A New Conversion Method of Bamboo Culm into Flat Sheet for Laminated Bamboo Board Manufacturing

Edi Suhaimi Bakar[1,2], Zaidon Ashaari[1], Mohd Zin Jusoh[1] and Mohd Dzafarin Sahrani[1]
[1]Faculty of Forestry,
[2]Institute of Tropical Forestry and Forest Products,
Universiti Putra Malaysia, Malaysia

1. Introduction

The demand on wood has been uninterruptedly increasing over the time along with increase in the world population. On the other hand, wood supply, especially those from traditional forests, has been declined as a result of decrease in forest area and forest productivity. Efforts have been made in many parts of the world to produce more wood. These include programs such as promotion of tree plantation with fast growing species, promotion of community forest outside the forest area, and utilization of agricultural waste (rubber wood and oil palm wood from unproductive rubber and oil palm plantations). However, the total increase in the wood production cannot match the total increase in its demand. Therefore, many industries in wood sector cannot maintain their production (even some of them are closed down) due to insufficient supply of wood. This situation occurs in almost all parts of the world, including Malaysia.

2. Bamboo as Wood Alternative Material

Bamboo is a fast growing woody plant which can be harvested annually and is sustainable after its maturity (Wooldridge, 2012). It takes only about 3–5 years for bamboo to reach its full maturity as compared to 20–120 years of traditional hardwoods. Because of that, bamboo has gained a reputation as an eco-friendly and highly renewable source of material (Anon, 2012a, 2012b), and has been seen as good alternative material for wood. For this purpose, the most important part of bamboo is its culm, which is a woody material that has good properties and appearance. The culm consists of nodes, and hollow cylindrical internodes (Zhang et al., 2002; Anon, 2012c).

With its fast growth and high annual yield, bamboo plays a vital role in economic development, especially in the third world. Bamboo is notable for its economic and cultural significance in South Asia, South East Asia and East Asia. It is used for both traditional and modern uses. Traditionally, bamboo has been used to hold up simple suspension bridges, scaffolding, split and woven bamboo, and supplemental and/or decorative element in buildings (Anon, 2012c). In fact, it is valuable from top to rhizomes, with extensive uses in many fields (Yang et al., 2010). In Malaysia, 14 out of 59 species are commonly used by the Malaysian bamboo industry for making poultry cages, vegetable baskets, incense sticks and joss papers, skewers and chopsticks, woven blinds and handicrafts (Azmy et al., 1994; Aminuddin, 1995). In modern uses, bamboos are converted into engineered products, such as laminated bamboo board, plybamboo, bamboo mat board, and bamboo curtain board to substitute the same material made from wood (Yang et al., 2010, Anwar, 2008).

3. The Processing of Bamboo

The processing techniques of bamboo have been developed and resulted in a large number of versatile products. Bamboo can be cut and laminated into sheets and planks. Laminated bamboo based panels was reported to be superior to wood based panels in almost all performance indexes (Yang et al., 2010).

To produce laminated bamboo, the cylinder culms must be converted into flat sheets or elements. The conversion of the cylinder shaped culms into flat sheets or elements can be made through the "splitting-pressing" (Figure 1) and "splitting-squaring" (Figure 2) method (Bakar et al., 2006), but only the splitting-squaring method can be applied for decoration purposes (Zhang et al., 2002). In this method, the culms are split into narrow strips and the resulting strips are edge squared piece by piece of even thickness and width with a planing machine before they are finally glued and pressed together to form laminated bamboo boards or planks.

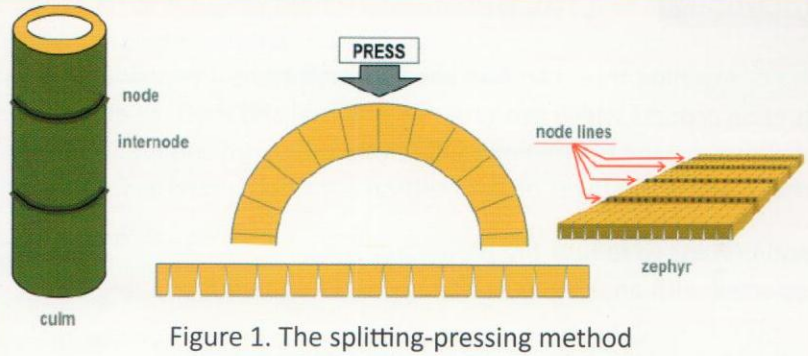

Figure 1. The splitting-pressing method

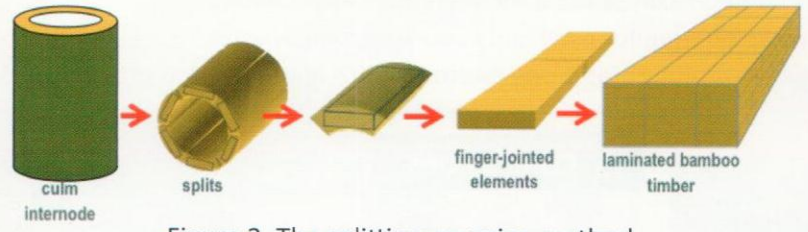

Figure 2. The splitting-squaring method

Nevertheless, the mentioned method is neither practical nor efficient. The squaring of narrow strips into even thickness and width with a planer piece by piece is a time consuming and inefficient process. Hence, a new conversion method for converting bamboo culms into flat sheets (and the apparatus thereof) has been developed by Bakar et al. 2012. This method is called the V-grooving method.

4. The V-Grooving Method

The V-grooving is a new, efficient, and practical method for converting cylindrical shaped bamboo culms into flat sheets that can be used for laminated bamboo timber manufacturing. This method and its machine that was exhibited and got Gold Medal award at the PRPI (Pameran Rekacipta Penyelidikan dan Inovasi) Malaysia 2012 have been patented by its inventor under Malaysian Patent Filing No. PI 2012001327.

4.1. How does the V-Grooving method work?

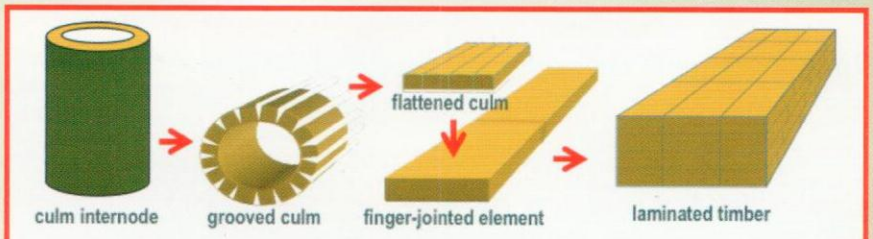

Figure 3. The V-Grooving Method

The culm internodes are cut in a series of V-shaped grooves at a certain interval from culms outer-side. A special design grooving machine was developed for this process. The grooving intervals are pre-calculated and presented in a Grooving Table for operator use. These intervals depend on the culm diameter and thickness, as well as the groove angle. Each groove is purposely made to have ±1mm uncut portion (called the grooving cease) that serves as connector to make the culm keep intact, and give a hinge function necessary for the flattening process. Figure 3 shows how the V-Grooving method works, while Figure 4 shows how the V-Grooving machine looks like.


Figure 4. The V-Grooving Machine

After the grooving is completed, the last groove is cut through and the groove surfaces are coated with certain glue. The culm is then flattened with a presser or clamper. Hinge function of the grooving cease will transfer the vertical forces into lateral ones and allow the entire grooves to close tightly forming a fixed, flat sheet. The flattened culm can be then simply planed on one or both of its surfaces with a planing machine and ready for use in manufacturing of laminated bamboo timbers or special decorative boards.

4.2. Advantages of the V-Grooving Method

This method involves shorter process and simpler machine thus, can save the time and lower the production cost. In addition, the method involves simple and precise process which can save raw material and produce quality products. Matured bamboo culm (aged 4-year and above) having the minimum diameter of 60 mm and minimum thickness of 8 mm can be processed with this machine. The advantages of this method are summarized as follows:

- Involve more efficient and more practical process to reduce the production cost.
- Involve small and simple machine, supported with an easy-to-use Grooving Table that is suitable for small and medium-scale industries.
- Can produce LBT with hard and beauty bamboo skin suitable for decorative applications.
- Create job opportunity and new income generation for rural and suburban communities.
- Involve green technology to produce green products (as wood alternative) to fill up the gap of wood supply for wood industry.

5. Conclusions

V-Grooving method (and its apparatus) is a new method to convert cylindrical shaped bamboo culms into flat sheets for laminated bamboo boards manufacturing. With this method, bamboo culms can be processed into wood alternative material efficiently and practically. This will not only give benefit to wood industry (through new alternative material supply), but also to the communities by providing opportunities for job creation and income generation.

References

Aminuddin, M., (1995). Bamboo in Malaysia: Conser vation status, biodiversity base and strategic programme for improvement. FRIM Report No.67. Forest Research Institute Malaysia.

Anon., (2012a). Why Bamboo? Retrieved from http://www.calibamboo.com/whybamboo.html. Accessed on 10 December 2012.

Annon., (2012b). Bamboo Floor.Retrieved from http://en.wikipedia.org/wiki/Bamboo_floor. Accessed on 15 December 2012.

Anon., (2012c).Bamboo.Retrieved from http://en.wikipedia.org/wiki/Bamboo. Accessed on 10 December 2012.

Anwar, U.M.K., (2008). Impregnation of Bamboo (Gigantochloa scortechinii) with Phenolic Resin for the Production of Dimensionally Stable Plybamboo. PhD Thesis. Universiti Putra Malaysia.

Azmy, M., Razak, W., and Norini, H., (1994). Buluh-buluh komersial dan kegunaanya. In: Norini, H., Roslan, I., Zana, A.U. (Eds.). Laporan dan Kertas-Kertas Kerja Seminar Pemindahan Teknologi Kayu Getah dan Sumber Hutan Lain Kepada Pekebun Kecil. FRIM Reports. No.64. Forest Research Institute Malaysia, pp.40-43

Bakar, E.S., Nugroho, N., Zulfa, U., Maniam, T., (2006). Conversion of Bamboo Culms into Bamboo Mat through V-Grooving Method. Presented at the 8th Pacific Rim Bio-Based Composites Symposium. Kuala Lumpur, Malaysia.

Bakar, E.S., Ashaari, Z., Jusoh, M.Z., Mohd. Sharani, D., (2012). An Apparatus to Convert Cylindrical Shaped Objects to Flat Sheet Objects and A Method Thereof. Patent Pending, PI 2012001327. Intellectual Property Corporation of Malaysia.

Wooldridge, M., (2010). Booming bamboo: The next super-material? Retrieved http://www.bbc.co.uk/news/magazine-17568088. Accessed on 12 November 2012.

Yang, Y., Hui, C., Du, F., (2010). China's Bamboo: Culture, resources, cultivation and utilization. Colour Max Commercial Printing Co. Ltd., Hong Kong

Zhang, Q., Jiang, S., Tang, Y., (2002). Industrial utilization on bamboo. INBAR Technical report 26. Colour Max Publishers Ltd., Beijing China.