual logs supply per year. Based on data obtained from [1] explains that the production of round wood for carpentry and composites in 2012 as many as 25.33 million m^3 and decreased in 2013 to 23.22 million m^3. While the need of industry for timber and composite in 2013 reached 28.63 million m^3 resulting in a shortage of wood supply by 5.41 million m^3.

These conditions made it difficult to supply the increasing demand for this timber, and it is necessary to have an alternative of raw materials to supply the timber wood industry and composites. Several alternatives have been conducted in order to solve it, for example by utilizing the development of composite technology such as OSB (Oriented Strand Board), cement board, fibreboard, etc. [2].

Bamboo as non-wood material contains lignocellulose in which can be utilized as composite materials such as OSB. According to the [3] Oriented Strand Board (OSB) is a structural panel suitable for extensive use in construction and industry. This structural panel made out of strands that cut from small diameter and fast-growing trees and bonded with adhesive and hot pressing. According to [4] mentions that OSB is made with patterns perpendicular to each other to produce a reliable and hard plywood panel structure.

According to [5], the bamboo in Indonesia consists of 160 species; 38 species of them are introduced species, and 122 species are native plants. According to data from [6], bamboo plant in Indonesia in 2000 is estimated at 2.1 million ha consisting of 0.7 million ha of planted area of bamboo in the forest

area and 1.4 million ha of bamboo plant area outside of the forest. Bamboo Tali chosen as the raw material for the manufacture of OSB due to the nature of Bamboo Tali fibre has a straight and has sufficient strength to withstand load. The focus of this experiment is to know the effect of a strand length to the quality of OSB. Longer strand has a high slenderness ratio (SR) value. High SR value produces a high mechanical strength of OSB, while the value of aspect ratio is more than facilitating the process of forming OSB [7].

This study used Bamboo Tali as the main raw material strand. Based on these descriptions, for optimizing the utilization of bamboo, the research on the effect of long strand toward the quality of OSB made from Bamboo Tali had been conducted.

2. Materials and Methods

2.1. Materials

Bamboo Tali obtained from Sunggal. Medan. The strands were produced by using knife and hand scissor. Strand length of 5, 10, 15, 20 and 25 cm, strand width of 2.5 to 3 cm, and strand thickness of 0.1 cm. Commercial isocyanate type H3M as the adhesive was used to bind the strands. The amount of isocyanate adhesive used was 5%. Then approximately 7% moisture content of the strand was applied in this research.

2.2. Methods

2.2.1. Board producing. Three layers OSB was made in size of 25 x 25 cm^2, the density and thickness targets were 0.7 $g.cm^{-3}$ and 1 cm respectively. OSB made with surface layers aligned perpendicular to the core layer. The ratio of every layer was set of 1:2:1 (face: core: back). Rotary drum blender was used for mixing strand and adhesive. Furthermore, the strand was pressed at 160°C temperature for 5 minutes using 25 $kg.cm^{-2}$pressure. The final step was the conditioning process of boards for 14 days at room temperature.

2.2.2. Board testing. The physical and mechanical test consisted of density, moisture content (MC), water absorption (WA), thickness swelling (TS), modulus of rupture (MOR), modulus of elasticity (MOE), and internal bond (IB) according to the standard of JIS A 5908 (2003).

3. Results and Discussions

*3.1. Strand geometry***.**

The results showed that strand length of 20 and 25 cm resulted better of bending properties compared to other sizes. It was due to that strand had the highest slenderness ratio. The average value of the slenderness ratio and the aspect ratio was presented in Table 1, Figure 1 (a), Figure 1 (b) and Figure 2.

Table 1. Geometry of strand

	Strand length size (cm)				
	5	10	15	20	25
Length	5.13±0.10	10.26±0.33	15.12±0.39	20.06±0.16	25.03±0.30
Width	3.06±0.09	3.05±0.08	3.07±0.07	3.07±0.06	2.99±0.04
Thickness	0.12±0.005	0.11±0.003	0.10±0.005	0.10±0.004	0.10±0.004
Slenderness Ratio	44.71±2.26	92.85±4.01	138.20±8.25	183.53±7.96	235.60±10.96
Aspect Ratio	1.68±0.06	3.36±0.13	4.92±0.17	6.54±0.16	8.38±0.11

3.2. Density and moisture content (MC)

The density of OSB was varied between of 0.61 to 0.69 $g.cm^{-3}$ (Figure 2). The lowest density has resulted in the board with used strand length of 5 cm. The highest density resulted from the board with a strand

length of 15 and 20 cm. The density of board in this experiment still below on the target was 0.70 g/cm^3. Springback of the board caused it appeared after the conditioning process. The density value in this research similar to research conducted by [8]. All the density in this experiment had fulfilled standard that requiring of density value ranged of 0.4 - 0.9 g.cm^{-3} [9].

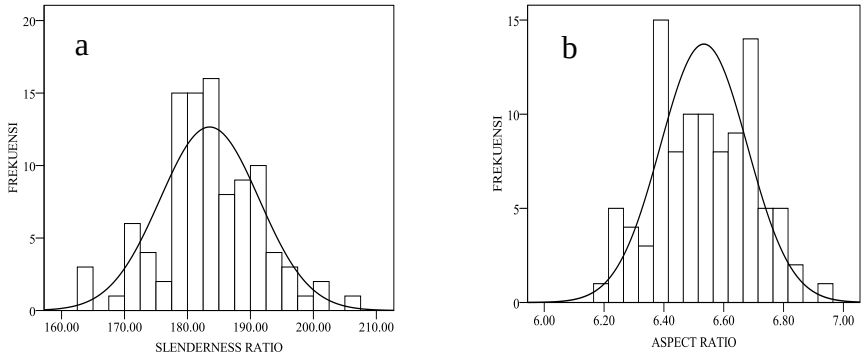

Figure 1. (a) Strand slenderness ratio and (b) aspect ratio of Bamboo Tali (*Gigantochloa apus* Kurz.).

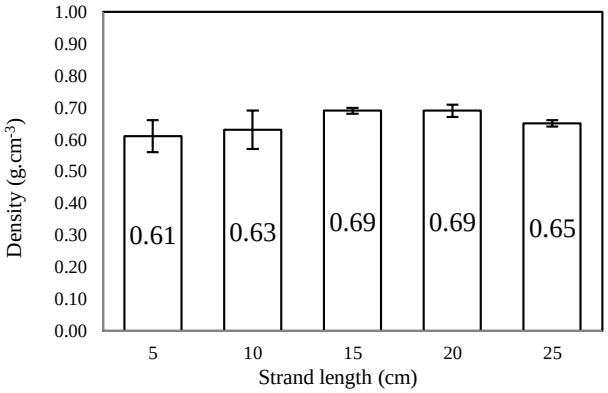

Figure 2. Density of OSB

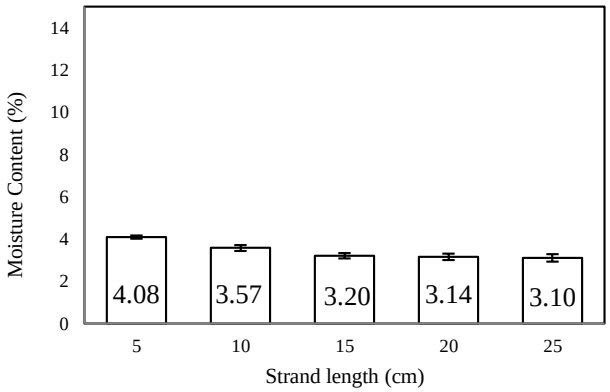

Figure 3. The moisture content of OSB

The MC values of OSB were varied between of 3.10 to 4.08% (Figure 3). The lowest and the highest MC resulted from OSBs with the strand length of 25 cm and 5 cm respectively. According to Figure 3, the board made from strand length of 5 cm resulted in the highest of MC values because it had a lower density. Overall, the MC in this experiment was below the JIS A 5908 (2003). The isocyanate adhesive had an important role in low moisture content value.

3.3. Thickness swelling (TS) and water absorption (WA)

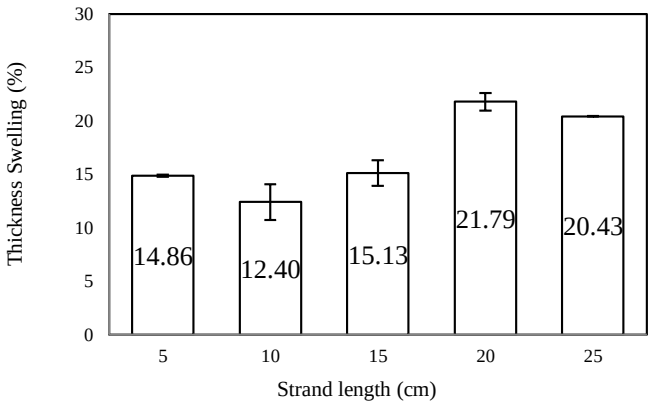

Figure 4. Thickness swelling of OSB

The TS values of OSB were varied between of 12.40 to 21.79% (Figure 4). The lowest and highest TS were provided from OSBs with the strand length of 10 cm and 20 cm respectively. According to the Figure 3, high TS value for strand length of 20 cm was caused by springback properties. It values approximately 8.53%.

Meanwhile, OSB with a strand length of 10 cm had the lowest springback value of 17.79%. All the TS values this experiment did not fulfil the standard that requiring of maximum thickness swelling value of 12% [9]. Amount of 5% isocyanate adhesive level had not been able to provide optimum results in this study.

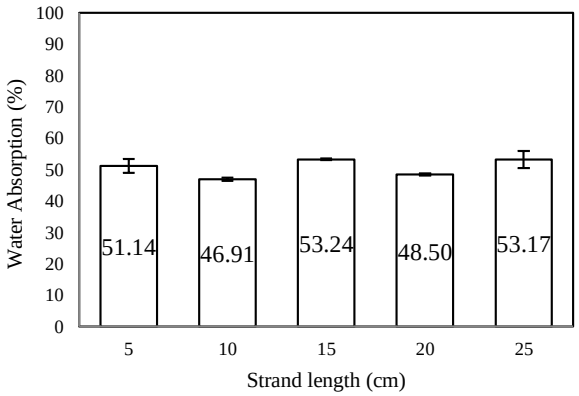

Figure 5. Water absorption of OSB

The WA values of OSB were varied between of 46.91 to 53.24% (Figure 5). The lowest and highest WA values were provided from OSBs with strand length of 10 cm and 15 cm respectively. According

to Figure 5, all these treatments resulted high of WA values. It was due to the absence of water repellent materials in this research. On the other hand, Bamboo Tali had a higher of hemicellulose content ranged between 28 to 36% [10]. According to [11] stated that hemicellulose is the main factor that responsible for the absorption of water.

3.4. Modulus of rupture and modulus of elasticity

The MoR and MoE of OSB varied between of 274.33 to 402.57 kg.cm^{-2} (Figure 6) and 51.575.74 to 78.349.75 kg.cm^{-2} respectively (Figure 7). The lowest and highest values of MOR have resulted from OSBs with strand length of 15 cm and 20 cm respectively. Similar results also were shown by MoE value. One of the factors that influence of MOR and MOE values of OSB was strand geometry. Strand with higher slenderness ratio (SR) value will provide better contact area to result of increasing mechanical properties and reducing the amount of adhesive needed on each layer surface. Beside of slenderness ratio (SR), the parameter needed to get a good orientation of strand on OSB was aspect ratio (AR). According to [7] that the ideally of SR value is 150 and the aspect ratio is 3. All the MoR and MoE values in this experiment had met the JIS A 5908-2003 that requiring of minimum MoR and MoR of 80 and 20.400 kg.cm^{-2} respectively [9]. Compared to OSB made from sentang wood was done by [2], bamboo Tali resulted in better-bending properties than OSB made from sentang wood.

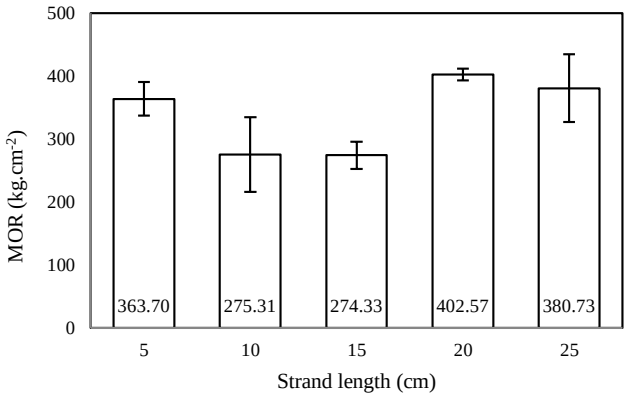

Figure 6. Modulus of rupture OSB

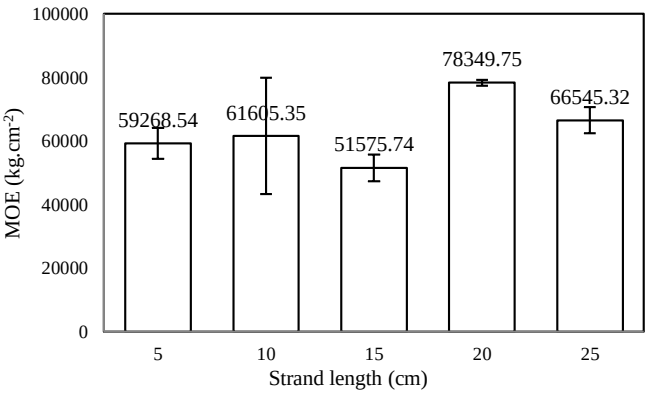

Figure 7. Effect of strand length on MOE of OSB

3.5. Internal bond (IB)

The IB value in this research ranged between of 3.30 to 4.44 kg.cm^{-2} (Figure 8). The lowest and highest of IB were provided from OSB with the strand length of 10 cm and 25 cm respectively. The strand length of 25 cm resulted in lowest IB value. It was due to overlap from the end of the strand that creates a gap in the board (Figure 9). According to [12] that the better of mat-forming and blending process will result in better bonding strength. All the IB values in this experiment had fulfilled the standard that requiring of minimum IB value of 1.5 kg.cm^{-2} [9].

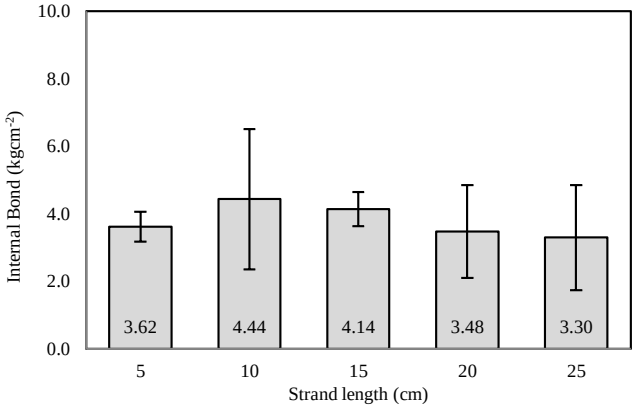

Figure 8. Effect of strand length on IB of OSB

Figure 9. OSB thickness appearance **(a)** strand length of 10 cm; **(b)** strand length of 25 cm

4. Conclusions

The increasing of strand length resulted better of some parameter in physical and mechanical like density, MoR, and MoE. Almost the physical parameter of OSB had fulfilled the standard, except moisture content. All the mechanical properties of OSB had fulfilled standard.

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