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Impact of Gypsum Coating on Palm Oil Trunk Fiber Board Surfaces

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Abstract

The objective of this study was to determine the impact of gypsum coating on the physical properties of fiber board obtained form palm oil trunk. The polyester is used as a filler board. This study was conducted based on testing in accordance with SNI 01-4449-2006 variation using a wax material, polyester and Palm Oil Trunk Fiber (OPTF) with formulation such as 30:40:30 (A), 20:40:40 (B), and 10:40:50 (C). From the results showed that physical test density ranged from 0.84 g / cm^3 to 0.94 g / cm^3 the value of the water content was about 9.61% - 13.3%, water absorption was about 8.22% - 8.75% and swelling thickness was about 0.94% - 1.31%. The water content of sample with the formulation10:40:50 is higher (13.3%) compared to requirement in SNI 01-4449-2006. The effect of gypsum coating on the physical properties of fiber boards such as affecting the density and gypsum values undergoes some changes such as color changes in gypsum, and cracks in gypsum.

Key-word: - Gypsum, Palm oil trunk, waste, fiber board

1. Introduction

The development of board material at the present time has increased very high. Board material is a material derived from wood forest products. The higher need for board resulted forest resources are being reduced. To reduce dependence on forest products, it is necessary other materials to meet the housing needs that have quality that is not inferior to the forest wood products (Trisna, 2012). Gypsum is a finished product after the raw material, the use of many building materials (Wijaya & Norizal, 2011). The use of gypsum one of them is as a plaster material. With characteristic light-free and quick-drying can be use as a plaster finishing. In addition, gypsum is also used in the manufacture of gypsum board. Fire-resistant characteristics can be used as an element of the partition walls and ceiling (Sinaga, 2009).

Gypsum board used as one element of the partition wall and board / ceiling to replace the plywood. Gypsum board has the advantage of fire retardant and easy to fix. Today the use of gypsum board is still limited. This is because the availability of gypsum board on the market is still very poor and strength is not as good as plywood and gypsum nature brittle, fragile and not waterproof. Unfavourable nature of gypsum can be improved by adding fiber in its production (Trisna, 2012). Sinaga (2009) studied the advantages and disadvantages of gypsum by utilizing waste as an environmentally friendly type of material on the manufacture of gypsum board ceiling with solid waste filler cigarette paper factory with a polyvinyl alcohol adhesive. The optimum procedure of testing obtained by adding a solid waste was about 125gram cigarette papers factory and 12,5gram PVA adequate enough to be used as ceiling gypsum board. In addition, Rahmadi (2011) conducted a study manufacture of gypsum board ceiling with powder filler material palm oil trunk where test results for mechanical properties, namely, test the flexural strength and modulus of elasticity not meet mechanical requirements according to SNI 03-6384-2000. Palm oil *(Elaeis)* is an important industrial plant producing cooking oil, industrial oil, and fuel (biodiesel) generates huge profits so much forest and old farm converted into palm oil plantations. Palm kernel palm oil is a solid waste containing lignocellulose. Indonesia has a potential to produce stem palm oil, because of the higher availability if palm oil in Indonesia. Palm oil planting in the field is usually done with a density of 130-143 trees per hectare. After 25 years of an estimated 10% of the trees are dead, so at the moment there are about 117 rejuvenations of old trees per hectare. In 1967-1982 extensive palm oil acreage additions reached an average of 15,000 hectares per year (Rahmadi, 2011). The palm oil trunk will continuously available throughout the year for palm oil replanting carried out continuously (Prayitno, 1994).

Gypsum is a mineral whose main ingredient is composed of *hydrated calcium sulfate.* As in minerals and stone, gypsum will be stronger if the suppression *(Gypsum Association,* 2007).The chemical composition of gypsum is: Calcium (Ca): 23.28%, Hydrogen (H): 2.34%. Calcium Oxide (CaO): 32.57%, Water (H2O): 20.93%, sulfur (S): 18.62%. Utilization gypsum, among others (Rahmadi, 2011): The additional material Portland cement, plaster materials, mold-making material, medicine, supplies chalk. Optical instruments in a polarizing microscope, the chemical industry and the food industry. Composite is a combination of two or more different materials as a unified combination (Harbrian, 2007). Composite materials are generally composed of two elements, namely fiber as filler and binder fibers called the matrix. In the main element is a fiber composite, while the bonding material using a polymer material that is malleable and has a high binding force.

In general, a composite material made up of two kinds, namely composite material particles *(particulate composite)*and fiber composite materials*(fiber composite).*Particle composite materials were generally weaker than the fiber composite material, but it has advantages such as resistance to wear, not easy to crack, and which has a good binder with matrix. Manufacture of fiber composites require a strong surface bond between the fiber and the matrix. To select a matrix to be aware of its properties, such as resistance to heat, bad weather resistant and resilient to shocks that are usually taken into consideration in the selection of the matrix material (Rangkuti, 2011).

The binders or adhesives used in the manufacture of composite boards of fiber include:

a. Polyester

Polyester is a type of thermoset resins in the form of liquid resin with a low viscosity, and hardens at room temperature with the use of a catalyst without producing gas during setup as many thermoset resins other (Nurmaulita 2010).

b. Catalyst

The process of hardening resin by additional material, namely, catalyst types Metyl Etyl Ketone Peroxide (MEKPO), the catalyst used to accelerate the hardening of the liquid resin at a higher temperature (Nurmaulita, 2010).

c. *Wax Emulsion*

Wax emulsion mixing a stable is between one candle and more with water. *Wax* is used for the *wax emulsion* is usually derived from natural or synthetic. *Wax emulsion* also called *wax* dispersion. *Wax emulsion* is usually used as a solvent.

The use of a mixture of wax emulsion in the manufacture of boards produced from palm oil trunk fiber blends using polyester adhesive should be able to cope with the organic content of the palm oil trunk fiber, so as to prevent weathering on board. From some of the above results it can be seen that the use of gypsum and waste as filler in the manufacture of gypsum boards are less effective in testing the strength of the physical and mechanical tests. But with the use of gypsum as a plaster material is expected to cover the weak of fiber composite boards. The objective of this research was to produce fiber board obtained Palm Oil Trunk Fiber (OPTF) and adhesive polyester as a filler and utilize gypsum for coating the surface of fiber board.

Characterization of Composite Board

The characterization of fiber composite boards made to identify and analyze a mixture of polymer fibers, and the effect on the gypsum. Characterization is done with reference to ISO standards 01-4449-2006 namely physical properties. The physical properties include density, moisture content, water absorption and thickness swelling. The size of the test sample used can be seen in the table below.

a. Density Test

Based on the classification SNI 01-4449-2006 density fiber board after the test there are three types, namely, Low Density Fiber board (PSKR), Medium Density Fiber board (PSKS), and High-Density Fiber board (PSKT).

b. Moisture content

Moisture content is the weight of water is removed from the board of the fiber through the heating oven. The water content was calculated from the mass of the sample before and after in the oven. SNI 01-4449-2006 based on fiber board maximum moisture content of 13%.

c. Water absorption

Water absorption is the weight of water absorbed by the sample after an immersion in water for 24 hours at room temperature. According SNI 01-4449-2006 water absorption after 24-hour immersion in water is a maximum of 20%.

d. Thick Development

Development is the size of the addition the thick after an immersion in water. According SNI 01-4449-2006 thickness swelling after water immersion for 24 hours is a maximum of 10%.

2. Methodology

This research was conducted at the Laboratory of Soil Mechanics Department of Civil Engineering Faculty of Engineering, State University of Medan and Polymer Chemistry Laboratory of the Department of Chemistry Universiti Sumatera Utara, Medan, Indonesia. This study used a method of testing the physical properties by referring to the Indonesian National Standard (SNI) 01-4449-2006. Polyester resin used in this study is Yukalac 157® series BQTN-EX Series.

Preparation Stages

Palms wood that has been preserved previously was cut into small piece to the length of each of 10 cm and a width of 1 cm using wood cutting machine. The timber was cut pounded / beaten with a hammer to produce a thin fiber with a length of 1 cm. Then the palm oil trunk fiber (OPTF) is dried in the sun for 8 hours. Stir the mixture of polyester and Mepoxe (5%) to be a uniform solution. Wax that is still in the form of a waxy weighed according to the composition, the wax is put into a small alauminium container. Furthermore, the container is placed on *a hot plate* to allow the wax melting.

Composite board manufacture

The palm trunk fiber, polyester, Mepoxe, and wax are weighed with an analytical balance according to the composition specified. The composition of the manufacture of fiber board material can be seen in the table 1.

Table 1. Composition of Fiber board

Wax		Polyester		Fiber	
%	gram	%	gram	%	gram
30	114	40	152	30	114
20	76	40	152	40	152
10	38	40	152	50	190

Melted wax using *a hot plate.* While waiting for the wax to melt, mix of polyester with the catalyst Mepoxe and stir using a wooden stirrer to be liquid evenly. A mixture of wax, polyester and Mepoxe then merged into one with palm fiber trunk and stirred with a wooden stirrer in a container. Stirring is done by hand. Then prepare the steel molds are placed on a metal plate previously coated with aluminum foil.

Furthermore, palm oil trunk fiber blends with polyester and wax that has been uniformly formed in the tool steel mold (20 cm x 15 cm x 1.2 cm). The top of the mixture coated with iron plates and aluminum foil as well. The mixture was subsequently compressed by using forged hot *(hotpress)* at 50 ° for 20 minutes.

Composite board is kept for 7 days at room temperature (30 ˚C) to eliminate evaporation and to achieve equilibrium moisture content.

Coating Production

Preparing composite board has been treated for one week, as well as materials gypsum powder and water. Gypsum was prepared by using 35% of gypsum powder and gypsum are mixed gently and stir until evenly distributed. Stirring should not be too long because the gypsum is hardened quickly. Slowly do plastering (5 gram of gypsum) by using a spatula. Perform until the surface of gypsum smooth and evenly, gypsum fiber board be allowed to harden and dry.

Physical Properties Analysis

To determine the physical properties of particle board composite testing density, water content, water absorption and thickness swelling as follows:

1) Density

Density was measured by using method by Indonesia National Standard (SNI), Density was measured as follows:

a. Samples were measured in length on both sides of the width, 25 mm from the edge, avarage value was taken.
b. Test sample width was measured on both sides of the long, 25 mm from the edge, avarage value was recorded.
c. Test sample thickness measured at all four corners, 25 mm from the corners (at the crossover point measurements of length and width).
d. Samples are weighed.

The density of the sample board is calculated using the equation (Eq 1.)

$$K = \frac{B}{I} \quad (1)$$

Where:
K: density (g / cm^3)
B: weight (g)
I: Content (cm^3) = length (cm) x width (cm) x thickness (cm).

2) Moisture

Moisture was measured as follows:

a. Samples are weighed to determine the initial weight.
b. Samples were dried in an oven at a temperature of (103 ± 2) ° C.
c. Insert the sample into the desiccator, then weighed.
d. This activity is repeated at intervals of 6 hours until the weighing equipment (oven dry weight), that is, if a maximum difference of 0.1 percent.

To determine the moisture content searched by the equaton (Eq.2)

$$KA = \frac{(Ba - Bk)}{Bk} \times 100 \quad (2)$$

with the understanding:

KA is the moisture content (%);
B_A is the weight of the specimen before being dried in an oven (g);
B_k is the sample weight after drying in an oven (g).

3) Water absorption

Water absorption was measured as follows:

a. Samples are weighed first.
b. Samples immersed in an upright position (vertical) about 2 cm below the water surface (1) for 24 hours.
c. Samples removed and placed on 10 sheets of blotting paper (2) measuring 120 mm^2 to remove or get rid of excess water that is still attached to the surface.
d. Give ballast in the form of slabs weighing 3 kg on top of the fiber board sample for 30 seconds.
e. Do the same for the surface of the sample fiber board behind it.
f. Perform the weighing of the specimen within no more than 10 minutes.

Water absorption is calculated using the following equation (Eq. 3):

$$PA = \frac{(B2 - B1)}{B1} \times 100 \quad (3)$$

with the understanding:

PA is the water absorption (%);
B1 is the weight of the specimen before immersion (g);
B2 is the weight of the specimen after immersion (g).

4) Thick development

Thickness was measured as follows:

a. Test sample thickness measured at the center using a micrometer.
b. Samples immersed 3 cm below the water surface horizontally or horizontally at a temperature of 20 ° C ± (prolonged submersion for example low density fiber board test is 2 hours, and for medium density fiber board and high-density fiber board 24 hours).
c. Samples issued.

Thickness swelling is calculated by using the equation (Eq. 4)

$$PT = \frac{(T2 - T1)}{T1} \times 100 \quad (4)$$

With the understanding:
PT is the thickness swelling (%)
T1 is the thickness before immersion (cm)
T2 is the thickness after immersion (cm)

3. Results and Discussion

Density Analysis

Density is one of the physical properties shows a comparison between the mass of the body against substances in volume or amount of mass per unit volume (Rangkuti, 2011). This test has been carried out against all kinds of variations in the sample. The results showed that the density value of fiber composite boards ranged from 0.84 g / cm^3 up to 0.94 g / cm^3, the lowest density obtained from the composition 10:40:50 (sample C) and the highest density obtained in Sample A (30:40:30). The lowest density value is obtained from the composition of the palm oil trunk fiber with the highest amount of adhesive. Figure 1 showed, there is relationship between the density and the sample variation.

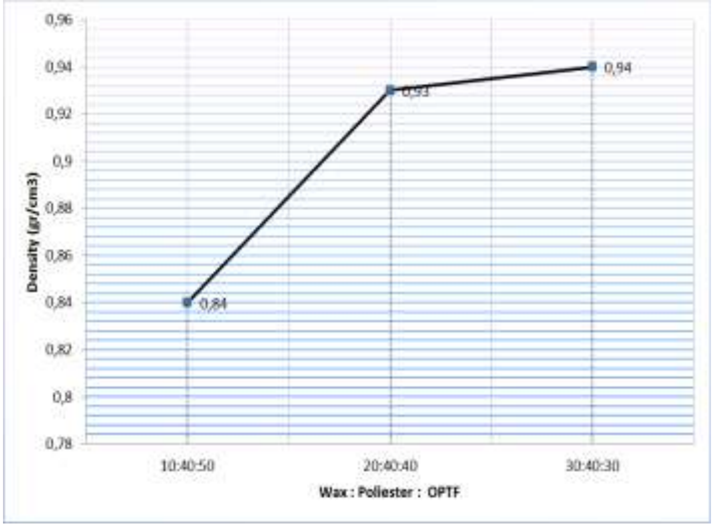

Figure 1. Density of Samples

According SNI 01-4449-2006 fiber board classified into PSKR (Low Density Fiber board), PSKS (Medium Density Fiber board), and PSKT (High Density Fiber board). Based on density results, the fiber board has density about > 0.84; it indicated that fiber board coating with gypsum is categorized as PSKT (high Density fiber board) due to the adhesive polyester. Sembiring (2013) stated that increasing amount of adhesive the denser sheets are obtained. According to Sinaga (2009) the higher amount of gypsum the lowest water absorption, because water act as an adhesive, the presence of water will allow bond cohesion of gypsum. From the results, it showed that the less water absorption, the smaller the density obtained.

Water Content

The results showed that the water content of particle board ranged from 9.61% for to 13.3%. The water content was obtained from the mixture of 50% OPTF (Figure 2), while the lowest water content was obtained from the mixture with 30% OPTF. It indicates that more OPTF composition the greater the water content produced (Rangkuti, 2011).

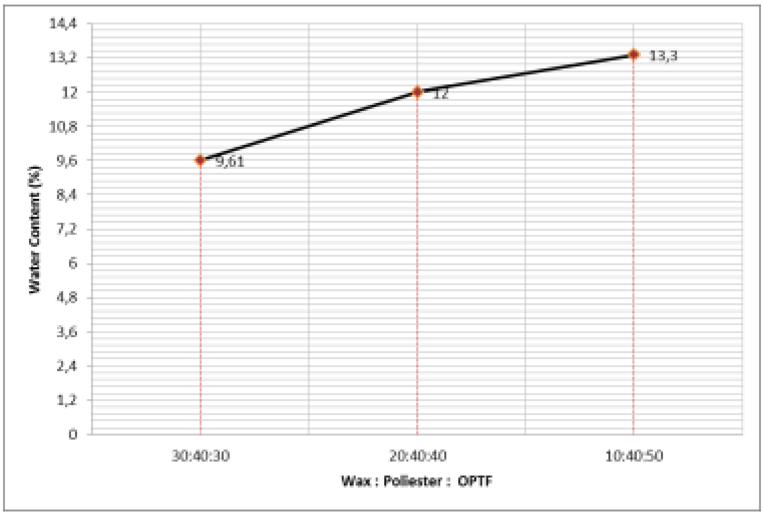

Figure 2. Water content of Samples

Indonesian National Standard (SNI) 01-4449 - 2006 Fiber board, requires the maximum water content is about 13%. Based on the results, it found that composite board with a mixture of 10:40:50 (sample C) has exceeded the maximum limit (13.3%) of the water content. Thus, sample C is not qualified as fiber board. In addition, sample with the additon of gypsum found there were some changes such as cracking, gypsum did not adhere to fiber board and color changes were obtained after in oven for 24 hours (Figure 3.).

Figure 3. Fiberboard after treated for 24 hours in oven

Water Absorption

Water absorption test was done during 24 hours of immersion to determine the percentage of water absorbed by the sample. The test results can be seen in figure 4.

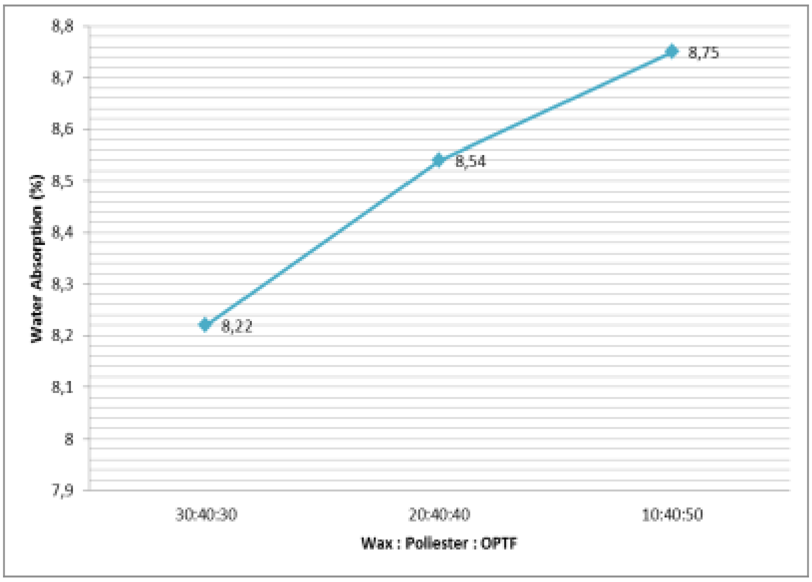

Figure 4. Water Absorption

Based on figure 4, the higest of water absorption was in the sample C (8.75%), while the lowest was in the sample A (8.22%). The increasing level of water absorption is due to the natural ability of palm oil trunk fiber which easily to absorb water. Thus, the more palm oil trunk fiber in the mixture, the greater the water absorption (Rahmadi, 2011). These results were supported by the previous studies done by Fitr (2002) and Maloney (1993). Maloney (1993) reported that the higher density of a board, the bonding between the particles more compact, thus the air cavities in the sheets of board shrink was resulted. This situation will not allow the water or moisture to fill the cavity. Thus, the lower the density resulted, the higher the water absorption (Fitr, 2002). According to SNI-01-4449-2006, the requirements of a board are content maximum level of water absorption is less than 20%. Based on the results, showed that all the samples tested in accordance with the minimum criteria according to SNI. The lower water absorption value was due to the natural ability of gypsum that is not resistant to excessive water (Trisna, 2012). Soaking treatment for 24 hours allowed reducing the weight of sample due to unability of gypsum to attach smoothly to the fiber board.

Thickness Swelling Test

The thickness of fiber board was increasing initially after sample was immersed in water at room temperature for 24 hours (Figure 5).

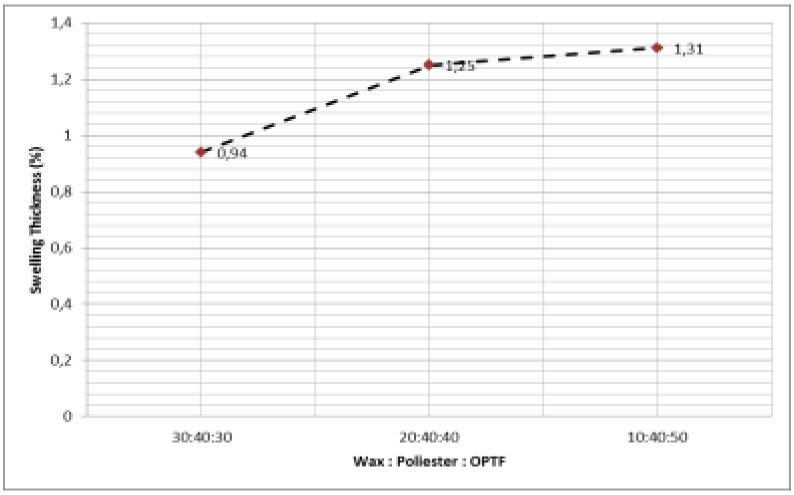

Figure 5. Swelling Thickness

Thelowest swelling thickness value obtained from sample A and the highest swelling thickness value was obtained in sample C (0.94% and 1.31% respectively). It shows that, with mixture of 50% OPTF could increase the thickness of the fiber board after immersed in water. Indonesian National Standard (SNI) 01-4449-2006, Fiber board reported that the value of swelling thickness did not require a maximum of 10%. While the value of the development of the highest thick composite boards produced from the test below 1.31%, and it indicated that samples tested were suitable with the requirements of the standards.

4. Conclusion

Gypsum coating influenced on the physical properties of the fiber board among which affected the value of the density. The moisture content of gypsum has undergone some changes as apart from fiber board, color changes, as well as cracks in gypsum. The immersed treatment of fiber board for 24 hours in water resulted separation of the gypsum from the fiber board. The value of the development of the highest thick composite boards produced from the test below 1.31%, and it indicated that samples tested were suitable with the requirements of the Indonesian National Standard (SNI).

5. Acknowledgement

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