Effect of Grain Size Coconut Frond Powder on The Strength of Particle Board

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Abstract. The aim of this research was to make particle board from coconut frond powder with various grain size. Particle board test pieces are made by mixing coconut frond powder with various grain sizes, namely 10; 25; 50 and 75 mesh with 40% of liquid rubber compound to obtain a particle board test pieces with the length, width and height of 5 x 10 x 7.5 cm and then dried in the sun. Then the particle board test pieces pressed to a thickness of 2.5 cm and then characterized its strength which includes the modulus of rupture (MOR), the modulus of elasticity (MOE), the Screw Hold Strength and water absorption. The results of this research indicated that the best strength of particle board was obtained on the use of 50 mesh coconut front powder and 40% liquid rubber compound as the adhesive. On this mix, the value of MOR, MOE, the strength of the screw and water absorption of resulting particle board are 1528.32 g / mm², 618.18 g / mm², 4.9111 N / cm² and 26.87% respectively.

1. Introduction
Particle board is a substitute for wooden board which can be made from lignocellulose material with a certain adhesive and then compressed¹. The advantages of this type of board are that the size and strength can be adjusted according to the needs. Another advantage of this type of board can be made from waste materials from agricultural and plantation products that are no longer used²,³.

One of the remaining materials from the plantation that can be used to make particle board is coconut frond powder which has been separated from its fibers⁴,⁵,⁶,⁷. Coconut fronds are coconut plant waste products that have not been widely used. In this study, a liquid rubber compound made from natural rubber latex with certain chemicals to improve its properties was used as an adhesive⁸. Natural rubber latex, the raw material for concentrated latex is very widely available in Indonesia because Indonesia is the second natural rubber producer in the world, so that the sustainability of particle board production comes from concentrated latex and coconut frond powder will be no raw material problems for long time.

Coconut frond powder all this time is only seen as waste material from coconut plants. So research on the manufacture and characterization of natural composite polymers from coconut frond powder and liquid rubber compound as an alternative to particleboard is very interesting to do.

2. Experimental
The experiment was started by separating the coconut frond powder from the leather and fibers of coconut frond, then continued with the process of filtering the powder to get a size of 10; 25; 50 and
75 mesh. Then a test piece of particle board was made by mixing 43.5 g of coconut frond powder with 40% of liquid rubber compound then formed with the size 10 x 5 x 7.5 cm and dried. The next step is pressing this particle board up to 2.5 cm thickness and followed by testing physical and mechanical properties including Modulus of Rupture (MOR), Modulus of Elasticity (MOE), screw hold strength and water absorption according to SNI 03-2105-2006. Experiments on making particle boards and testing for water absorption were carried out in the chemistry lab, Faculty of Mathematics and Natural Sciences, Bengkulu University, while testing for MOR, MOE and screw holding strength were carried out in the materials lab, Faculty of Mechanical Engineering, Gadjah Mada University Yogyakarta.

3. Results And Discussion

3.1. Particle Board Test Pieces
The dry particle board test pieces from coconut frond powder and liquid rubber compound before and after pressed is as shown in Figure 1.

![Particle Board Test Pieces](image)

**Figure 1.** Particle Board Test Pieces

3.2. Modulus of Rupture (MOR)
The particle board modulus of rupture (MOR) on various coconut frond powder grain size is shown in figure 2.

![MOR](image)

**Figure 2.** Modulus of Rupture on various grain size of coconut frond powder
Figure 2 show that the particle board modulus of rupture (MOR) increase on the smaller grain size powder reaching maximum at the use of 50 mesh of coconut frond powder, then little decrease on the use of smaller grain size. This is because of greater touch area of the particles on smaller grain size, so that the bonds that occur between the polyisoprene molecule from liquid rubber compound and lignocellulose from coconut frond powder are also increase and this causes the resulting particle board to be stronger too. The results of this study indicate that the use of coconut frond powder as much as 50 mesh was the optimum condition. This is because the number of bonds that occur has reached the maximum and When using the smaller grain size, there were powder particle surface that does not bind to the polyisoprene as an adhesive so that actually reduces the strength of the resulting particle board. The MOR value on this optimum condition was 1528.32 g / mm².

3.3. Modulus of Elasticity (MOE) Test Result
The test results of particle board modulus of elasticity (MOE) on various grain size of the coconut frond powder is as shown in figure 3.

Figure 3. The Modulus of Elasticity on various grain size of coconut frond powder

Figure 3 shows that particle board modulus of elasticity (MOE) increases with the decrease of grain size used, reaching maximum on the use 50 mesh grain size, then little decrease on the use smaller grain size. This is because of the smaller grain size, the interaction that occurs between the chemical components in the powder and the polyisoprene from compound is more perfect so that the resulting particle board is also more flexible. This interaction reaches optimum when using a grain size of 50 mesh. It was show that at the use of 50 mesh grain size, the particle board made show the highest flexibility. In this condition, the modulus of elasticity of the particle board was 2051.28 g / mm².

3.4. Screw Hold Strength
The result test particle board screw hold strength on various grain size of the coconut frond powder is as shown in figure 4.
Note : 1 = 10 ; 2 = 25 ; 3 = 50 ; 4 = 75 mesh

Figure 4. Particle Board Screw Hold Strength on various grain size

Particle board screw hold strength is increase on the decrease of grain size and reaching the maximum value on the use of 50 mesh grain size then decrease on smaller grain size. This is because the smaller the grain size, the interaction between the chemical components in the powder and the liquid rubber compound is getting more perfect so that there are more chemical bonds. This interaction reaches e maximum value when using a grain size of 50 mesh, so that in this condition the strength of the particle board to hold the screws is the highest. In this conditions the screw hold strength value was 4.9111 N / cm².

3.5. Water Absorption
The water absorption capacity of particle board on various grain sizes of coconut frond powder is shown in Figure 8.

Figure 5. Particle Board Water Absorption on various grain size

In figure 5 above can be seen that the smaller grain size of the coconut frond powder used, the smaller the water absorption of the resulting particle board. This is because the smaller the grain size, the interaction between the chemical components in the powder and the liquid rubber compound will
be more perfect so that the bonds that occur will also increase. This situation results in the resulting particle board getting tighter so that the opportunity for the entry of water molecules in the space between the particles is also getting smaller so that the water absorption is also decrease.

4. Conclusion
The particle size of coconut frond powder has a major effect on the mechanical properties of particle board. The result of this research show that the use 50 mesh of coconut frond powder indicates the optimum size. At this optimum size, the value of MOR, MOE, the screw hold strength and water absorption were 1528.32 g / mm2, 2051.28 g / mm2 and 4.9111 N / cm2 and 26.87% respectively.

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