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IMPROVED PROPERTIES OF OIL PALM TRUNK (OPT) LAMINATED VENEER LUMBER (LVL) THROUGH THE INCLUSION OF RUBBERWOOD VENEERS

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ABSTRACT

Currently, much research efforts were concentrated towards utilizing oil palm trunk as alternative materials to replace or reduce dependency on rubberwood for furniture. In this study, 30 years old oil palm trunk (OPT) that is normally regarded as waste after falling for re-planting is used as raw material in combination with rubberwood veneers for the manufacture of laminated veneer lumber (LVL). Their properties, in terms of bending and compression strength, were evaluated in accordance with the Japanese Agricultural Standard for LVL. It was found that the bending and compression strength were greatly improved as compared to LVL produced entirely from OPT. Significant reduction in strength properties variations between boards was also found when OPT was utilized in the form of LVL. Being a monocotyledonous species, oil palm trunk properties is stipulated of having great variations between the outer parts of the stems and towards the center of the stem. Such results indicated that more uniform board properties could be produced. It was also found that the bending and compression strength of OPT-LVL produced in this study were comparable to the strength properties of solid rubberwood.

Keywords: oil palm trunk, laminated veneer lumber, rubberwood veneer, bending strength, compression strength

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1. INTRODUCTION

Oil palm tree, scientifically known as *Elaeis guineensis* is among the most important agricultural crops in Malaysia since 1960's for palm oil production. The average economic life span of oil palm trees is between 25-30 years after which the trees were felled to make way for re-planting. Currently, there were abundance of oil palm trunks (OPT) generated from re-planting process, and this created problems of waste handling and disposing. The current practice of burning, left to rot in the field, and cutting into smaller pieces before it was pulverized are no longer favourable due to environmental and costs reasons. Through research and development, these wastes are reported to have commercial importance and potentially could be used as an alternative raw material for the furniture manufacturing industry. Currently, research on OPT have been conducted for the production of briquette, particleboard[1], medium-density fiberboard[2], cement-bonded particleboard[3], blockboard[4], plywood[5], as well as furniture[6] with the prospects ranging from little to highly potential. Preliminary study on the utilization of OPT for laminated veneer lumber (LVL) has also been conducted with promising results[7]. This study was carried out with the objective to explore the potentials of OPT for the manufacture of LVL with the hope to improve the strength properties through the inclusion of several layers of rubberwood veneers.

2. MATERIALS AND METHODS

Samples of mature OPT logs of approximately 30 years old were obtained from a re-plantation site in Perak. They were transported to a furniture factory in Sungai Petani, Kedah for veneer peeling and LVL production. The OPT logs were peeled to veneers, and were later subjected to normal process of drying, cutting, pre-pressing, and glue spreading before they were finally laid-up and hot-pressed to produce LVL of 25mm (t) × 500mm (w) × 780 mm (l) in size. The LVL, which consisted of 9 layers of veneer, was bonded together using urea-formaldehyde glue. Three different configurations of OPT-LVL were produced as illustrated in Figure 1.

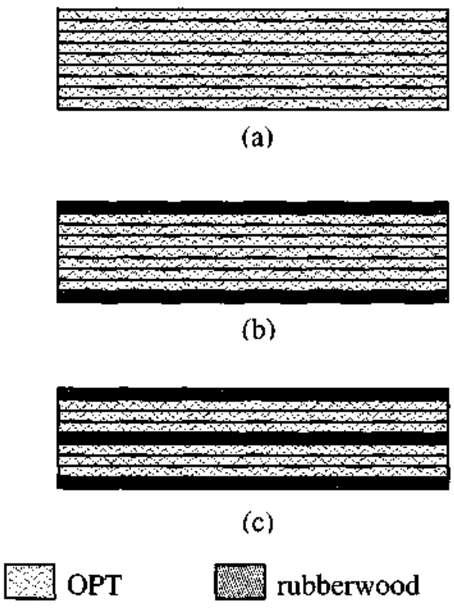

Figure 1: Three different configurations of OPT-LVL produced. (a) OPT-LVL (b) OPT-2RW LVL and (c) OPT-3RW LVL.

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They were LVL made entirely of OPT veneers (OPT-LVL), OPT-LVL with the inclusion of 2 layers of rubberwood veneers (OPT-2RW LVL) as well as the one with 3 layers of rubberwood veneers (OPT-3RW LVL). In order to evaluate the strength properties of the manufactured LVL, bending and compression strength tests were conducted according to the standard as stipulated in Japanese Agricultural Standard for LVL JAS: SE-10.

3. RESULTS AND DISCUSSON

The bending and compression strength results for the LVL are presented in Table 1. The mean bending modulus of rupture (MOR) and modulus of elasticity (MOE) for the OPT-LVL board were 41.0 MPa and 4,219 MPa, respectively. In comparison with LVL made with the inclusion of rubberwood veneers, the results of this study showed that the bending properties of the LVL were greatly improved. For OPT-2RW LVL, the mean MOR and MOE values escalated to 49.1 MPa and 6,828 MPa, which shows an increase of about 19.8% and 61.8%, respectively. The inclusion of another layer of rubberwood veneers (OPT-3RW LVL) markedly enhanced the bending properties of the LVL with the MOR and MOE values improved to 59.7 MPa and 7,613 MPa, an increase of approximately 45.6% and 80.4%, respectively.

Analysis of variance (ANOVA) test conducted on the mean bending MOR and MOE values between LVL boards of the three different configurations revealed that significant different exists between them. Thus, the inclusion of rubberwood veneers significantly improved the OPT-LVL bending properties. In terms of compression strength, a similar trend to bending was also observed which saw a substantial improvement of the mean compression strength, as additional layers of rubberwood veneers were included in the OPT-LVL.

The OPT-LVL with the inclusion of rubberwood veneers were found to be 49.8% (OPT-RW3 LVL) and 26.1% (OPT-RW2 LVL) stronger than LVL made entirely of OPT veneers. The compression strength between the three different configurations of LVL boards was significantly different based on ANOVA test. The improvement in bending and compression strength could be attributed to the densification of the LVL board as a result of the inclusion of a more uniform and higher density rubberwood veneers during manufacturing. This was evident from Table 1, which showed an increase in the density of the LVL board as additional of layers of rubberwood veneers were included. Other factors such as the introduction of urea-formaldehyde glue, and dispersion or removal of strength reducing veneer characteristics could perhaps be the contributing factor as well.

Another interesting finding that needs to be highlighted is the reduction in strength properties variation. Being a monocotyledonous species, OPT properties was stipulated of having great

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variations between outer parts of the stems and towards the centre of the stem[8]. In contrasts to solid OPT lumber (Tables 1 and 2), this study indicated that, by utilizing OPT in the form of LVL, the variations between boards were significantly reduced, implying that more uniform board properties could be produced. The ANOVA test conducted confirmed that there was no significant difference between boards in terms of the mean bending MOR and MOE values. Furthermore, with the inclusion of a few layers of rubberwood veneers, more promising results were achieved. This could potentially make OPT wastes feasible for the production of LVL.

Table 1. Bending and compression strength of OPT-LVL with three different configurations.

Material	No. of samples	Bending strength MOR (*MPa*)	Bending strength MOE (*MPa*)	Compression strength (*MPa*)	Oven-dry density (*kg/m*^{3})
OPT-3RW LVL	30	59.7^a (5.4)	7,613^a (533)	31.6^a (3.3)	589 (20.0)
OPT-2RW LVL	30	49.1^b (4.2)	6,828^b (319)	26.6^b (2.9)	572 (29.1)
OPT-LVL	30	41.0^c (7.8)	4,219^c (774)	21.1^c (2.5)	545 (32.2)

Note: Values in parentheses denote standard deviations.
Means followed by the same letter in the column are not significantly different.

Table 2. Bending and compression strength of solid OPT and rubberwood.

Material	Bending strength MOR (*MPa*)	Bending strength MOE (*MPa*)	Compression strength (*MPa*)	Oven-dry density (*kg/m*^{3})
Solid OPT[9]	8 – 45	800 - 8,000	5 – 25	220 – 550
Solid Rubberwood[9]	58	8,800	26	530

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In comparison to solid rubberwood (Tables 1 and 2), The compression strength of the OPT-LVL with 3 layers of rubberwood veneers was slightly higher than solid rubberwood. While the bending strengths are comparable to the solid rubberwood. Despite of having lower bending strength, the compression strength of the OPT-LVL with 2 layers of rubberwood veneers was comparable to solid rubberwood. These results showed that with further research and development efforts, OPT veneers have the potential to be utilized in combination with rubberwood veneers for the production of LVL.

4. CONCLUSION

This study showed that the properties of OPT-LVL were improved by combining OPT veneers with several layers of rubberwood veneers during the process of LVL manufacturing. Such combinations have resulted in the improvement of bending and compression strength of LVL. In addition, they showed less variation in strength properties as compared to solid OPT properties. The OPT-LVL produced from this study was found to possess bending and compression strength comparable to solid rubberwood. With further research and development, overall performance of the OPT-LVL could be improved for commercial utilization of OPT wastes for LVL manufacturing in the near future.

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