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Properties of Composite Boards from Coconut Coir, Plastic Waste and Urea Formaldehyde Adhesives

To cite this article: Milawarni and Yassir 2019 *IOP Conf. Ser.: Mater. Sci. Eng.* **536** 012110

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Properties of Composite Boards from Coconut Coir, Plastic Waste and Urea Formaldehyde Adhesives

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Abstract. The objective of this research was to evaluate the characteristic of composite boards made from coir, plastic waste, and urea formaldehyde (UF). The board samples were manufactured at a target density of 0.7 gr/cm³. The weight ratio of waste plastic and coir was 50: 50. The UF adhesive added at 0%, 4%, 8%, 12% and 16% of the total weight of the composite board. The result shows that the characteristic of composite boards improves with UF adhesive added, however, no significant difference was found statistically.

1. Introduction

One alternative to overcome the shortage of wood made from raw materials is to replace them with composite board products made from non-wood materials. One example of this non-wood material is coconut fiber, which has a large potential, but its utilization is considerably suboptimal. The coconut fiber produced by Indonesia is estimated to reach 1.8 million tons / year [1]. The huge potential of coconut fiber has not been fully utilized for productive activities that can increase its added value. On the other hand, with increasing population growth in Indonesia, the consumption of plastic will also increase. As a result, the amount of plastic waste produced will also increase. Plastic waste has the potential to cause problems in handling the environment because it is difficult to be degraded [2]. One type of plastic waste which is the daily waste of the community is polypropylene (PP) derived from mineral water glass, plastic bottles and sacks. Some existing research results show that recycled plastic can be used as a substitute for adhesives in composite manufacturing but there are still weaknesses, namely the board MOE values that cannot meet the JIS A 5908-2003 standards [3]. Thus, efforts need to be made to improve the quality of composite boards of coconut fiber and polypropylene plastic. UF adhesives are the most used adhesives in making particle boards and produce adequate particle board quality. It is expected that the addition of UF on plastic composite boards can improve the quality of the composite boards produced. This study aims to determine the physical and mechanical properties of composite boards of coco fiber and polypropylene plastic with the addition of UF adhesives.

2. Research methodology

This research was conducted in the Chemical Laboratory Analysis of the Department of Chemical Engineering and Material Laboratory, school of Mechanical Engineering, Politeknik Negeri Lhokseumawe. The material used in this study is coco fiber, which has been separated from the cork, and cut into 5 cm. Plastic waste made from a clear color of polypropylene (PP) is washed and then cut into small pieces with a size of ± 1 cm. In addition, the adhesive of urea formaldehyde (UF) is



obtained from PT. DPN. The dimension of composite board is 30 x 30 x 1 cm with a target density of 0.7 g / cm³. The ratio of coconut fiber and plastic waste is set at 50: 50. UF adhesives (SC 55%) are added with varying amounts, namely 0%, 4%, 8%, 12% and 16% of the total composite weight. After all the ingredients are weighed according to the predetermined composition, the initial process is mixing coconut coir fibers with UF adhesives. The process involves inserting coco fiber into the plastic and spraying the adhesive with spray until the ingredients are evenly mixed. Furthermore, plastic waste is added, with the distribution of plastic in the upper layer as much as 15%, the middle part 70% and the bottom part of 15%. Pressing the heat is carried out with a temperature of 180°C for 20 minutes. In sequence, the board is conditioned for 1 week at room temperature. The composite boards that have been finished are then cut according to the size that refers to the standard JIS A 5908-2003 test sample. The parameters tested in this study include physical properties (density, moisture content, thickness and absorption of water) and mechanical properties (elastic modulus, fracture modulus, firmness and screw holding strength). The test is carried out in accordance with the JIS A 5908-2003 standard.

3. Results and Discussion

3.1. Physical Properties of Composite Boards: Density.

The average value of composite board density ranges from 0.5784 gr / cm³ - 0.6275 gr / cm³, as shown in Figure 1.

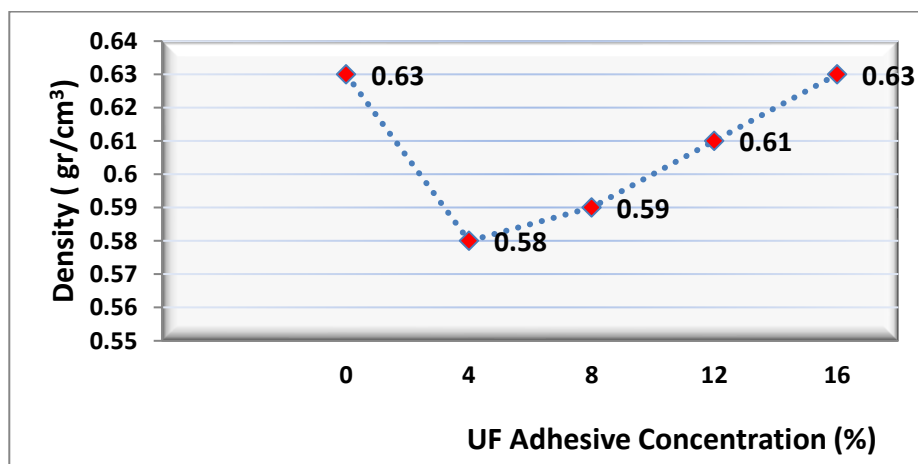


Figure 1. Shows the relationship between density values and variations in the composition of UF.

In this study, the product of composite boards did not meet the target density of 0.7 g / cm³. It is caused by the thickness of the board exceeds the set target of 1 cm. This is due to the effect of spring back on the board, namely the tendency of the board to return to its original shape due to the effort to free from the pressure experienced at the time of pressing. This is partly due to the higher coconut fiber used in bulk density (the number of particles divided by the total volume occupied) compared to wood powder so that in the same weight, coconut fiber has a much larger volume. Adjusting the water content at the time of conditioning also leads to an increase in the thickness of the composite board produced (Nuryawan et al., 2008). In this study, the resulting density tends to increase with the addition of UF adhesive concentrations. This is in line with the study of Sulastiningsih et al (2006) which states that the higher the adhesive content, the higher the particle board density. This can be understood because as the use of adhesives is increasing, the composition of the board material will also be increased.

Although the density of composite boards tends to increase with increasing levels of adhesives, the results of the diversity analysis show that the concentration of UF adhesives does not

significantly affect the composite board density. The highest composite board density is at the adhesive concentration by UF 0%, this is because in this treatment the composite board thickness produced is the lowest and is close to the target density so that the density obtained will be high. Japanese Industrial Standard (JIS) A 5908-2003, requires a density composite board of 0.4 - 0.8 gr / cm³. So, all the composite boards produced meet the specified requirements.

3.2. Water content

As the density of the composite board produced in this study varies, the test parameters are then calculated and corrected based on the target density of 0.7 gr / cm³ so that a more precise comparison value is obtained. The results showed that the addition of UF adhesives tended to increase the water content of composite boards. This can be understood because UF adhesives contain water so that the increasing levels of UF adhesives will also increase the water content in the composite board. This is shown in figure 2.

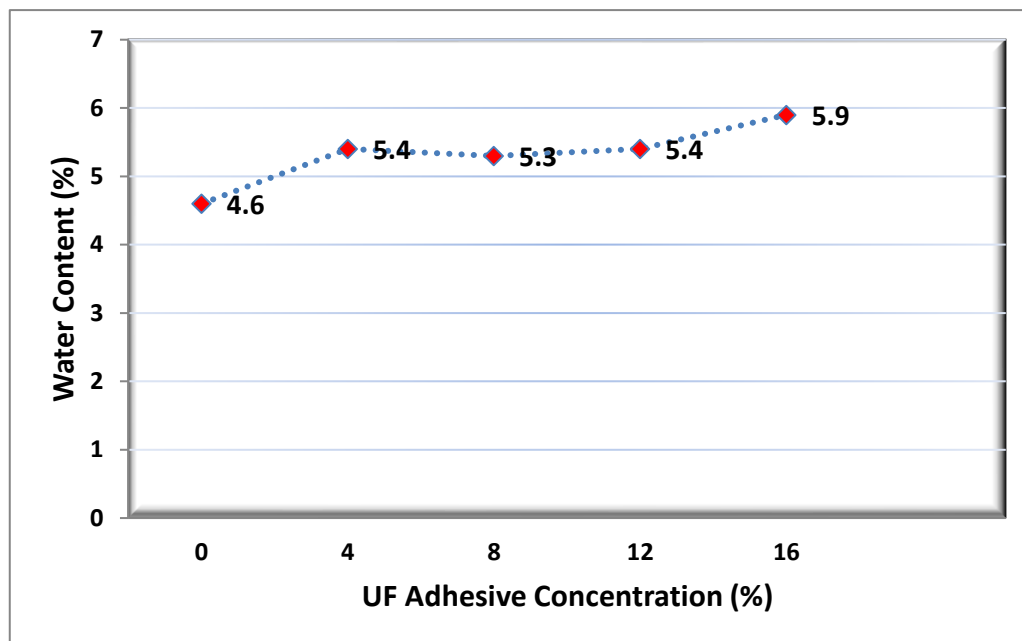


Figure 2. Composite Board Water content at Some UF Adhesive Concentrations.

The results showed that the addition of UF adhesives tended to increase the water content of composite boards. This can be understood because UF adhesives contain water so that the increasing levels of UF adhesives will also increase the water content in the composite board. The low value of the composite board moisture content produced in this study can be understood because plastic is hydrophobic so that it will reduce the overall ability of the board to absorb water (Setyawati and Massijaya, 2005) Japanese Industrial Standard (JIS) A 5908-2003, requires board moisture content composite of 5 - 13%. So, all the composite boards produced meet the specified requirements.

3.3. Mechanical Properties of Composite Board Modulus of Elasticity (MOE.)

The average modulus of particle board elasticity ranged from 11733,4951 kg / cm² - 19491,1935 kg / cm² is presented in Figure 3.

The results showed that in general there was an increase in MOE values with the addition of UF concentrations. The highest MOE value is achieved on a board with an adhesive concentration of 12%, after which the value decreases. This is due to, among other things, the addition of a concentration of UF adhesives of 12% to the optimum level, so that the addition of larger UF levels can no longer improve board quality. However, the results of the diversity analysis showed that the

adhesive concentration did not significantly affect the composite board MOE value. This means that the addition of UF adhesives to recycled PP composite boards does not contribute to the elastic modulus of the composite board. The higher the composite board MOE value the more rigid the board is (resistant to changes in shape) so that its ability in general is an increase in MOE value with the addition of UF concentration. The highest MOE value is achieved on a board with an adhesive concentration of 12%, after which the value decreases. This is due to, among other things, the addition of a concentration of UF adhesives of 12% to the optimum level, so that the addition of larger UF levels can no longer improve board quality. However, the results of the diversity analysis showed that the adhesive concentration did not significantly affect the composite board MOE value. This means that the addition of UF adhesives to recycled PP composite boards does not contribute to the elastic modulus of the composite board. The higher the composite board MOE value the more rigid the board is (resistant to changes in shape) so that its ability to withstand loads is also greater. Maloney (1993) states that the MOE value of composite boards is influenced by the content and type of adhesive used, adhesive bonding strength and fiber length. When compared with the value of MOE Setyawati and Massijaya (2005) using coconut fiber and recycled PP without UF adhesives (11408 kg / cm²) then using UF adhesives in this study can increase MOE values by 1.13 to 1.26 times. However, the value of the MOE produced is still below the standard Japanese Industrial Standard (JIS) A 5908-2003, which requires a minimum MOE value of 20000 kg / cm².

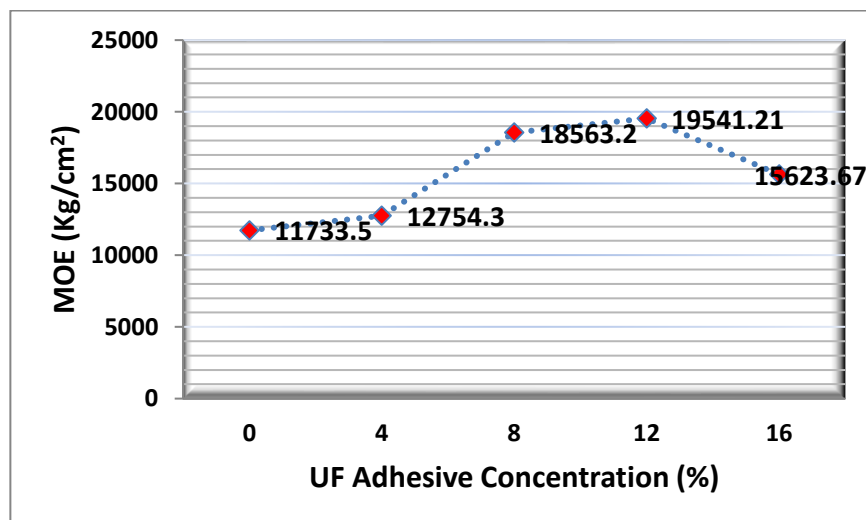


Figure 3. MOR values of composite boards at several UF adhesive concentrations.

3.4. Modulus of Rupture (MOR)

The average value of the brokenness of the particle board produced can be seen in Figure 4. Based on the results of the study, it can be seen that with the increasing concentration of UF adhesives, the value of fractured modulus tends to increase, except at a concentration of 4% UF with a lower value. The MOR value of recycled PP plastic composite boards with adhesive concentrations of UF above 4% higher 0.79% to 156.84% compared to recycled PP plastic composite boards without using UF adhesives. Gunara (1993) states that adhesive resins have a very significant effect on the mechanical properties of the bonded material. To a certain extent, the higher the resin content of an adhesive, the higher the value of MOR and MOE. The MOR value is also influenced by the content and type of adhesive used, adhesive binding capacity and fiber length (Maloney, 1993). The results of the analysis of composite board diversity showed that the concentration of UF adhesives did not significantly affect the increase in fracture strength of the composite boards produced. All composite board MOR values have met JIS A 5908-2003 standards (minimum 80 kg / cm²).

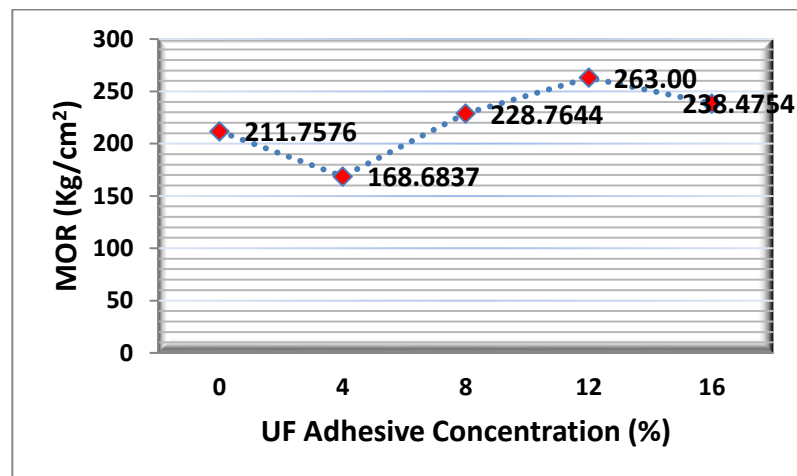


Figure 4. Relationship between MOR and variations in UF composition.

3.5. Internal Bond

The average value of the solidity of the composite board can be seen in Figure 5. The test results show that the value of the firmness of the composite board tends to increase along with the addition of UF adhesive concentrations. The firmness value of recycled PP plastic composite boards using UF adhesives has a value of 154.03% to 188.36% higher than that of recycled PP plastic composite boards without using UF adhesives. Composite board with the largest concentration of UF adhesive will make the board more solid so that the adhesion between particles is greater. The percentage of adhesives play an important role in binding to coconut coir fiber particles, the higher the percentage of adhesives with evenly mixing the higher the bonding capacity between particles, which affects the structural strength of the composite board and causes the stickiness to increase. However, the results of the diversity analysis showed that the concentration of UF adhesives did not significantly affect the firmness of the particle board produced. All values of the firmness of the composite composite board produced have met the JIS standard A 5908-2003 JIS A 5908-2003 which stipulates the firmness of the composite board adhesives of at least 1.5 kg / cm².

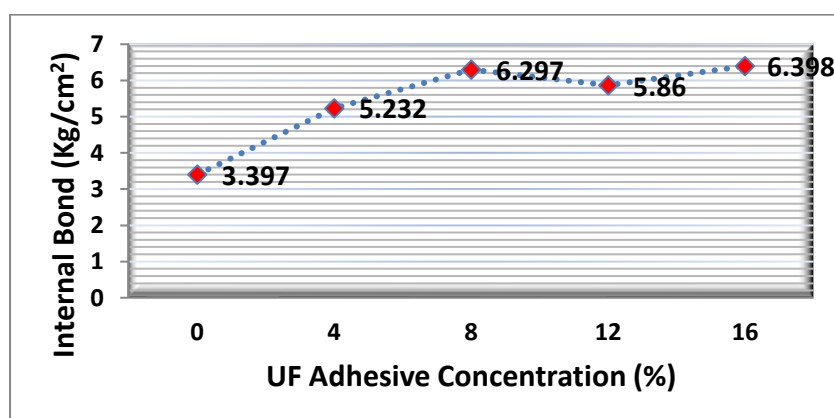


Figure 5. Rate of internal bond of composite board: a few adhesive concentrations

4. Conclusion

Based on this research outcome, the addition of UF adhesives improved the properties of the composite boards tested and the results of mechanical properties testing met the JIS A 5908-2003 standard, except for MOE values.

Acknowledgment

The authors acknowledge support of fund from Politeknik Negeri Lhokseumawe

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