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ORIGINAL RESEARCH

PROCESSING OF SAWDOW WASTE OF MAHONI AND JATI WOOD AS A MATERIAL GYPSUM CEILING FILLERS WITH POLIVINYL ADHESIVE ALCOHOL

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Abstract. *Along with the increase in population, the need for building materials, namely wood, will increase, thus triggering rampant illegal logging, which will cause floods, landslides, and global warming. One of the efforts made to reduce the use of wood is to make gypsum composite boards. This study aims to utilize mahogany wood waste and jati wood powder as gypsum board fillers. Research has been carried out on processing waste sawdust from mahogany and jati wood as a filling material for making gypsum ceilings with polyvinyl alcohol adhesive by mixing and compacting using a hot compressor at 70^o C. Good quality with a density value of 0.82 g /cm^3 and absorption capacity of 38.4% complied with SNI 03-2105-2006. Mechanical properties with variations in impact strength (95:5:10) of 19.014 J/m^2, flexural strength of variation (95:5) of 395, 446 N/m^2, and fracture strength of variation (95:5:5) of 1.7758 N/m^2. A Gypsum board was obtained, which did not meet SNI 03-6384-2000 on the gypsum board specification for the results of testing for flexural strength and fracture strength.*

Keywords: *Ceiling, Gypsum, Mahoni and jati Wood Powder, PVA.*

1. INTRODUCTION

Along with the increasing population and the rapid development of technology, especially in the property sector, such as housing, hotels, office buildings, shops, and high-rise buildings, the need for building construction materials is also increasing. *Wood* is a building material widely used to construct housing, hotels, office buildings, shops, and multi-story buildings. Considering that the higher price of wood triggers illegal logging in the forest, it harms the environmental ecosystem in the forest, such as soil erosion resulting in landslides, floods, air pollution, and global warming (Kho, 2014).

One of the efforts made to reduce the use of wood as a building construction material is to make gypsum composite boards. *Composite* is a polymeric material formed from a combination of two or more constituent materials through a non-homogeneous blending process, which has different physical properties, namely as a filler or reinforcing material and matrix as a binding material. Composite materials generally have strong, tough, and heat-resistant advantages. Natural fibers are an alternative composite filler for various polymer composites because of their superiority over synthetic fibers. Natural fibers are easy to obtain at low prices, easy to process, low density, environmentally friendly, and biodegradable (Minah, et al, 2017).

Gypsum ($CaSO_4.2H_2O$) is one of the raw materials for making ceilings. It is widely used as a building construction material because it has advantages in terms of its mechanical properties: fire retardant, good finishing, lightweight, fast processing, and drying easily. Gypsum board is widely used for ceilings, particle wall elements, and decorative ceiling trim in residential rooms, hotels, office buildings, shops, and high-rise buildings. The ceiling is a building construction material widely used as a ceiling between the roof and the room below; it serves to place electrical installations, muffle loud and noisy sounds when it rains, and keep the temperature conditions in the room cool due to the intense sunlight. Illuminating the roofs of houses and hot steam and adding to the aesthetics of the building (Rizki et al., 2018).

So far, the manufacture of gypsum board is still dominated by using gypsum or other materials as reinforcing materials. Currently, the use of gypsum board is still limited. This is because the availability of gypsum board on the market still needs to improve in strength, not as plywood, and the nature of gypsum board is brittle and not waterproof. Commercial gypsum ceilings that are widely circulated among the public have weaknesses in terms of poor physical properties such as low density (density) and high water absorption resulting in poor mechanical properties resulting in compressive strength, flexural strength, impact strength, very low tensile strength, and price. Expensive (Yang et al., 2013).

The unfavorable properties of gypsum board can be corrected by adding fiber to its production. In general, the fibers often used as fillers are artificial fibers such as glass fiber, carbon, and graphite. Using natural fibers, namely hibiscus skin fiber, as a substitute for artificial fibers will reduce production costs. This can be achieved because of the low cost required for processing natural fibers compared to artificial fibers. One of the natural fibers that can be used as a composite filler to manufacture gypsum ceilings is sawdust from mahonia and jati wood (Widiarta et al., 2018).

Sawdust of mahoni and jati wood has yet to be utilized optimally, mostly used as boiler fuel or burned without utilization, causing significant environmental damage. So far, the utilization of sawdust of mahoni wood waste *(Swietenia macrophylla king)* and jati *(Tectona grants lf)* has already been done, namely its utilization as alternative energy by pyrolysis method (Abdurachman, 2018; Rabiatul, 2017).

Mahoni sawdust is a type of sawdust widely used in Indonesia's wood processing industry. The structural components of sawdust of mahonia wood are 47.26% cellulose, 27.37% hemicellulose, 74.63% holocellulose, and 25.82% lignin (Abdurachman, 2018). Jati wood produces sawdust waste which is widely used for making paper. Teak sawdust also contains 47.5% cellulose, 29.9% lignin, 14.4% pentosan, 1.4% ash content, 0.4% silica, solubility in cold water 1.2%, solubility in hot water 11.1%, solubility in alcohol benzene 4.6% and solubility in NaOH 1% 19.8% (Martawijaya, 1999)

2. METHODOLOGY

Tools and Materials

The equipment used in this study includes analytical balance, a set of matrix printers and hot presses, and a set of test kits.

The materials used in this study were gypsum flour, mahogany sawdust, and teak wood polyvinyl alcohol adhesive.

Making Gypsum Ceiling from a Combination of Sawdust of Mahoni and Jati Wood before Addition of Polyvinyl Alcohol Adhesive (PVA)

Gypsum flour and a combination of mahoni & jati wood sawdust were weighed according to a predetermined composition variation (% b/b) 95:5, 93:7, and 90:10. Then mixed into one for each composition variation and stirred using a spatula in the container manually until homogeneous. Then the mixture is poured into a mold evenly coated with aluminum foil. The mixture is then pressed/pressed using a hot compressor for 30 min at a temperature of 90^{o}C. Then it is removed from the mold. The printed sample is divided into several parts to carry out tests, both physical and mechanical properties, FTIR test.

Making Gypsum Ceiling from a Combination of Mahogany and Teak Wood Powder after Adding Polyvinyl Alcohol Adhesive (PVA)

Gypsum flour and a combination of mahoni & jati and PVA sawdust were weighed according to a predetermined composition variation (% b/b) 95:5:5, 95:5:7.5 and 95:5:10. Then mixed into one each composition variation and stirred using a spatula in a container manually until homogeneous. Then the mixture is poured into a mold that has been evenly coated with aluminum foil. The mixture is then pressed / pressed using a hot compressor for 30 min at a temperature of 90 ^{o}C. Then it is removed from the mold. The printed sample is divided into several parts to carry out tests, both physical and mechanical properties, FTIR test.

3. RESULTS AND DISCUSSION

Several tests and analyses have been carried out on samples of gypsum board ceilings by utilizing sawdust of mahoni and jati wood as filler for gypsum board using polyvinyl alcohol (PVA) as an adhesive, with variations in the ratio of the composition of gypsum and fillers without the addition of adhesive (95:5,93:7, and 90:10) and variations in the ratio of the composition of gypsum and fillers with polyvinyl alcohol (PVA) adhesives namely (95:5:5, 95:5:7,5, and 95:5:10).

Results of Physical Characterization of Ceiling Gypsum Board

1. Density Test Results Before And After Adding PVA

a. Before the addition of PVA

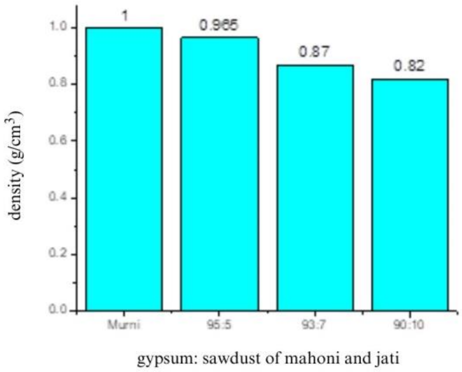

Figure 1. Relationship between Gypsum Ceiling Density and Mahoni and Jati Powder Filler.

So adding sawdust of mahoni and jati as a filler by reducing the composition of the gypsum produces a much smaller sample density. With the addition of mahonia and jati sawdust as fillers, the density value of the material tends to decrease; this is because mahogany and teak sawdust have a lower density, so when adding fillers to the mixture, it will reduce the density of the mixture (Parinduri, 2013).

b. After Addition of PVA

Density values range from 0.975 g/cm^3 to 0.995 g/cm^3, indicating that adding PVA tends to lower the density values. This shows that the smaller the density of a gypsum board, the better it is used as a ceiling because it is lighter and safer for the user in the event of damage. (Salon, 2009).

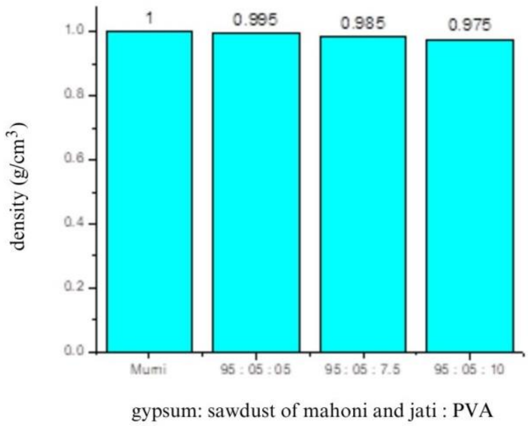

Figure 2. The relationship between Gypsum Ceiling Density And Mahoni and Jati Powder Filler with PVA adhesive

2. Absorption Test Results Before And After Adding PVA

a. Before PVA Addition

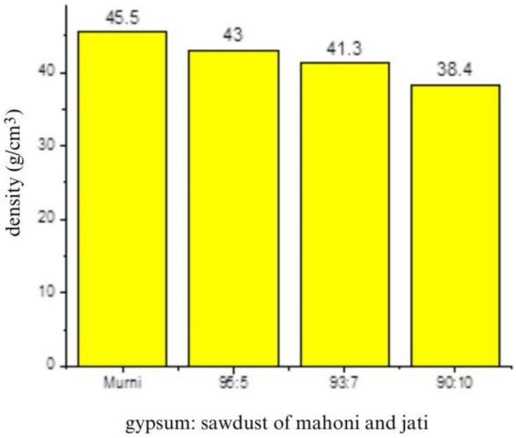

Figure 3. The relationship between the percentage of water absorption and powdered gypsum of mahoni and jati wood.

Based on Figure 3, the graph shows that the percentage for pure gypsum is 45.5%. The maximum percentage of water absorption in the 95:5 variation is 43.0%, while the minimum percentage in the 90:10 variation is 38.4%. From the graph of Figure 4.3, it can be seen that the addition of mahoni and jati sawdust tends to reduce the water absorption value in the test sample where the minimum composition of mahoni and jati wood is 90:10 the water absorption is around 38.4%, while the maximum composition of mahoni and jati wood powder is 95: 5 which is 43.0% water absorption. The 90:10 composition is the optimum composition for water absorption in the sense that the ability to absorb water decreases (Salon, 2009).

b. After Addition of PVA

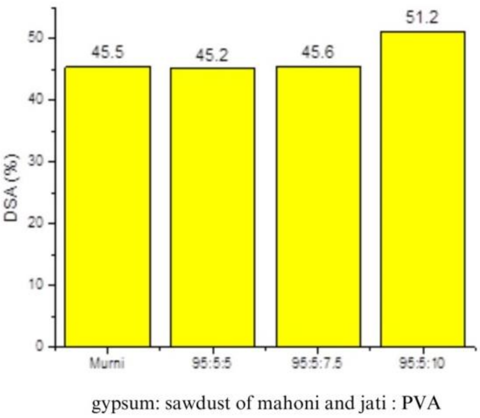

Figure 4. The relationship between the percentage of water absorption and powdered gypsum of mahogany and teak: PVA

In Figure 4. The maximum percentage of water absorption in the 95:5:10 variation is 51.2%, while the minimum percentage in the 95:5:5 variation is

45.2%. It can be seen that the addition of PVA adhesive with gypsum composition and fillers as a constant variation tends to increase the water absorption value of the test sample where the maximum composition is 95:05:10, which is 51.2%, and the minimum composition is 95:05:5, which is 45.2, %. Based on SNI Standard 03-2105 (2006), the results of this study are still by the standard, where the maximum permissible water absorption limit is 50%, except for the 95:5:10 variation (Rahmadi Indra, 2011).

Results of Mechanical Characterization of Gypsum Ceiling Board

1. Impact Test Results before and after the addition of PVA

a. Before the addition of PVA

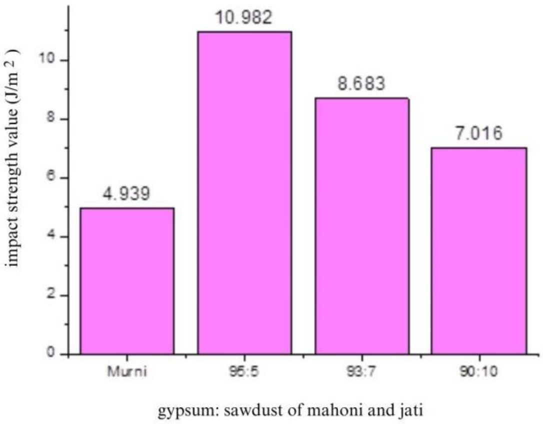

Figure 5. Strong impact relationship with the composition of Mahoni and Jati Powder without the addition of adhesives

From the graphic display above, it can be seen that there is an optimum increase in the 95:05 composition, which is equal to 10,982 J/m2, while in the other compositions, it tends to decrease. The minimum test results are at a composition of 90:10 ie7.016J/m2. This shows a tendency for the material to experience brittleness when the composition of mahoni and jati wood powder increases; these results also indicate a decrease in the bond between the powders composing the specimen (Widiarta et al., 2018).

b. After Addition of PVA

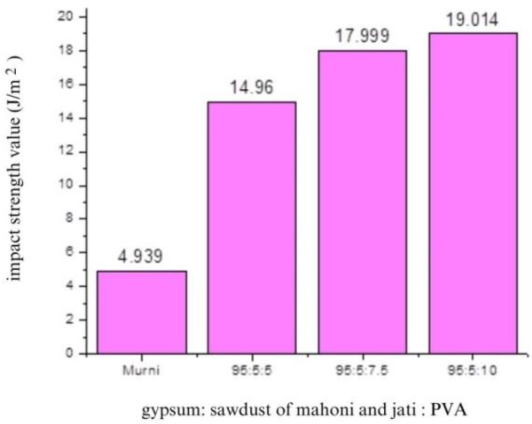

Figure 6 Strong impact relationship with the composition of Mahon and Jati Powder with PVA.

The impact strength of gypsum ceilings ranges from14,960J/m^2 -19.014 J/m^2, where optimum results were obtained on the composition of gypsum and sawdust of mahoni and jati with a ratio of (95:05:10) 19.014 J/m^2. The results show that adding PVA adhesive increases the impact strength value. The existence of empty cavities that are not filled with PVA adhesive will affect the impact strength of the resulting gypsum ceiling, where the more amount of adhesive is distributed, the impact strength of the gypsum ceiling will increase (Purnama et al., 2013). In addition, adding fiber to the composite can disrupt the bonds between the matrices in the polymer.

4. CONCLUSION

1. The results of the research included physical properties, including a density value of 0.82 g/cm^3 at a composition of 90:10 and a water absorption value of 38.4% at a composition of 90:10. The gypsum board produced met the standards required by SNI 03-2105-2006. Mechanical properties with impact strength at variation (95:5:10) of 19.014 J/m^2, flexural strength at variation (95:5) of 395.446 N/m^2, and fracture strength at variation (95:5:5) of 1.7758 N/m^2. However, these results must meet SNI 03-6384-2006 concerning gypsum board specifications for flexural and fracture strength test results.
2. The FTIR results of pure gypsum, gypsum: mahoni and jati wood powder: PVA, and gypsum: mahoni and jati wood powder can be identified when the FTIR spectra have different spectra where the FTIR characterization of pure gypsum shows a wave number of 1006 cm^{-1}, however, after the addition of mahoni and jati sawdust fillers the wave number (1006 cm^{-1}) did not appear. Meanwhile, after adding PVA, the wave number (1006 cm^{-1}) reappeared. This shows that after adding PVA to the gypsum ceiling after being characterized by FTIR, the resulting gypsum ceiling has presented groups in pure gypsum compounds.

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