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Analysis of Tensile Strength of Jute and Coconut Coir Reinforced Polymer Matrix Composite

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ABSTRACT

A Composite is a mixture of two or more elements that are physicochemical and different from one another which can produce new products with better properties. As technology advances, conventional composite materials began to be replaced with polymer materials. One way of making polymer composites is to use polyester resin with natural fiber reinforcement. Coconut coir is a natural fiber with a high cellulose content and can produce high lignin is the cause of coconut coir having stiffer properties than other natural fibers. It is this rigid nature that causes coconut coir to be widely ogled by the textile industry. Another example that is often used as a reinforcement for polymer composites is jute fiber. Jute fiber is a natural fiber with high quality derived from the extraction of plant stems with a multicellular structure. This research is about measuring the tensile test of composites with a polyester resin matrix reinforced by jute and coconut fiber.

INTRODUCTION

A Composite is a mixture of two or more elements that are physicochemical and different from one another which can produce new products with better properties [3,9]. Filler in composite materials is not only in the form of synthetic composites, but there are also those from natural fibers. For various reasons and considerations, conventional composite materials began to be replaced with polymer materials [12]. So that the constituent of the polymer composite itself is a matrix and reinforcement. Composites with polymeric materials have several advantages, including excellent adaptability, high tensile strength, corrosion resistance, easier maintenance, and ease of design [15]. One way to manufacture polymer composites is to use polyester resin with natural fiber reinforcement [17].

Tropical countries such as Sri Lanka, the Philippines, and Indonesia produce abundant natural fibers. Some of them are consumption waste [3,17]. One example of natural fiber from consumption waste is coconut fiber. The chemical composition of coco fiber according to the United Coconut Association of the Philippines includes cellulose, pectin, hemicellulose, lignin, pyroligneous, gas, charcoal, tar, tannin, and potassium [4,18]. Coconut coir is a fiber with a high cellulose content. Where the cellulose content can produce high lignin and is the cause of coconut coir having stiffer properties than other natural fibers. It is this rigid nature that causes coconut coir to be widely ogled by the textile industry [10,17]. Not only that, for several other reasons such as its environmentally friendly nature, as a form of reusing consumption waste, the price is more affordable and sustainable, making coconut coir widely used in the manufacture of polymer matrices [5,12]. Since ancient times, natural fibers have been widely used in the manufacture of various products. One example is clothing. The natural fiber is an environmentally friendly material with high specific strength, has non-abrasive characteristics, and is biodegradable so it is proven to be a good reinforcement in polymer matrices. It is not surprising that at present there have been many studies that utilize natural fibers as polymer matrix reinforcement. Its high modulus, as well as its ability to reduce carbon footprint, make natural fibers play an important role in the environment [6,15]. Mechanical properties of coconut coir fiber composites with polyester. After testing and SEM photos, the optimal fiber volume fraction of the coconut fiber composite that can withstand crack

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propagation is obtained [8].

Fig. 1. Coconut and jute fibers used in the fabrication of composites

Another example that is often used as a reinforcement for polymer composites is jute fiber. Jute fiber is widely cultivated and processed in China, Japan, and Malaysia. Jute fiber is a natural fiber with high quality derived from the extraction of plant stems with a multicellular structure. Not much different from coconut coir, jute fiber is also composed of cellulose, hemicellulose, lignin, and gelatin. And jute fiber is widely used in the automotive industry.

This study aims to measure the tensile strength of a composite material with a matrix of polyester resin reinforced with jute and coconut coir fibers.

EXPERIMENTAL METHOD

The materials used in this experiment are polyester resin as a matrix, jute and coconut fiber as filler, and also catalysts and wax. The tools used in this research is a set of glass molds consisting of a glass plate that serves as a mold base, mold, latex gloves, and plastic cups. In the manufacture of this composite, three variations were carried out, as shown in table 1.

Table 1. Designation of composites.

Composition of composite	Designation
Resin 85% + Jute Fiber 15%	A
Resin 85% + Coco Fiber 15%	B
Resin 85% + Jute Fiber 7.5% + Coco Fiber 7.5%	C

The jute and coconut coir fibers are cut to lengths equal to the length of the mould. The molds and glass plates are smeared using waxing. Jute fiber and coconut fiber are inserted into the mold according to a predetermined variation. The resin with the catalyst is mixed as needed. The resin mixture with the mixed catalyst is poured into the mold until the jute and coconut fiber sinks. The material is dried by aerating. The material can be removed from the mold when it is completely dry. After the material is dry, the tools and materials are cleaned. Before the material is tested, the length, width and thickness of the material are first measured. Tensile test is carried out using the Universal Testing Tensile tool.

RESULTS AND DISCUSSION

Mechanical properties such as tensile strength were investigated and the results were evaluated. Test results on samples of different compositions will provide insight into the performance of each reinforcement with the polyester matrix. The experimental results of reinforcing materials combined with matrix materials will facilitate the study of the properties and effects of reinforcing materials on mechanical properties. Tensile specimens were prepared according to ASTM D3039 and tested using a universal testing machine. Young’s modulus, tensile strength, and elongation are directly related to the sample showing the mechanical characteristics of the material shown in Figures 2-4.

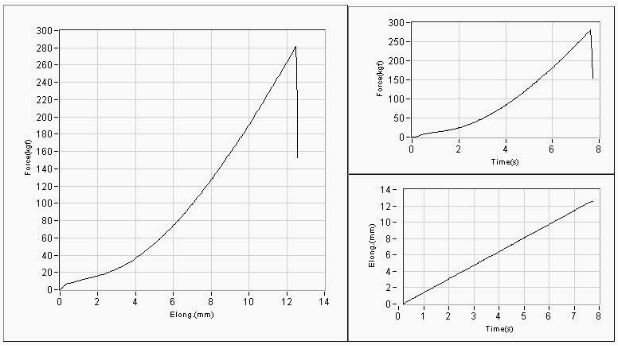

Fig 2. Characteristics of composite A

The composition of the specimens made with various volume fractions was tested for their mechanical properties through tensile strength. The tensile strain of the tensile stress for different combinations of composite specimens is shown in Fig. 5. The results showed that composite A had a strength of 281.19 kgf and a modulus of 3.47 MPa, composite B had a strength of 271.96 kgf and a modulus of 4.11 MPa. It can be seen in Figure 5, the 50% jute and 50% coconut hybrid samples have excellent tensile qualities and can withstand the strength of up to 20.8 MPa with a time of almost 7 seconds, to be exact, 6.844 seconds as shown in

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Figure 6. The tensile strength of fibers is affected by many factors, such as fiber properties, fiber size, biodegradability, chemical properties, matrix type,

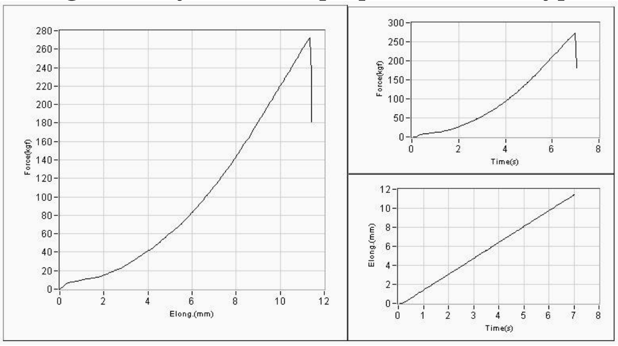

Fig 3. Characteristics of composite B

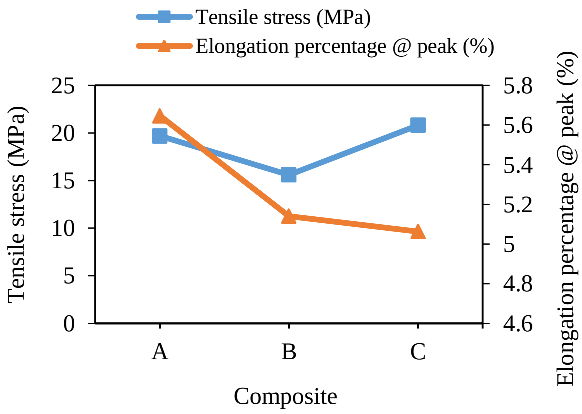

Fig 5. Comparison of tensile strength and % elongation of various composite materials

number of epoxy and fiber layers, and fiber orientation in the matrix [1,2]. It is proven that the combination of two types of filler produces a material with high tensile strength. This is because the coco fiber is compatible with glass fiber and resin to produce a hybrid composite and it was found that the length of the coir fiber and the glass fiber layer affect the mechanical properties of the composite [3-7]. In addition, jute fiber itself has excellent compatibility with various resins [14-17]. Jute fibers were tested in different directions of polyester and found that the transverse direction provided better abrasion resistance and improved adhesion between fiber and matrix [12]. It is also known that the surface area of jute fiber in the composite per unit area is the same as that of coconut fiber [13], so the resulting stress transfer is the same, indicating that composite A produces good tensile properties compared to other composites.

Figure 7 shows the maximum elongation percentage of 5.67% for Composite A and 5.06% minimum elongation percentage for Composite C

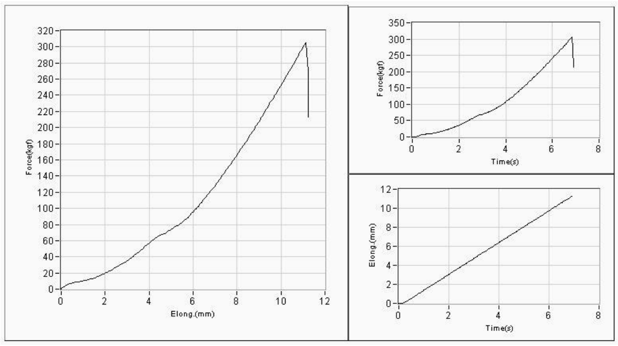

Fig 4. Characteristics of composite C

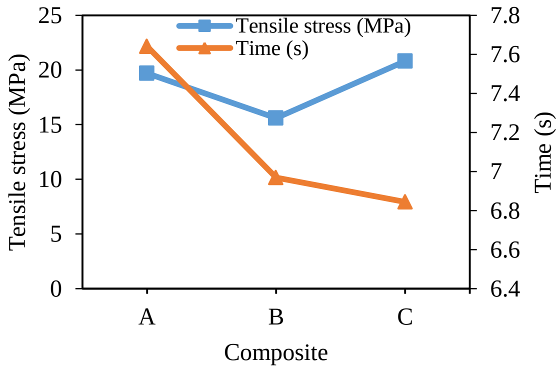

Fig 6. Graph of the tensile stress-time curve for each composite

(50/50% by weight, jute/coconut). The percentage of elongation in composite B is between compositesA and C, which is 5.14%. The difference in each percentage of elongation in the composite is not so large. The time required for the specimen to fracture is increasing as the percentage of elongation increases. Composite A has the highest elongation because the jute fiber content as a leather material has a higher ultimate tensile strength so it can with-

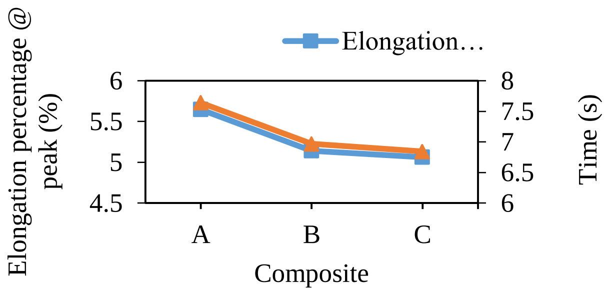

Fig 7. Graph of the elongation percentage-time curve for each composite

Table 2. Tensile strength test results

Composite	Force @ peak (kgf)	Tensile stress @ peak (MPa)	Elong @ peak (mm)	Elongation percentage @ peak (%)	Modulus (MPa)
A	281.19	19.70	12.48	5.67	3.47
B	271.96	15.60	11.36	5.14	3.03
C	305.54	20.81	11.14	5.06	4.11

stand the load. Table 2 provides tensile test data for all composites obtained in this study.

CONCLUSION

Research has been carried out with coir and jute fibers were used as polymer composite filler. Following the experimental analysis carried out in this study, a better understanding of the properties of natural fibers related to tensile strength has been obtained. The maximum tensile strength obtained for the composite made with 50% jute and 50% coconut fiber was 20.8 MPa. The tensile strength curve shows that the composite with the highest tensile strength takes the shortest time compared to other composites, make only 6.8 s. With this, it can be concluded that the composite sample with a blend of jute and coconut fibers is more durable than the coconut fiber sample and the jute fiber sample.

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