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MECHANICAL PROPERTIES OF AGROFIBER COMPOSITE RUBBER REINFORCED RAMIE FIBER AND BANANA STEM FIBER APPLICATIONS IN AUTOMOTIVE COMPONENTS

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Abstract. Utilization of natural fiber can be used as an automotive component product with structural and composite strength that is in accordance with ASTM standards. The purpose of this study is to measure compression, tensile, and microstructure using digital microscope as an analysis of the composite structure between rubber composites made from ramie reinforced and banana fibers with latex. The material use is agro fiber form banana tree and ramiee, mixing with latex. The Variation are 10%, 20% and 30% reinforce,and latex start from 70% to 90%. Mechanical Properties of Composite Strengthened Rubber Ramiee Fiber and Banana Fiber with latex used for sample prototype replacement Automotive Rubber Installation (Synthetic rubber). This research method is by making samples according to ASTM with each of 3 specimen samples in each fiber composition and rubber composite, a total of 30 specimen samples. 15 specimens were subjected to tensile tests, 15 Compression test specimens and specimens with optimal results in each composite composition were subjected to macroscopy photos. Agro fibre composite with ramie reinforced is better than banana stem fiber and mixing ramie and banana. The highest tensile and compression strength values is found in variations in the variation of the composition of the Ramie fiber + Latex 90 : 10 with a value of 4,58 N / mm^2 for tensile test; 0,21 kgf / mm^2 for compression test. The agrofiber composite can be used for automotive part like: air filter, car body, and chassis

Keywords: ASTM, Compression Test, Composites, Macrostructure

1. Introduction

Composite is a new type of engineered material consisting of two or more materials in which the properties of each material differ from one another both chemical and physical properties and remain separate in the final result of the material. The composite consists of two parts, namely the matrix and reinforce [1]. The largest amount of composite production is currently dominated by synthetic materials and metals. Natural ingredients can also be used to make composites as an alternative material that is more environmentally friendly than its predecessor. Natural fiber reinforcement that can be used is ramie fiber and banana stem skin fiber, with latex as matrices.

Ramie is a result product of the plantation that fibers are from tree trunks that are commonly used as textile materials. Ramie fiber has a fairly good tensile strength compared to other fibers. In Rohaeti, et al research of ramie fiber bio composites with modified alloys of 10% latex obtained a tensile strength of 0,982 MPa, whereas without modification of 0,932 MPa. Interfacial bonding in the fiber depends on the surface of the fiber and the roughness of the fiber, the use of alkali is able to increase the surface of the fiber more homogeneously as the reduction of lignin hemp fiber. The tensile strength value of flax

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fiber is 41,9 MPa with an alkaline soaking for 8 hours, and the impact strength is 0,0725 Joules / mm^2 at a 4 hours immersion. Banana stem fiber is a type of fiber of good quality and is one alternative material that can be used as a reinforcement in making composites [2].

Already research that discusses the influence of the thickness of the banana frond fiber on the mechanical properties of polyester material on the specimen addition of 0,7 mm fiber thickness Compression strength of 12,92 N/m^2. Whereas with the addition of 0,82 mm fiber thickness to the tensile strength of 2,53 N/m^2 [3]. The use of banana fiber in automotive components with the addition of an alkali and not from every specimen of fiber and epoxy samples has a tensile strength of 34,99 MPa and compressive strength of 122,11 MPa and 40,16 MPa at tensile strength and 123,28 MPa at compressive strength with do not use alkali [4].

Rubber latex is a plantation product from rubber trees of primary value that can be used as a variety of quality secondary products in the form of household appliances, automotive and transportation components, as well as various textile-non-textile industry needs [5]. Natural rubber in the form of a polymerisoprene liquid has elastic properties, high tensile strength, and high flexural strength, but expands when exposed to liquid oil [6]. Liquid latex can be used directly or as a primary alloy composite material as abounding material to increase elastic properties, flexural strength and damping data on rubber composites [7].

Under these conditions, it is very positive if automotive component products are made with non-synthetic products that are easily recycled, easily made and able to accommodate the strength of the material based on the allotment specifications of automotive and transportation components [8]. The results of this research are expected that the material properties of each variation of the composite can be used according to load requirements. The purpose of this research is to find the highest tensile and Compression strength values of each variation of fiber and matrix composition, so that the initial data is obtained as a reference for use as an automotive component material

2. Experimental procedure

The research method that will be used is true experimental research. The material used is ramie and banana stem fiber for reinforced, latex for matrics. Variation composition of fiber-reinforced and matrix presented in **Table 1**. Made composite specimens using the hand lay-up method.

Table 1. Spesification of specimen

Specimen	Composition		
	1	2	3
Banana stem fiber + Latex	90 : 10	80 : 20	70 : 30
Ramie fiber + Latex	90 : 10	80 : 20	70 : 30
Banana stem fiber + Ramie fiber + Latex	45 : 45 : 10	40 : 40 : 20	35 : 35 : 30

The stages of this research are: 1. Making fibers from ramie plants and stems of banana stones that have been cut down. 2. The shape of the fiber consists of random fibers, short straight fibers, and long straight fibers. 3. The fiber is washed with Alkali liquid and soaked for 2 hours [9]. 4. Stage of drying fibers in the flowed wind so that the fiber does not harden and break easily. 5. Making specimens in the form of a mixture of rubber and fiber to form ASTM type D 638 type specimens [10] (**Figure 1**). 6. The shape of the tensile test specimen is adjusted to the ASTM standard. 7. The form of compression test specimens is adjusted to ASTM standards. 8. The specimen is tested tensile to determine the tensile strength of an agrofiber mixture. 9. The specimen is compressive tested to determine the compression strength of the sample. 10. Macro pictures specimens are taken to discuss the degree of homogeneity of the mixture. Measurement of Mechanical Properties of The Composites using:

1. Tensile Test Spesimen:

$$\sigma = \frac{F}{A} \tag{1}$$

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Where:
σ = Tensile strength (N/mm^2)
F = Maximum load (N)
A = Cross section area (mm^2)

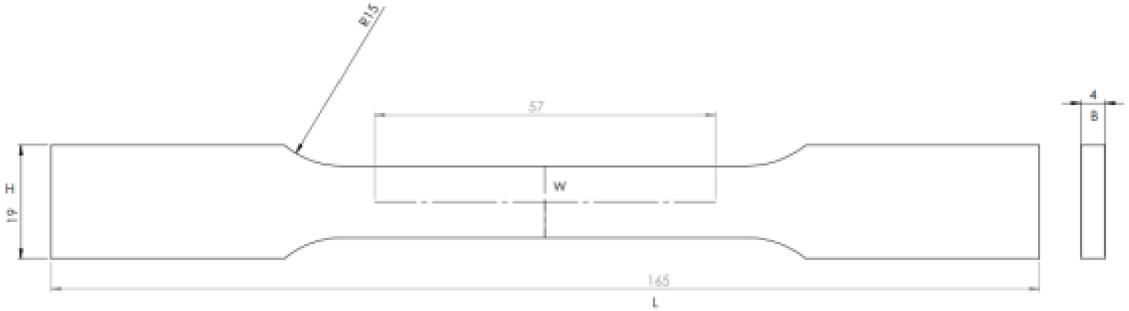

Figure 1. Tensile test specimen ASTM D638.

2. Compression Test Spesimen:

$$\sigma = \frac{P}{A} \quad (2)$$

Where:
σ = Tensile strength (kgf/mm^2)
P = Maximum pressure (kgf)
A = Area (mm^2)

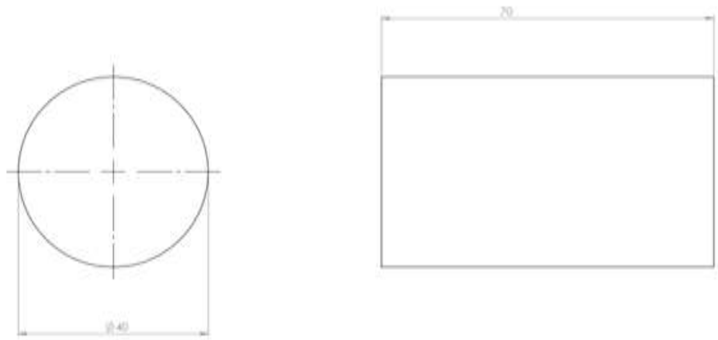

Figure 2. Compression test specimen.

Application of specimen composition is described as a figure

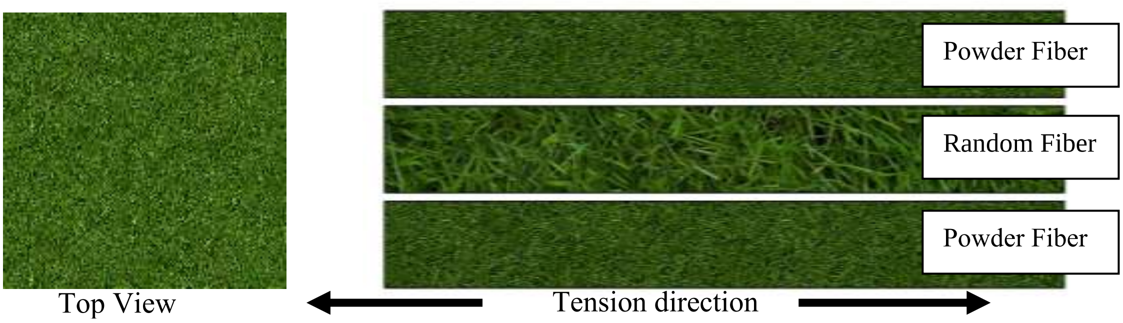

Figure 3. Composition of powder fiber and random fiber on the composite agrofiber specimen

ISBN : 978-602-14917-9-9

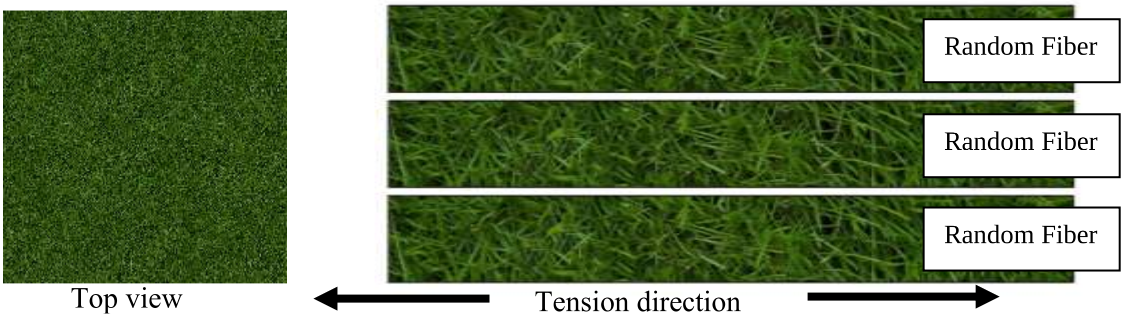

Figure 4. Composition of powder fiber and random fiber on the composite agrofiber specimen

3. Results and Discussion

3.1 Tensile Test and Compression Test

From the results of tensile and compression tests on agro fiber composites with ramie fiber and banana stem fiber with latex matrix obtained the highest tensile strength values in variations in the composition of Ramie fiber + Latex 90 : 10 with a value of 4.58 N / mm^2. This shows that the variation of the composition of ramie fiber + Latex (all composition ratio) has the strongest chemical bond and is more able to distribute tensile force more evenly compared to other variations. While the highest value of compression strength is found in the variation of the composition of the Ramie fiber + Latex 90 : 10 with a value of 0.21 kgf / mm^2. With the addition of latex as a matrix, the value of the tensile strength in this study increased by almost 500% compared with previous studies [2]. This shows that variations in the composition of Ramie fiber + Latex (all composition ratios) have the strongest chemical bonds and are more capable of received greater compression forces than other variations. The complete results are presented at **Table 2**.

Table 2. Test results of agrofiber composite

Average Tensile and Compression Strength				
Specimen	Spesification	Compotition Ratio	Tensile Strength (N/mm^2)	Compression Strength (Kgf/mm^2)
Banana stem fiber + Latex		90 : 10	2,02	0,09
		80:20	2,22	0,08
		70:30	2,58	0,06
Ramie fiber + Latex		90 : 10	4,58	0,21
		80:20	4,29	0,14
		70:30	3,49	0,13
Banana stem fiber + Ramie fiber + Latex		45:45:10	3,39	0,18
		40:40:20	2,99	0,12
		35:35:30	2,72	0,08

3.2 Macrostructure

From macrostructure image from the results of tensile and compressive tests can be seen the results of the spread of latex bonds into fibers so as to produce strong chemical bonds.

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Figure 5. Banana stem fiber + Latex


Figure 8. Banana stem fiber + Latex


Figure 6. Ramie fiber + Latex


Figure 9. Ramie fiber + Latex


Figure 7. Banana stem fiber + Ramie fiber + Latex


Figure 10. Banana stem fiber + Ramie fiber + Latex

Figure 5 until 7 shows the macrostructure of the tensile strength test, and figure 8 until 10 shows the compression strength test. It can be seen in figure 5 the latex material only visible on surface of banana fiber, the material tensile strength lower than ramie fiber, also figure 6 show the ramie fiber better mixing is evenly covered by latex than figure 5 the tensile strength better than banana fiber or figure 7. The fractures that occur in the middle are extended outward, compared to Figure 5 and 7 which tend to be latex only on the outside of the fiber and the fractures tend to be flat. While on the compression test specimen, all variation composition has the same form after the test so the compression strength is similar.

4. Conclusion

Based on the results of this research on the Mechanical Properties of Agro fiber Composite Rubber Reinforced Ramiee Fiber and Banana Stem Fiber Applications in Automotive Components can be concluded as follows:

1. Highest tensile strength values in variations in the composition of Ramie fiber + Latex 90 : 10 with a value of 4.58 N / mm^2.

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2. The highest value of compression strength is found in the variation of the composition of the Ramie fiber + Latex 90 : 10 with a value of 0.21 kgf / mm^2.
3. Agro fibre composite with ramie reinforced is better than banana stem fiber and mixing ramie and banana.
4. The agrofiber composite can be used for automotive part like: air filter, car body, and chassis

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