Veneer and Thin Plywood Overlaid for Quality Improvement of Particleboard Made of Palm Oil Empty Fruit Bunches (EFB)

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Abstract

Many efforts to find alternatives raw materials in the particleboards have been done and one of them is utilizing Empty Fruit Brunches (EFB) from palm oil production. Based on some reports, low performance of particleboards especially mechanical properties was obtained when using EFB as raw materials. Overlaying the particleboards made of EFB with veneer and thin plywood is predicted as one way to improve the quality of such particleboards. The raw material of overlaid particleboards was EFB, veneer of 2 mm Falcata, and 3 mm commercial plywood. Commercial urea formaldehyde (UF) and phenol formaldehyde (PF) were used as binder. The adhesive content varied from 8%, 10% to 12% based on oven dry of particles. The size of board was 250 X 250 X 10 mm with target density of 0.6 g/cm^3.

The experiment results showed that particleboards made of EFB with UF resin demonstrated better physical and mechanical properties than particleboards with PF resin. It was also found that direct overlaying veneer and thin plywood on the surface of particleboards would significantly improve the mechanical properties of the boards especially the modulus of elasticity and modulus of rupture.

Introduction

The supply of wood raw material from natural forest was decreased in quality and quantity. Therefore, the research to find the alternative raw materials as raw material for wood industry is necessary. One of the raw material resources is oil palm waste. Usually, in the oil palm mill, the mesocarp fiber and shell are used as boiler fuel to produce steam and to generate power for the various mill operations. Empty Fruit Brunches (EFB) is mainly fermented to produce compost, which contains high percentage of potassium nutrient to be distributed back to the field as fertilizer. Because, the incineration of EFB generates severe air pollution problems that it is currently prohibited by government. Consequently, EFB, oil palm trunks (OPT), and oil palm fronds (OPF), which collectively comprise the bulk of the lignocellulosic residues, are available for commercial exploitation. From the types of biomass residue, the EFB has a higher potential for commercial exploitation than the other types of biomass residue (Kawai *et.al.* 2000, Subiyanto *et.al*. 2002)

Based on previous report (Subiyanto *et.al*. 2002) that low performance of particleboards especially mechanical properties was obtained when using EFB as raw materials. Overlaying the particleboards made of EFB with veneer and thin plywood is predicted as one way to improve the quality of such particleboards.

Materials and Method

The raw material of overlaid particleboards was EFB after soaking in the water at room temperature for 24 hours, 2 mm veneer of Falcata, and 3 mm commercial plywood as overlaid materials. Commercial urea formaldehyde (UF) and phenol formaldehyde (PF) were used as binder. The solid content adhesive varied from 8%, 10% to 12% based on oven dry of particles. The adhesive was sprayed on the EFB particles in a drum-type rotary blender by means of an airless gun. Hand formed particles mad were pressed at 130^{o}C for UF and 160^{o}C for PF resins as control boards. Veneer of Falcata and plywood were covered to both surfaces of mat prior entered to hot press. For control board (without overlaid board), both of bottom and top surfaces of the mat was covered with glass-fiber reinforced Teflon sheets to prevent the mat from sticking to the platens. Target density was 0.6 g/cm^3 in air-dry condition.

Specimens cut out of boards with dimensions of 250 X 250 X 10 mm were tested after conditioning for 2 weeks at 20^{o}C and 65% RH. Modulus of elasticity (MOE) and modulus of rupture (MOR) in air-dry condition, internal bond strength (IB), screw-withdrawal resistance (SW) in air-dry condition, and thickness swelling (TS) after 24-hours water immersion were measured according JIS A-5908 (1997). Three replications were used for each condition.

Results and Discussion

Modulus of elasticity (MOE) of empty fruit bunches (EFB) particleboards was significantly improved with both veneer and plywood overlaid comparing with control (un-overlaid boards) for both UF and PF boards as shown in Figure 1. This may be due to the fact that veneer and thin plywood overlaid in the both of surfaces boards have higher MOE properties than that of particleboard. The MOE properties increased with increasing adhesive content.

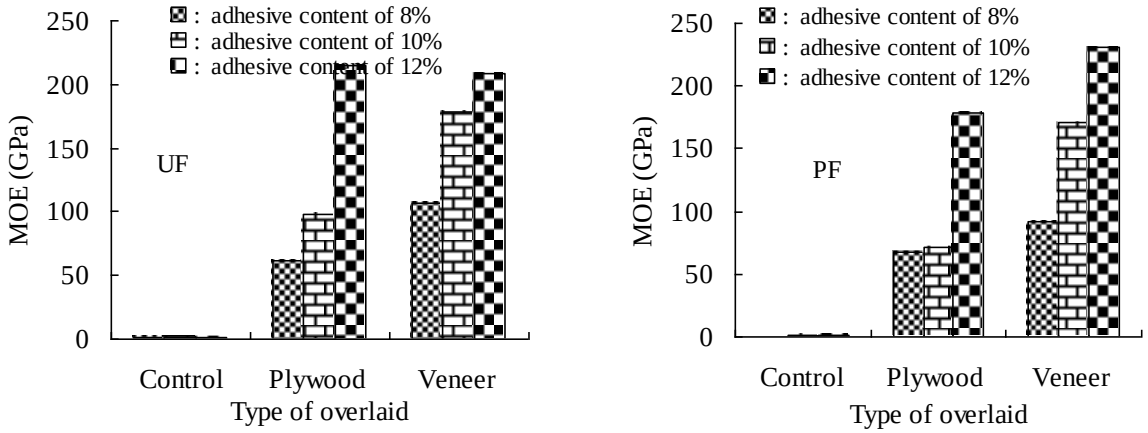

Figure 1. Modulus of elasticity (MOE) of overlaid empty fruit bunches particleboard bonded with UF and PF as functions of increasing adhesive content.

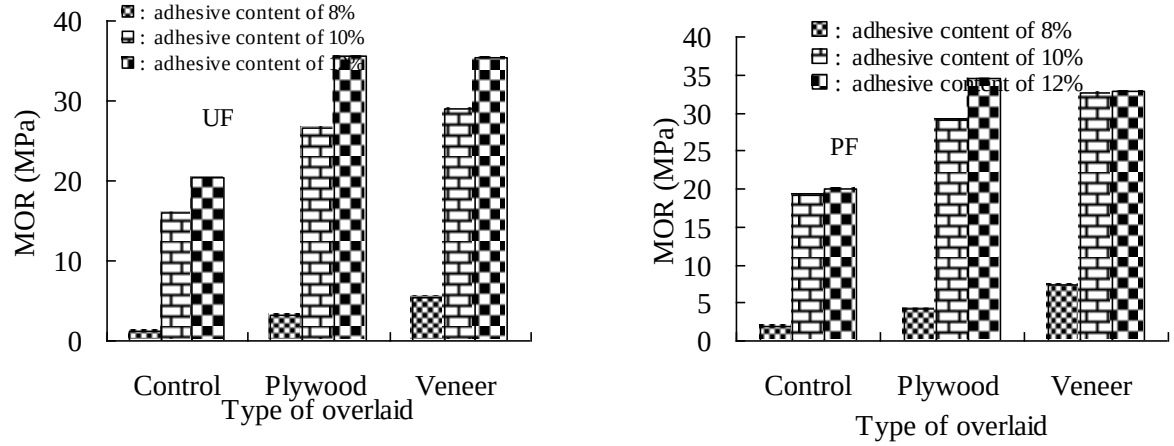

Figure 2. Modulus of rupture (MOR) of overlaid empty fruit bunches particleboard bonded with UF and PF as functions of increasing adhesive content.

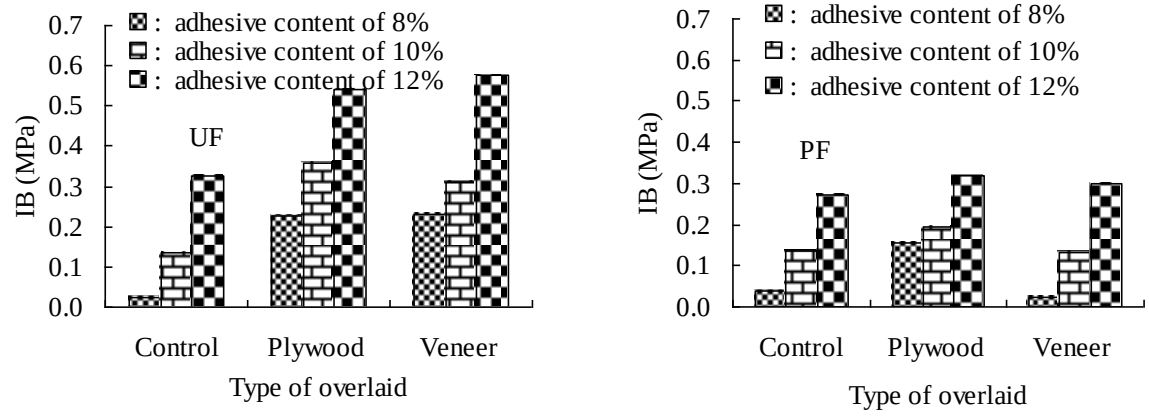

Figure 3. Internal bond strength (IB) of overlaid empty fruit bunches particleboard bonded with UF and PF as functions of increasing adhesive content.

The modulus of rupture (MOR) properties was significantly improved with both veneer and plywood overlaid comparing with control (un-overlaid boards) for both UF and PF boards as shown in Figure 2. The tendency for increasing in MOR is very similar to MOE properties.

Figures 3 show internal bond strength (IB) of overlaid empty fruit bunches particleboard bonded with UF and PF as functions of increasing adhesive content, respectively. Particleboard bonded with UF showed higher IB properties than that of PF bonded board. Generally the internal bond strength of PF bonded particleboards showed higher than UF bonded boards. This may be due to the fact that chemicals component of EFB which retarded curing of PF resin.

The screw withdrawal resistance (SW) was significantly improved with both veneer and plywood overlaid comparing with control (un-overlaid boards) for both UF and PF boards as shown in Figure 4. Particleboard bonded with UF showed higher SW properties than that of PF bonded board.

The thickness swelling (TS) was decreased with increasing adhesive content, however, TS graded by JIS can not be obtained with UF and PF bonded of overlaid particleboard made from EFB as shown in Figures 5, respectively. Principally, TS would decrease with increasing adhesive content and decreasing compaction ratio, particle thickness, and particle length. The quality such as surface condition and fiber damage of particle is may be another factor. A further experiment searching for suitable conditions to decrease the TS is necessary.

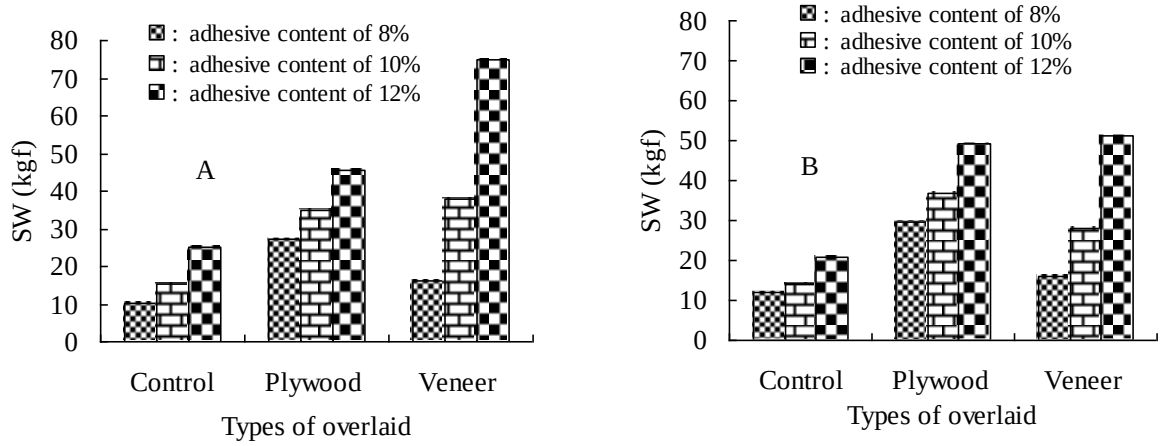

Figure 4. Screw withdrawal resistance (SW) of overlaid empty fruit bunches particleboard bonded with UF (A) and PF (B) as functions of increasing adhesive content.

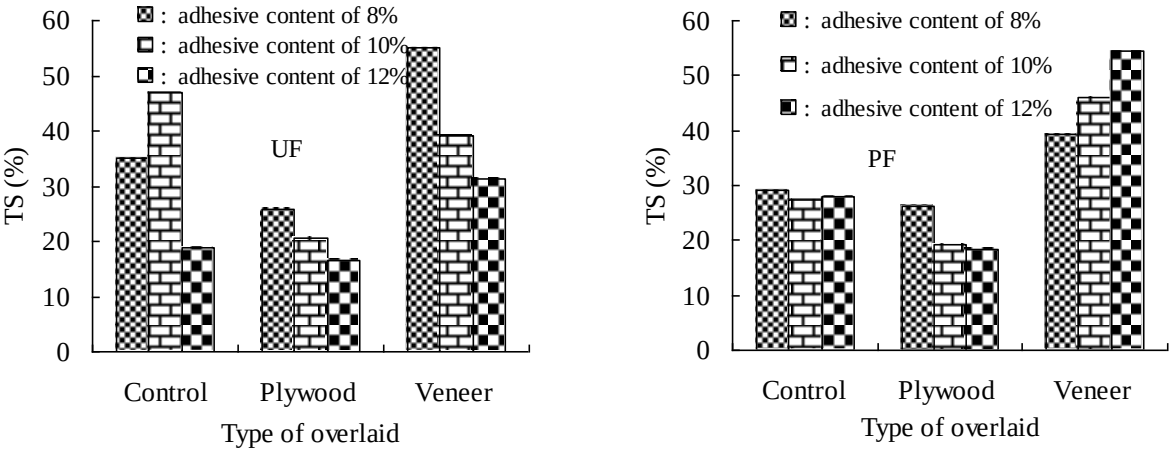

Figure 5. Thickness swelling (TS) of overlaid empty fruit bunches particleboard bonded with UF and PF as functions of increasing adhesive content.

Conclusion

Mechanical and dimensional stability properties of empty fruit bunch particleboard overlaid with veneer and thin plywood bonded with UF and PF adhesives were determined. The mechanical properties of EFB particleboard significantly improved by overlaid veneer and plywood. TS graded by JIS can not be obtained with UF and PF bonded of overlaid particleboard made from EFB. A further experiment searching for suitable conditions to decrease the TS is necessary.

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