

The Utilization of Coconut Fiber and Marble Waste with Mechanical Tests

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ABSTRACT

The area of coconut plantations in South Aceh Regency was 6839 Ha, out of the total number of sub-districts in South Aceh. South Kluet District was the area with the largest coconut plantation area compared to other districts, reaching 1433 Ha. Coconut coir fiber was usually used for household equipment, such as floor brooms, doormats and rope. Coconut farmers rarely process coconut husks, and after harvest, they just leave the coconut husks piled up under the coconut trees until they rot. In this research, coconut fiber waste was used as reinforcing fiber for composite materials. The aim of this research was to be determined the mechanical strength of marble waste composites mixed with resin and reinforced with coconut fiber. The composition tests carried out were: 85 : 10 : 5, 80 : 10 : 10, 90 : 7.5 : 2.5, and 80 : 12.5 : 7.5. The test carried out on each test specimen composition was a tensile test. From the results of the tests carried out on the test specimens, the maximum stress was found in the composition: (85: 10: 5) 85% Resin, 10% Marble, 5% Coconut Fiber with an average maximum stress value of 29.44827586 N /m² and the average modulus of elasticity is 0.2415123283 N/m².

INTRODUCTION

South Aceh Regency was an area surrounded by stretching and fertile mountains, which were directly connected to beautiful beaches facing the Indian Ocean. This area was also known as a plantation and horticultural area. Coconut plantations were often found in South Kluet District with 1433 Ha, while in other districts it was only 6839 Ha (Dataset Aceh selatan, n.d.). Coconut farmers regularly harvest every harvest every 4 months, peeling the coconuts directly under the coconut tree, and then leaving the coconut husks to pile up and rot. Coconut fiber is a fairly large part of the coconut fruit, namely 35% of the total weight of the fruit. Coconut fiber consists of fiber and cork which connected one fiber to another fiber. Fiber is a valuable part of coir (Ningtyas et al., 2022)

On the other hand, South Aceh Regency was also known as a marble producing area, where the rock was processed and produced into various high-performance products (Lindawati et al., 2020). However, the remainder of marble processing in the form of marble powder still accumulates and was left as waste. Thus, marble powder waste must be utilized into products that were more valuable and beneficial for local communities. Previous research results reported that marble powder can be used as a mixture for making composite materials (Ihsan & Fitriadi, 2018).

LITERATURE REVIEW

Coconut fiber is an agricultural waste that has been underutilized, coconut fiber is composed of organic and mineral elements, namely pectin and hemicellulose (components that are soluble in water), lignin and cellulose (components that are insoluble in water), potassium, calcium, magnesium, nitrogen and protein. The main components of coconut fiber are lignin and cellulose, where naturally the lignin cellulose compounds along with hemi cellulose and pectin can undergo decomposition in a relatively long time by microbes.

Marble was usually used as flooring, house foundations and other household products. Apart from the main marble product, it was used as a by-product in the form of small stone fragments (gravel) and marble powder (Syaiful Amal & Saleh, 2016). Marble stone waste was the remainder of the processing of marble stone. So efforts need to be made to utilize marble waste into products, namely as aggregate material in concrete mixtures to increase compressive strength (Nauk; et al., 2012). Utilization of marble mud, Styrofoam waste and coal fly ash to make hollow concrete bricks. (Mizwar et al., 2012). Study of Mechanical Strength of Composite Materials Made from Marble and Sago Fiber Waste for Rencong Marble Souvenirs Storage (Anwar et al., 2023). Mechanical Properties Characterization of Marble and Resin Composite Materials (Husaini et al., 2019). Thermal Conductivity of Some Marble Stones Available in South Aceh District (Lindawati et al., 2020). Resin and matrix materials have the ability to withstand heat, where these materials were made from plastic or polymer. Furthermore, the resin functioned to be protected and bind the fibers so that they can work well in the composite matrix. Tensile test was a test of a material by pulling it to the point where the



material experiences maximum stress and strain until it broke or broken. Then it can be explained mathematically as follows:

$$\sigma = \frac{P}{A} \qquad E = \frac{P.L}{A.\Delta L}$$

- σ = Stressing
- P = Motion
- A = Cross-sectional area
- E = Modulus of Elasticity
- L = Long
- ΔL = Length Increase

METHOD

Tools and Materials

Tools

- a) Specimen Mold
- b) Sieve
- c) Measuring cup
- d) Stirring Container
- e) Spoon
- f) Paintbrush

Materials

- a) Marble Powder
- b) Coconut Fiber
- c) Resin
- d) Catalyst
- e) Wax

Tabel 1. Percentage Composition

No	Resin %	Marble %	Coconut fiber %
1	85	10	5
2	80	10	10
3	90	7,5	2,5
4	80	12,5	7,5

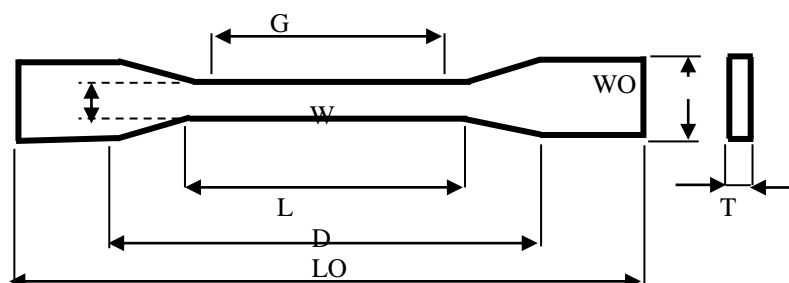


Figure 1. Tensile Test Specimens ASTM D 638- 03

Note:

- G (Length “measure length”) : 50 mm
- W (The cross-sectional width is small) : 13 mm
- L (Small cross-sectional length) : 57 mm
- D (Distance between clamp grips) : 115 mm
- LO (Overall specimen length) : 165 mm
- WO (Clamp grip width) : 19 mm
- T (Specimen thickness) : 3,2 mm

Steps for making tensile test specimens;

- a) Pour the resin into a container

- b) Add the sifted marble powder little by little into the container containing the resin and stir slowly so that the marble powder can be mixed completely.
- c) After the resin and marble powder are mixed evenly, then add the catalyst to the powder and stir until evenly mixed.
- d) Insert the coconut fiber fiber into the mold, then pour the resin into the test specimen mold.
- e) The composite mixture has been poured into the mold and dried for 1-3 days at room temperature.
- f) The dry composite is then removed from the mold, then sanded on the surface of the composite until the test specimen is clean and matches the test standard size.

Each test specimen composition is as shown in the table. 1 was tested three times.

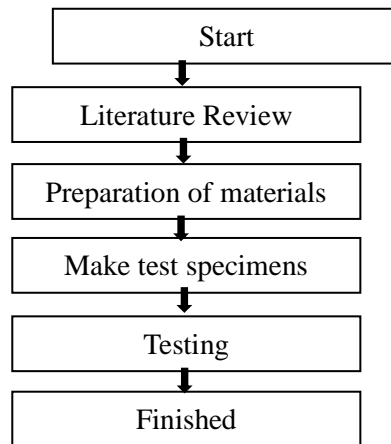


Figure 2. Flow Diagram

1. Start
2. Literature review, namely before carrying out the activity the author studied the work system that will be carried out during testing, looks for research references related to what will be researched.
3. Material preparation, namely preparing the materials needed for the experiment such as marble powder, coconut fiber, resin and catalyst.
4. Make a test specimen, namely pour some marble powder mixed with resin into the test specimen mold, then place the fiber into the mold according to the composition of the mold, pour the marble powder mixed with resin and catalyst again into the mold until it was full, wait 1-2 day until dry, then remove from the mold.
5. Testing, namely before carrying out the test, make sure the test specimen was completely dry, smooth the surface of the test specimen with paper and did not reduce the standard size, rub it so that the surface was completely flat and smooth. Then the product was ready to be tested using a tensile testing machine.
6. The results are the maximum stress and elastic modulus values for the specimens tested
7. Completion, namely the completion of the research series by obtaining data.

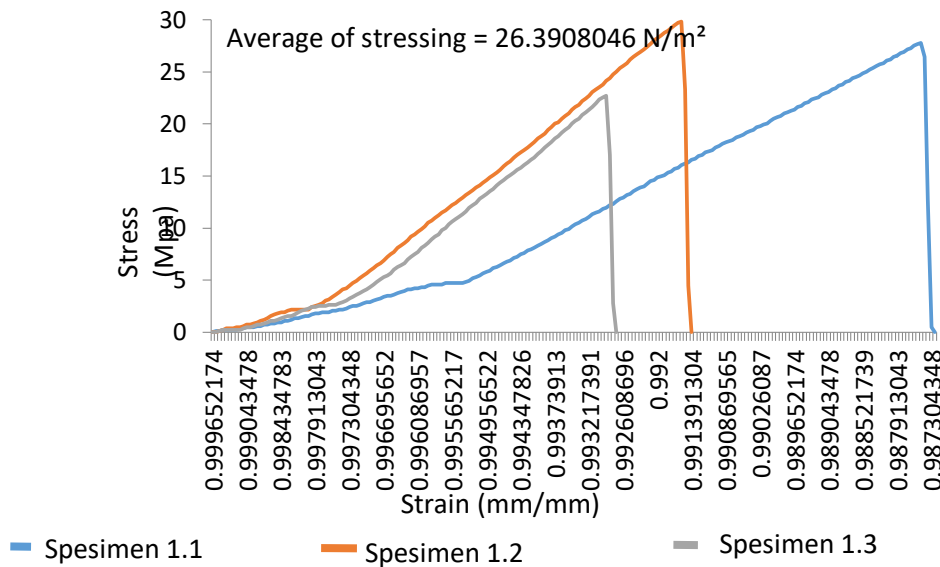


Figure 3. Results of three tensile test specimens of composition 85-10-5

Description of figure 3 above in specimen 1.1, the blue graphic line showed that the maximum stress that occurred was 27.15517241 N/m² and the modulus of elasticity was 0.241568364 N/m², in testing specimen 1.2 the orange graphic line saw that the maximum stress was occurred at 29.44827586 N/m² and the modulus of elasticity was 0.241442295 N/m². In testing specimen 1.3, the gray graphic line explained the maximum stress that occurred was 22.56896552 N/m² and the modulus of elasticity was 0.241526326N/m².

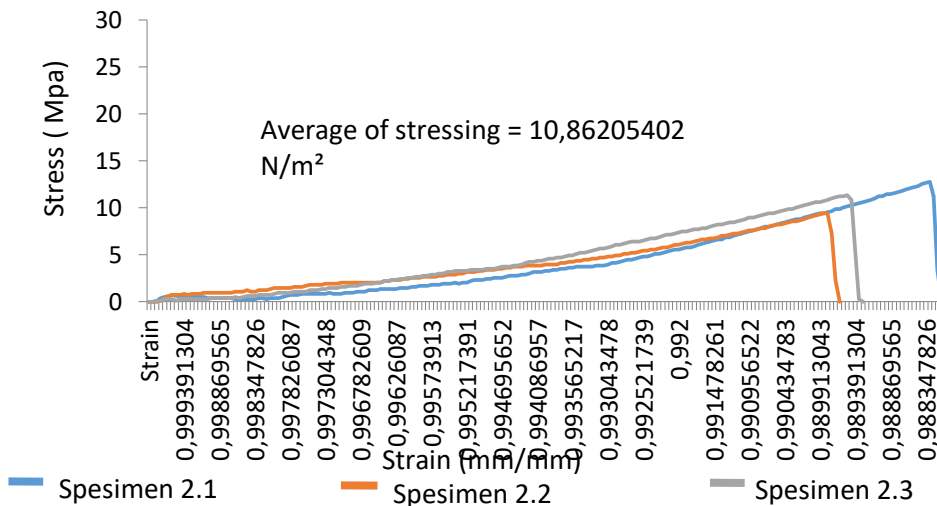


Figure 4. Results of three tensile test specimens of composition 80-10-10

Description in figure 4 above, in specimen 2.1, the blue graphic line showed that the maximum stress that occurred was 12.31034483 N/m² and the modulus of elasticity was 0.36216344 N/m², in testing specimen 2.2 the orange graphic line saw the maximum stress that occurred of 9.05172414 N/m² and the elastic modulus of 0.36219495 N/m². In testing specimen 2.3, the gray graphic line explained the maximum stress that occurred was 11.22413793 N/m² and the modulus of elasticity was 0.12079469 N/m².

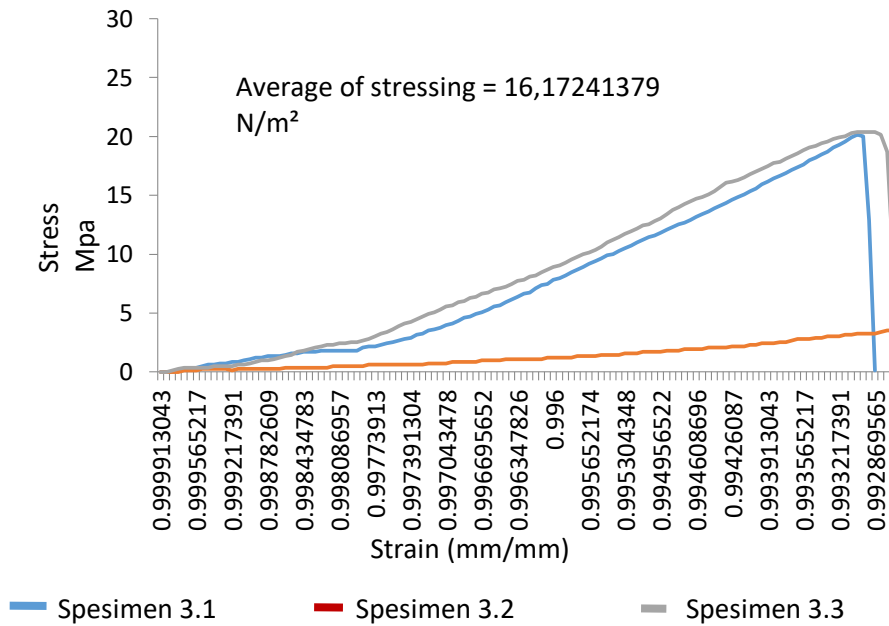


Figure 5. Results of three tensile test specimens of composition 90-7.5-2.5

Description of figure 5 above, on specimen 3.1, the blue graphic line showed that the maximum stress that occurred was 19.9137931 N/m² and the modulus of elasticity was 0.362226455 N/m², on testing specimen 3.2 the orange graphic line saw the maximum stress that occurred amounting to 8.3275862 N/m² and a modulus of elasticity of 0.241526326 N/m². In testing specimen 3.3 the gray graph line explained the maximum stress that occurred was 20.27586207 N/m² and a modulus of elasticity of 0.120721148N/m².

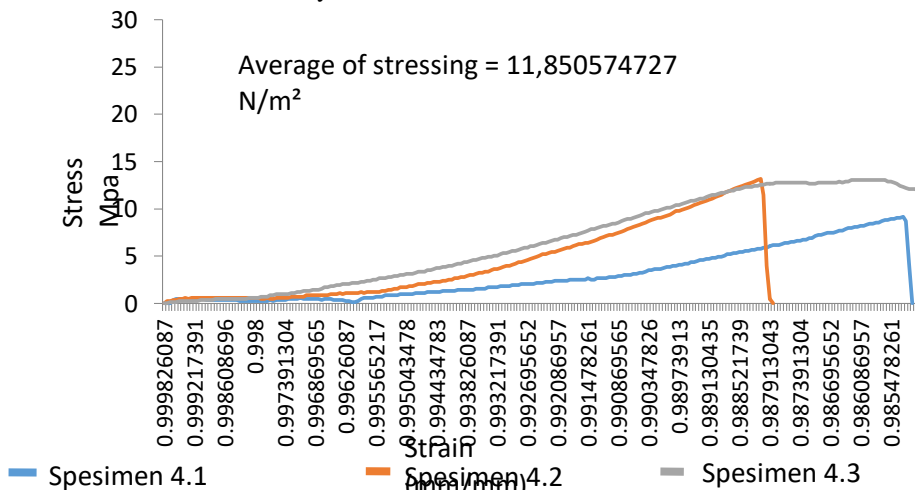


Figure 6. Results of three tensile test specimens of composition 80-12.5-7.5

Description of figure 6 above, in specimen 4.1, the blue graphic line showed that the maximum stress that occurred was 9.724137931 N/m² and the modulus of elasticity was 0.482966861 N/m², in testing specimen 4.2 the orange graphic line saw the maximum stress that occurred of 12.79310345 N/m², and the modulus of elasticity was 0.483347043 N/m². In testing specimen 4.3, the gray graphic line explained that the maximum stress that occurred was 13.0344828 N/m² and the modulus of elasticity was 0.241484304 N/m².

RESULT END DISCUSSION

Each test specimen composition was tested three times. In this test, the test carried out was a tensile test, each



composition will get the maximum compressive stress and modulus of elasticity.

Figure 3 showed that the three test specimens have a composition of 85:10:5, where in specimen 1.1 the blue graphic line saw that the maximum stress that occurred was 27.15517241 N/m² and the elastic modulus was 0.241568364 N/m². in testing specimen 1.2 the orange graphic line showed the maximum stress that occurred was 29.44827586 N/m² and the modulus of elasticity was 0.241442295 N/m². In testing specimen 1.3, the gray graphic line explained the maximum stress that occurred was 22.56896552 N/m² and the modulus of elasticity was 0.241526326N/m².

Figure 4 explained the results of three test specimens with a composition of 80:10:10, where in specimen 2.1 the blue graphic line showed that the maximum stress that occurred was 12.31034483 N/m² and the elastic modulus was 0.36216344 N/m², at testing specimen 2.2, the orange graphic line seen the maximum stress that occurred was 9.05172414 N/m² and the modulus of elasticity was 0.36219495 N/m². In testing specimen 2.3, the gray graphic line saw the maximum stress that occurred was 11.22413793 N/m² and the modulus of elasticity was 0.12079469 N/m².

Figure 5 saw the tensile testing of three specimens with a composition of 90:7.5:2.5, where in specimen 3.1 the blue graphic line showed that the maximum stress that occurred was 19.9137931 N/m² and the modulus of elasticity was 0.362226455 N/m², in testing specimen 3.2 the orange graphic line explained the maximum stress that occurred was 8.3275862 N/m² and the modulus of elasticity was 0.241526326 N/m². In testing specimen 3.3, the gray graphic line showed the maximum stress that occurred was 20.27586207 N/m² and the modulus of elasticity was 0.120721148 N/m².

Figure 6 showed the tensile test of three specimens with a composition of 80:12.5:7.5, where in specimen 4.1 the blue graphic line saw that the maximum stress that occurred was 9.724137931 N/m² and the elastic modulus was 0.482966861 N. /m², in testing specimen 4.2 the orange graphic line explained the maximum stress that occurred was 12.79310345 N/m², and the modulus of elasticity was 0.483347043 N/m². In testing specimen 4.3, the gray graphic line showed the maximum stress that occurred was 13.0344828 N/m² and the modulus of elasticity was 0.241484304 N/m².

Marble Waste



Figure 7. Marble Stone Waste

The waste resulting from splitting marble was mixed with water over a period of four or a week, the waste will settle to the bottom. The waste tank will be full if the marble laboratory operated for a month. This waste was not used and usually this waste will be wasted (overflow) when it exceeded capacity. This can also cause environmental pollution. By utilizing marble waste, waste that has been ignored was not wasted in vain and has resale value.



Figure 8. Drying process for marble waste

Marble waste that has been taken from the storage tank was dried in the sun for 7 days so that the water content in it must be completely dry. After drying, the waste was crushed so that there were no lumps in the marble powder to make it easier to sift. If there are still a lot of lumps in the waste, you should be increased the drying time.



Figure 9. Process of drying coconut fiber fiber

Decomposed coconut fiber also needed a drying process so that there was no water content in the coconut fiber and it must be completely dry. So that during the mixing process of resin and marble there were no other ingredients in the test specimen other than resin, marble powder and coconut fiber.



Figure 10. Marble waste sieving process

This sieving process was carried out when the marble powder was completely dry and contains no water content, using a 100 mesh sieve, the purpose of sieving was to make the powder really fine and clean, so that the marble powder particles that we will be used were of uniform size, and prevent other particles from being mixed into the marble powder.



Figure 11. Test specimens

Test specimens with a composition that has been determined according to ASTM D 638-03 dimensions. Before the test was carried out, the specimen you want to be tested must first ensure that the test specimen matched the size and the surface must be flat and smooth. If the surface was flat, then rubbing must be carried out on the wide surface of the specimen using fine sand paper. Furthermore, if the surface was flat, smooth and did not reduce the size of the test standard and was ready to be tested.

CONCLUSION

Of the four specimen compositions tested, each specimen was tested three times, composition (85-10-5), the average maximum stress was 26.3908046 N/m² and the average modulus of elasticity was 0.2415123283N/m²,

composition (80-10-10) average maximum pressure of 10.86205402 N/m² and average modulus of elasticity of 0.2817176933 N/m², composition (90-7.5-2.5) average maximum stress of 16.17241379 N/m² and the average modulus of elasticity was 0.2414913097 N/m², and the composition (80-12.5-7.5) the average maximum stress was 11.850574727 N/m² and the average modulus of elasticity was 0.40259940 N/m².

Based on the results of the four test compositions that have been carried out, it can be concluded that the test results with a composition of 85% resin, 10% marble, 5% coconut fiber with an average maximum stress value of 26.44827586 N/m² and an average elastic modulus of 0.2415123283 N/m². Higher value compared to other compositions. Thus, we can use the composition 85:10: 5 as a composition for making household equipment.

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