Properties of Thermoplastic Composite Using Sesendok and Kelempayan Sawdust at Different Filler Loading of Polypropylene

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ABSTRACT

This study provides mechanical and physical properties of wood plastic composite from Sesendok and Kelempayan. In this study, polypropylene was used due to the high curing temperature and high strength. The effect of different filler loading of 40 mesh Sesendok and Kelempayan sawdust such as 10%, 30%, and 50% were performed. The properties of bending strength, internal bonding (IB), thickness swelling (TS) and water absorption (WA) were evaluated base on ASTM standard. From the study, it showed that filler loading and type of species affected the physical and mechanical properties of wood plastic composite.

Keywords: *filler loading, thermoplastic composite, physical and mechanical properties*

Introduction

Wood plastic composite is still a very new material relative to the long history of natural lumber as a building material but can be substituted in most non-structural instances. Although being highly resistant to rot, wood plastic composites still soak up water due to their mixture with organic wood fibers. Some manufacturers have tried to avoid this by loading up their wood fibers with oils or other products that repel water. Still the major advantage of this category of building materials is its ability to add another stage of upstream use to materials previously considered waste lumber. Although these materials continue the lifespan of used and discarded materials, and have their own considerable half-life, the polymers and adhesives added make wood-plastic composite difficult to recycle again after use due to the many impurities in such a compound. It can be recycled easily in a new wood-plastic composite (Anatole, 2007).

Wood has been long been used by the plastic industry as inexpensive filler to increase strength and stiffness of thermoplastic or to reduce raw material cost. During the late 1980s, researchers and industries began investigating high filler level and coupling agent to encourage interaction between the wood and thermoplastic component. An improved sophistication in processing and formulating led to development of wood plastic composite (WPC) that exhibits synergistic material properties (Michael , 2000).

Material and Methods

Sawdust Preparation

Sesendok (*Melastomamalabathricum*) and Kelempayan (*Neolamarckiacabamba*), were cut from HSUiTM Pahang. Leaves were removed from the log. The logs were then chipped to 3-5 cm size. Then, the chips were put into ring flakers to produce particles. The size is usually less than 5.0mm. After being air-dried, the particles were ground to get the desired size. : 250μm, 150μm, 75μm and fines. The particles were then oven dried at 90±5°C until the desired moisture content was attained.

Bulk density

In the determination of bulk density the weight of the empty cylinder was first determined. The sawdust was then sieved into the cylinder until it was full. The process was replicate for six times to achieve the average bulk density.

Blending in the Dispersion Mixer

The synthetic material that was used in producing the wood plastic composite is polypropylene (PP). The particle geometry used in the study was 150μm and with filler loadings of 10%, 30%, and 50%. First, the temperature of dispersion mixer was increased up to 180°C. The polypropylene (PP) were then melted and blended and mixed together with the sawdust to form a homogenous mixture. After mixing, the temperature of the dispersion mixer was reduced to turn the mixture into granule. Then, the granule was transferred to a crusher to obtain plastic composite pellets. The pellet was the used to produce the thermoplastic composite using a mould. Bending and tensile samples were producing using the mould.

The pellet was pressed under heat and pressure in the hot press to cure the thermoplastic and produced the thermoplastic board. For the tensile board, the mould was pressed at 180°C under 1000 p.s.i pressure for 300 second. While for the bending board, the mould was pressed under the same temperature and pressure but required time is 540 seconds. After hot pressing, the board was pressed by using cold press. The tensile board was pressed for two minutes while the bending board was pressed for three minutes.

Composite Evaluation

Pressed panels were then cut into test samples according to ASTM Standards Methods after they had been conditioned in a climate chamber at a temperature of 20 °C and a relative humidity of 65%.

Results and Discussions

Modulus of rupture (MOR) and Modulus of elasticity (MOE)

Figure 1 and Figure 2 show the bending strength (Modulus of Rupture; MOR and Modulus of Elasticity; MOE) of wood plastic composite from Sesendok and Kelempayan at different filler loading. The results showed that MOR value for 10% filler loading was higher compared to panels at 30% and 50% filler loading. It was because; lower filler loading will increase the bonding ability of polypropylene. According to Daniel (1998) , the loss of bending strength results from additional fracture site with associated more flour particles and this create void in the plastic material potentially allowing for tensile failure at lower load. However, the MOE value showed at 50% filler loading was higher compared to other filler loading. This was due to the higher filler loading that can contribute stiffness in flexural modulus since the sawdust act as the filler. In addition, Kelempayan showed slightly higher MOR value than Sesendok, though Sesendok and Kelempayan are the same group which are light hardwood in the range of wood density of 305kgm^{-3} to 705kgm^{-3}(Gan *et al.*, 1999).

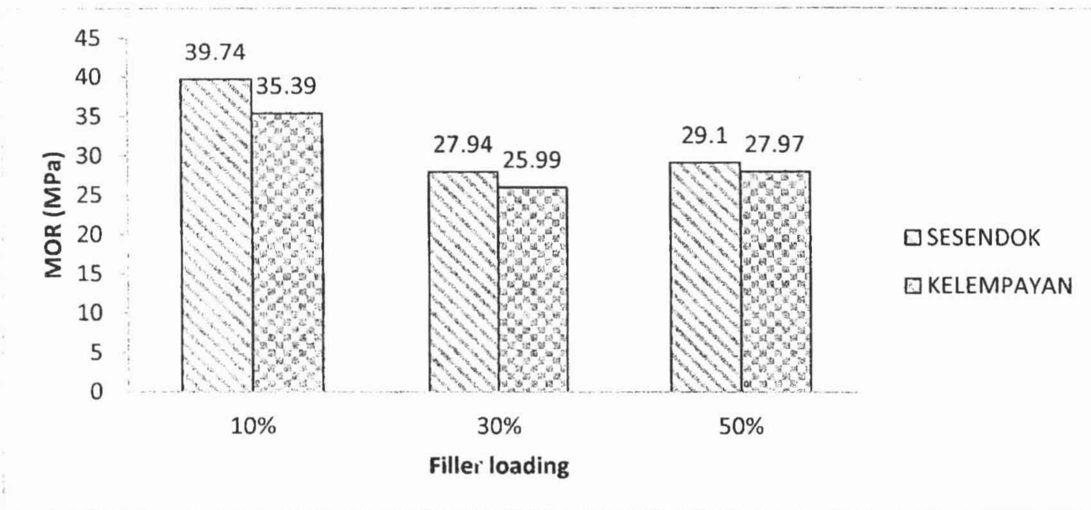

Figure1: Modulus of rupture (MOR) of wood plastic composite at different filler loading and species of wood

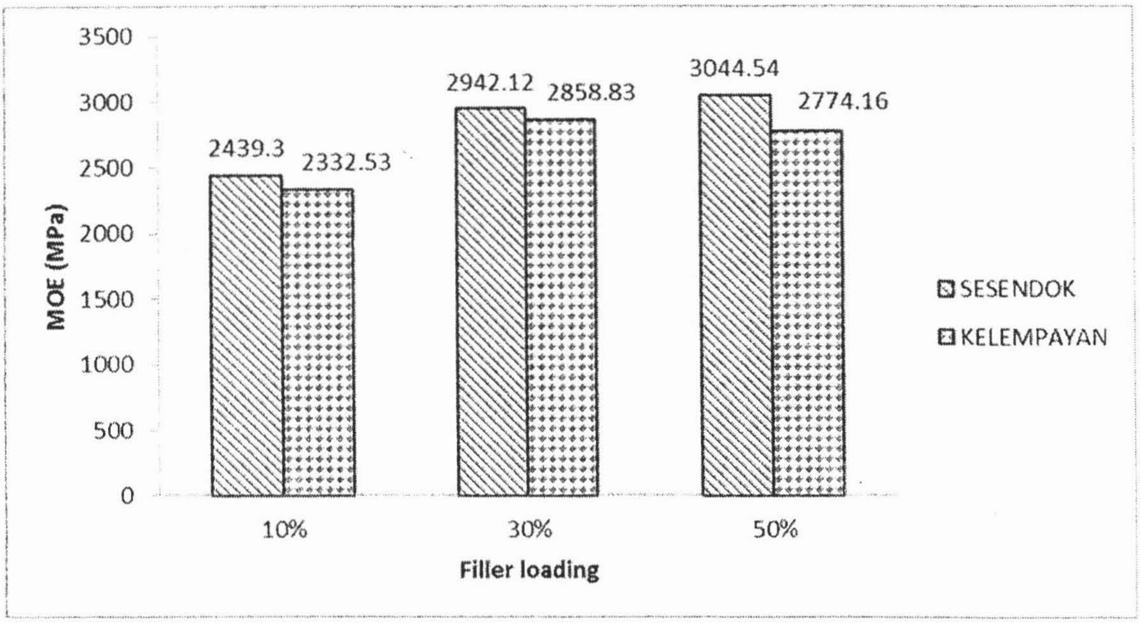

Figure 2: Modulus of elasticity (MOE) of wood plastic composite at different filler loading and species of wood

Internal Bonding Strength (IB)

Figure 3 shows the internal bonding (IB) strength of wood plastic composite at different filler loading and species of wood. From the results, it can be seen that 10% filler loading shows the highest value of IB compare to 30% and 50% filler loading. This was due to the large amount of plastic that will give better tensile strength properties. Higher amount of filler loading will lead to brittleness since there is less internal bonding in the panel.

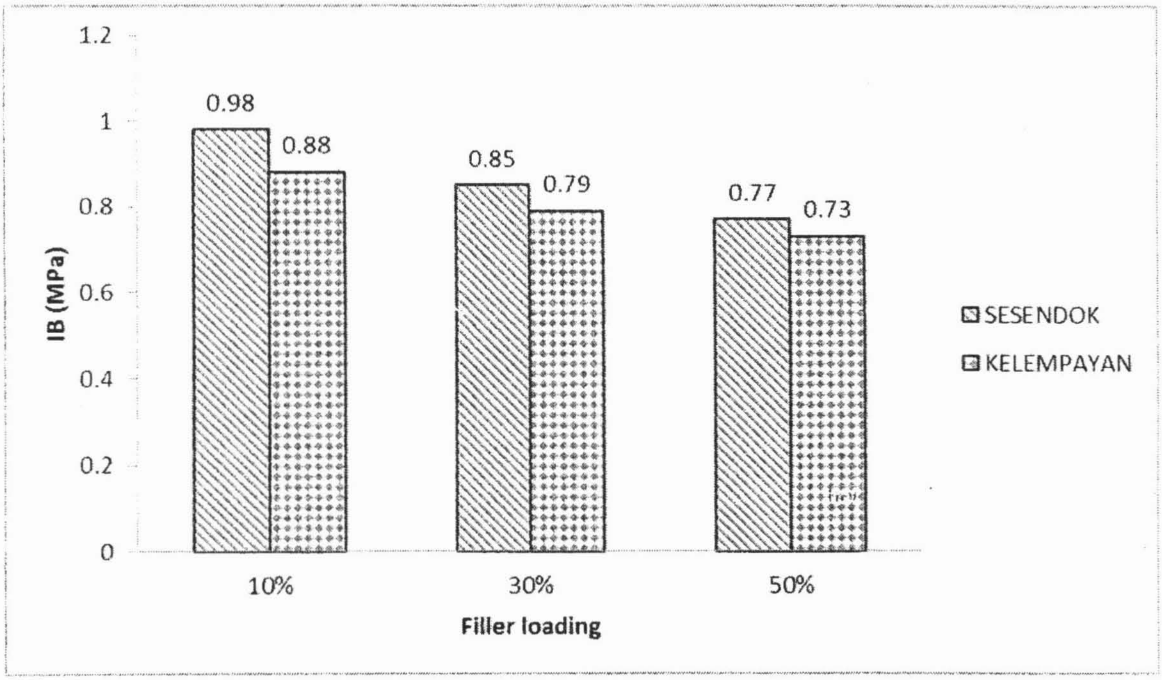

Figure 3: Internal Bonding strength of wood plastic composite at different filler loading and species of wood

Thickness Swelling and Water Absorption

Figure 4 and 5 show thickness swelling and water absorption rate for wood plastic composite. From the result, it shows that higher filler loading will increase the thickness swelling and water absorption. 10% of the filler loading board shows the lowest rate of thickness swelling and water absorption. It was due to the presence of high amount of thermoplastic (polypropylene) which prevented the ability of water absorption. In addition, Sesendok shows higher percentage of thickness swelling rate compared to Kelempayan.

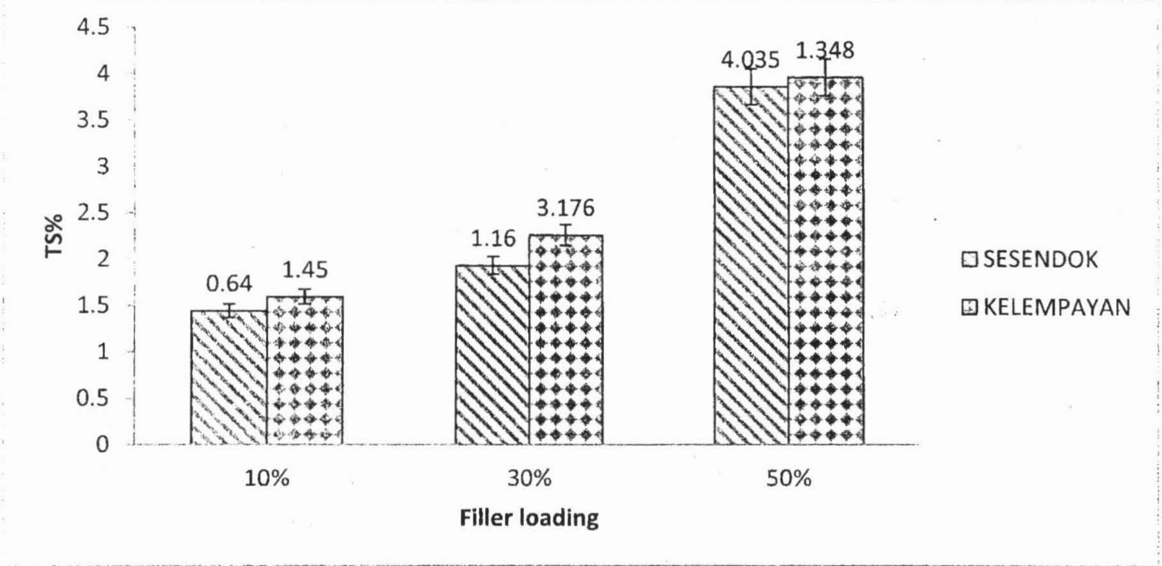

Figure 4: Thickness swelling of wood plastic composite at different filler loading and species of wood

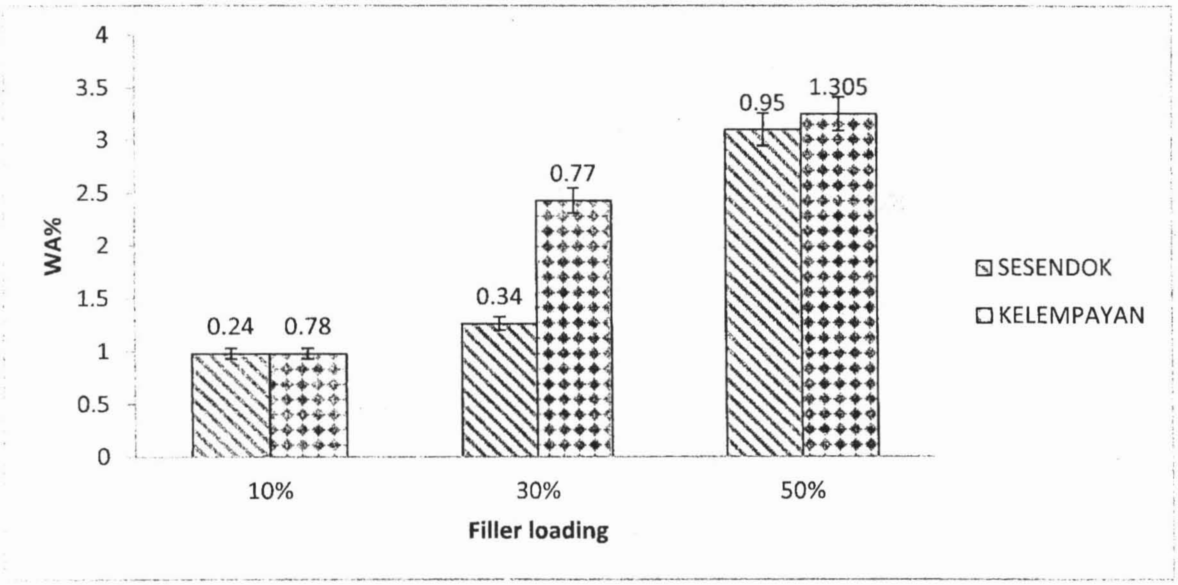

Figure 5: Water absorption of wood plastic composite at different filler loading and species of wood

Conclusion

In conclusion, filler loading and types of species affected the physical and mechanical properties of wood plastic composite. It may be concluded that, Sesendok and Kelempayan are suitable raw materials to produce wood plastic composite. Filler loading had significant effects on the MOR, MOE and IB strength, whereas higher filler loading increased the MOR, but decreased the MOE. As a result, the wood plastic composite had met the requirements set by ASTM standard for general uses.

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