

The Influenced of Compression on Properties of Binderless Compressed Veneer Made from Oil Palm Trunk

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Abstract— Binderless compressed veneer panels from oil palm trunk consisted of 5 layers of oil palm trunk veneers were made with 3 different thickness, 7 mm, 10 mm and 15 mm. The panels were pressed at temperature of 180 °C with pressure 5 MPa at duration time of 20 minutes. The veneers were pressed without using any synthetic adhesive in the manufacturing process. Mechanical and physical properties such as flexural test, thickness swelling and water absorption, density and compression ratio were observed and evaluated based on Japanese Agricultural Standard 2003 (JAS). The findings showed that binderless compressed veneer panels that undergo pressing process with thickness bar 7 mm showed the highest value of flexural strength compared to other type of panels. Dimensional stability such as thickness swelling and water absorption showed relationship with compression ratio. Based on the results, the compression ratio did influenced the properties of binderless compressed veneer panel made from oil palm trunk.

Keywords— oil palm trunk; binderless; compressed veneer; compression ratio.

I. INTRODUCTION

Compression is a technique used to increase the density of the final product by decreasing the thickness of the raw material [1], [2]. Compression of wood also known as densification had being practiced since decades ago in particle board industry to produce wear resistant particle board [3]. The technique of densification with varies methods have been reported can improvise the strength in term of physical and mechanical properties of the wood product during its performance [4]. Moreover, this process is believed could smoothen the surface of the final product [5]. Based on previous researches, the compressed wood were produced by using two techniques known as Compreg and the other one is Staypack. Compreg is a wood compression process that involved resin treatment meanwhile Staypack is non-resin treated process [5]. The compression techniques were not just focussing on solid wood only but also applied to other materials such as wood chips and veneers [2],[6],[7].

Recently many researches focused on manufacturing wood based panels without adhesive or resin which is known as binderless board [8], [9], [10]. The ideology of binderless was to produce a product that is environmental friendly product by reducing or not utilize binder in the manufacturing process and at the same time reduce the

production cost. This is due to the concern of formaldehyde emission issues [11] [12]. Besides that, the ability of lignocellulosic materials to be bonded together without synthetic adhesive inside the binderless board is called self-bonding activity [13]. However, the research on binderless board studies mostly focused on producing particleboard type panel by using different kind of lignocellulosic materials such as oil palm trunk, rice husk, kenaf, baggase and banana bunch [14], [15], [16].

A few studies had proved that oil palm trunk can be considered as one of a promising lignocellulosic materials to produce a value added wood based panel products such as binderless particleboard, compressed lumber and etc [8], [9], [17]. This is due to its chemical constituent's properties of oil palm trunk itself which is known to be rich with hemicellulose and starch content. The botanical classification of oil palm is *Elaeis guineensis Jacq* is a native species to west and central of Africa. High production of palm oil as cooking oil had made oil palm become a domestic plant in Malaysia and some other Asian countries. That factor had made this biomass resources easily to be found abundantly in Malaysia as oil palm is one of major plantation in this country. Besides that, oil palm trunk can be categorized as one of a renewable resources because oil palm tree will be replanted after 25-30 years economic life span [18]. The oil palm biomass such as trunk, frond, and

leaves were estimated had being generated at least 30 million tonnes every year. The objective of this study was to investigate the effect of compression towards the properties of binderless compressed veneer and the possibility of oil palm trunk veneer to be pressed with no consumption of synthetic adhesive.

II. MATERIALS AND METHODS

A. Sample preparation

Oil palm trunks of 25 – 30 years were used to produce veneer in this study. The veneer was made using rotary veneer by peeling process. Then the veneers were cut into dimension 205 mm x 205 mm x 4.5 mm. After that, the veneers were air dried until the moisture content about 10 – 12 %.

B. Board making process

The dried veneers were arranged perpendicular to each other for 5 layers. The fine particle of oil palm trunk with size pass through 500 µm sieve were spread at each layer. Then, the arranged veneers undergo hot pressing process with condition of 180 °C, duration time 20 min at pressure 5 MPa. The compressed veneer panels were conditioned in a conditioning room for a week. Then the panels will undergo testing to observe its property.

C. Determination of compression ratio (%)

Sample with size 50 mm x 50 mm was used for calculation compression. Compression ratio was calculated based on the equation:

$$\text{Compression ratio} = [(T_1 - T_0) / T_1] \times 100 \quad (1)$$

Where, T_1 : thickness before compression

T_0 : thickness after compression

D. Thickness swelling and water absorption

The shrinkage and swelling study includes thickness swelling and water absorption were carried out based on JAS of plywood-2003 [19]. The standard was slightly modified to accommodate the panel size and then being immersed in the hot water with temperature of 60 ± 3 °C for duration 3 hr.

E. Modulus of rupture

The Modulus of rupture of the compressed veneer was tested by using Instron machine. This testing was evaluated based on JAS of plywood-2003 [19] with slightly modified to suit the size of the compressed veneer. The deflection was measured and calculated based on Bending Young's Modulus formula.

$$\text{Bending Young's Modulus (MPa or N/mm}^2\text{)} = \Delta P l^3 / 4bh^3 \Delta y \quad (2)$$

F. Scanning electron microscopy (SEM) study

Scanning electron microscopy (SEM) was employed to compressed veneer panels in order to characterize the morphology which related to the effect of compression towards raw materials and the bonding quality. The micrograph was viewed using machine Scanning Electron Microscope LEO Supra 50 Vp, Field Emission SEM.

III. RESULTS AND DISCUSSION

The data on density and compression ratio of binderless compressed veneer from oil palm trunk with different thickness were presented in Table 1. The density values showed the compactness of the panel together with the percentage of compression ratio of 5 layers of veneers which had being compressed into 3 different target thicknesses.

TABLE I
THE VALUES OF DENSITY AND COMPRESSION RATIO OF VENEER OF BINDERLESS COMPRESSED VENEER PANELS FROM OIL PALM TRUNK FOR DIFFERENT THICKNESS

Thickness (mm)	Density (g/cm ³)	Compression ratio (%)
7	1.02 (0.06)	68.89 (0.57)
10	0.65 (0.07)	55.56 (0.64)
15	0.57 (0.05)	33.33 (0.59)

*the values in parenthesis showed standard deviation

Table 1 showed the density and compression ratio values of binderless compressed veneer from oil palm trunk. Based on the data above, the density values of the panels was effected by the degree of compression that was carried out during pressing process. The total layers used in this study was 5 layers of veneers for each panel that were arranged perpendicular to each other. The different was the thickness spencer used which were 7 mm, 10 mm and 15 mm. Binderless compressed veneer panel with thickness 7 mm had the highest density values followed by sample with thickness 10 mm and 15 mm. This factor is related to the compression degree where the panel with thickness 7 mm had being highly compressed and compacted which reduced the void inside the panel. Higher compression will cause higher in density which influenced the strength and compactness of the binderless compressed veneer [20]. The degree of compression of the panels with thickness 10 mm and 15 mm not so high.

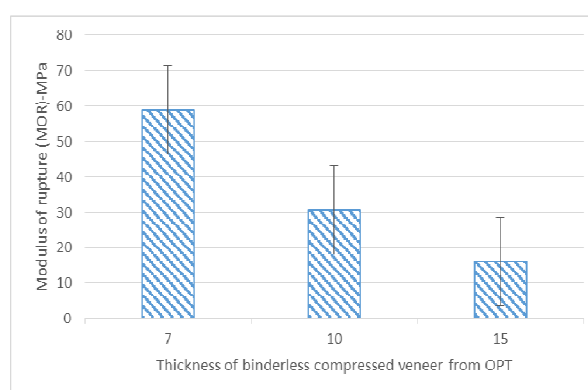


Fig. 1: Relationship thickness of binderless compressed veneer panel with MOR

Fig. 1 showed the effect of compression ratio towards the modulus of rupture (MOR) of binderless compressed veneer panel from oil palm trunk. The highest values found in panel with thickness 7 mm, 58.9 MPa followed by panel with thickness 10 mm and 15 mm 30.8 MPa and 16.2 MPa respectively. This findings were correlated with compression degree and density values. High in density will produce high

modulus of rupture values. Compressed veneer with thickness 7 mm and 10 mm had met the standard based on Japanese Agricultural Standard 2003 (JAS) [19]. The compression happened during hot pressing process somehow had degraded hemicellulose which weaken the cell wall and caused the parenchyma cells inside the panel to be completely compressed. Moreover, the reduction of total volume which related to the increment of density of the binderless compressed veneer panel had caused the strength of the board increase. The panel with thickness 7 mm showed good bonding quality created during compression process which resulted in high strength even though no adhesive being added. Binderless compressed veneer panel with thickness 15 mm showed the lowest reading because the veneers not completely pressed.

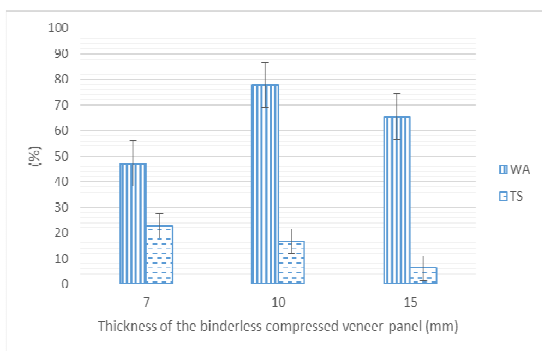


Fig. 2: Relationship thickness of binderless compressed veneer panel with water absorption and thickness swelling

Shrinkage and swelling of the compressed veneer panels from oil palm trunk can be observed based on Fig 2. The values of water absorption and thickness swelling showed contrary pattern. Water absorption values increased from panel with thickness 7 mm to 10 mm and drop a little bit for panel with thickness 15 mm. however the values of thickness swelling decreased as the thickness were increased. This findings somehow related to density values. The panel with thickness 7 mm showed the lowest WA compared to the other panels due to compactness phenomenon and degree of compression happened inside the panel where most of the fibres completely pressed caused no void inside the panel. Thus, water intake become less. The compressed veneer panel with thickness 10 mm showed the highest WA because the water intake was the highest among the panels as the veneers not completely pressed and still got void inside the panel. Therefore too much water intake will cause the panel easily peel of layers by layers of veneer. However, TS showed opposite result.

Fig 3 showed the interphase morphology of binderless compressed veneer from oil palm trunk with thickness 7 mm thickness. Based on the figure above, the fibres and cell walls can be seen completely compressed during the pressing process [11]. Besides that, the vascular bundles also discovered to be compressed. The vascular bundles is the main element in the oil palm trunk which responsible to give mechanical strength to the binderless compressed veneer panel. The pressed parenchyma cells also being observed in the Fig 3. The compactness and pressed fibres had contributed to the better dimensional stability in term of water absorption [21]. Moreover, mechanical interlocking

between fibres happened when the fibres and cells inside the panel being completely pressed together [11].

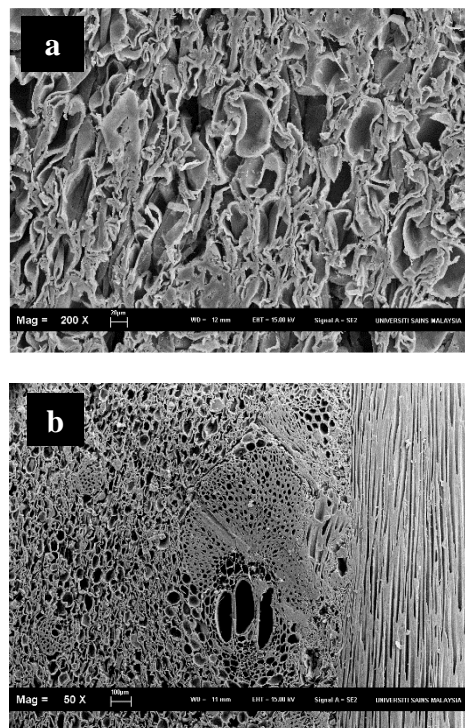


Fig. 3 (a) & (b): Scanning electron microscopy micrographs of binderless compressed veneer panel of oil palm trunk with thickness 7 mm

IV. CONCLUSIONS

The findings showed that high compression and compactness will caused the binderless compressed veneer panel made from oil palm trunk increase in modulus of rupture and its density. Besides that, the 5 layers of oil palm trunk veneer can be bonded together with hot pressing method even though no additional synthetic being utilized. This binderless compressed veneer panel with 7 mm thickness showed good modulus of rupture and improvement in dimensional stability properties in term of water absorption. Thus proved that compression did influenced some properties of binderless compressed veneer from oil palm trunk. Further study and modification are needed because some properties such as thickness swelling and water absorption still did not meet the standard. However oil palm trunk veneer have high potential to be used as raw material for binderless compressed veneer product.

ACKNOWLEDGMENT

The authors would like to acknowledge Ministry of Higher Education (MOHE) for the MyPhd scholarship to Norhafizah Saari and Universiti Sains Malaysia for Research University Grant 1001/PTEKIND/811255.

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