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Effect of Areca Nut Fiber and Pineapple Leaf Fibers and Polyester Composition on Mechanical Properties of Composite

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ABSTRACT

Areca nut fiber and pineapple leaf fiber are natural fibers that are interesting to research as composite reinforcing fibers because they are abundantly available. This research uses polyester resin metrics to make composite boards from areca nut and pineapple leaf fiber. This research varied different mixtures starting from areca nut fiber, pineapple leaf fiber, and polyester resin, namely 20%: 30%: 50%, 25%: 25%: 50%, and 30%: 20%: 50% using the hand lay-up method. The highest bending strength results were found in a mixture of 20% betel nut fiber, 30% pineapple leaf fiber, 50% polyester resin, 52.60 MPa, and an impact value of 0.379 Joules/mm^2. This is because the influence of the mixture of fiber and matrix causes the elasticity modulus value to increase, and because of the influence of fiber density, where the smaller the density value, the greater the mechanical strength, both bending strength and impact value. This phenomenon can also be seen from macro-observations of composite boards experiencing fiber pull-out in more significant quantities than other composition variations. When the fiber can still accept the given load, but the matrix can no longer break, the fiber can still withstand it.

Keywords: *Areca Nut Fiber, CompositePineapple Leaf Fiber, Polyester*

INTRODUCTION

Areca nut fiber is attractive to research as a composite reinforcing fiber due to several advantages. One of the advantages of areca fiber compared to other natural fibers is the presence of trichomes on the fiber's surface. Trichomes are expected to influence the surface roughness of the fiber to increase the bond between the fiber and the matrix. Another advantage is the mechanical properties of areca nut fiber (Irwan Ade et al. 2001).

Betel nut processing in other fields must also be pursued. In this case, it uses betel nut fiber into a new material through technological breakthroughs and innovations, namely composite material engineering. Composite is a composite material engineering consisting of two materials that have better properties and become better (Rachman et al., 2001).

Pineapple leaf fiber is a type of fiber that comes from plants (vegetable fiber) and is obtained from the leaves of the pineapple plant. Pineapple leaf fiber as a composite material is one alternative in making scientific composites, where pineapple leaf fibers have good quality and a smooth surface. Pineapple leaf fiber is also one of the natural fibers currently available in abundance. However, it is no longer used and is thrown away as waste, even though pineapple leaf fiber can still be used as an alternative natural fiber for composite materials (Fahmi and Hermansyah, 2011).

Fiber is the main ingredient in making fiber composites. The fibers used can be natural or artificial (synthesis). Natural fibers are more profitable to develop than synthetic fibers because they are easy to find, have economic value, and are biodegradable. Synthetic fibers in manufacturing are not environmentally friendly, and the waste is difficult to decompose naturally.

The physical properties that depend on the fiber source used to increase the strength of the composite require modification of the matrix or reinforcement. The betel nut fiber used in this research is obtained from areca nuts that are old and no longer used (Hafis et al., 2018).

Picking pineapple leaves is generally done when the plant is between 1 and 1.5 years old. Fibers from young pineapple leaves are typically not long and less intense. Meanwhile, the fiber produced from pineapple plants that are too old has a long and robust fiber texture (Wiranto and Ahmad 2021).

This research will be carried out by making composites of various mixtures in different percentages and with polyester resin to obtain composites of areca nut fiber and pineapple leaf fiber with percentages and fibers that have mechanical properties measured by bending and impact tests.

RESEARCH METHODOLOGY

The research method was carried out experimentally. The research stages were as follows:

1. Prepare tools and composite board materials: pineapple fiber, betel nut fiber, and polyester resin.
2. Provide mixed variations, namely areca nut fiber and pineapple leaf fiber using polyester resin, carried out in a ratio of 20%: 30%: 50%, 25%: 25%: 50%, 30%: 20%: 50%.

3. Making composite boards using glass molds.
4. Composite board specimens are ready to be tested for bending strength, impact, and microstructure.
5. Provide analysis and discussion
6. Then, conclude and provide suggestions from the research results.

2.1 Bending Testing

The composite formed is then tested using the bending test method using the ASTM D790 standard. The steps for bending testing of composite specimens are carried out as follows:

1. Prepare the specimen that has been formed
2. Turn on the bending machine and make sure the machine is guaranteed safety.
3. Lower the bending machine chuck so that the material can enter the chuck on the machine.
4. Place the material into the bending machine chuck, then measure the right and left sides of the chuck according to the specified provisions.
5. Then, slowly lower the chuck again until the tip touches the material so that the material does not come loose during the testing process.
6. Install the dial indicator and set the needle on the zero line.
7. Use the specified load specifications.
8. Start turning the handle on the machine until the needle and dial move, then record the bending test results.
9. After the data from the bending test is obtained, repeat it on the next specimen until complete.
10. The data and calculations are then processed and displayed in tables and graphs.

2.2 Impact Testing

The steps in impact testing are as follows:

1. Ensure the needle is in zero position when the sledgehammer hangs freely.
2. Place the test specimen on the support, and make sure the sledgehammer hits the center of the notch.
3. Raise the sledgehammer slowly until the angle indicator shows the initial angle; in this case, the sledgehammer is locked automatically.
4. Press the key release button, and the sledgehammer will swing down and break the test object.
5. Then repeat the test on other specimens until complete.
6. After testing all test specimens, make observations and write data.

RESULT AND DISCUSSION

In this research, a variation of the mixture of 20% areca nut fiber, 30% pineapple leaf fiber, 50% polyester resin, 25% areca nut fiber: 25% pineapple leaf fiber, 50% polyester resin, and 30% areca nut fiber: 20% pineapple leaf fiber %: 50% polyester resin. Then, the printing process is carried out using the hand lay-up method, which is pressed using a 5 kg load. After that, bending strength testing was carried out according to the ASTM D 790 standard, impact testing according to the ASTM D 6110 standard and microstructure observations. The composite board printing results are shown in Figure 1 below.

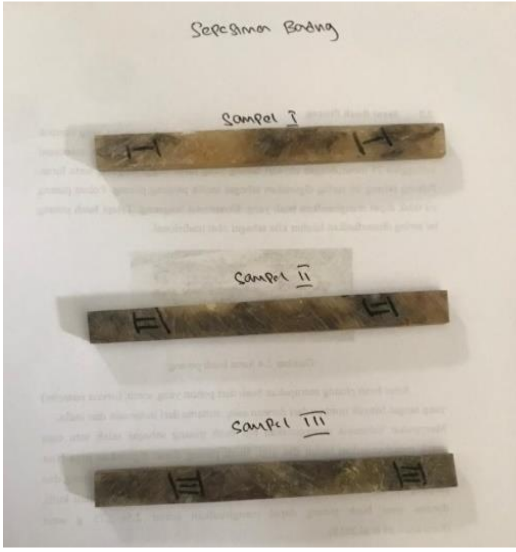

Figure 1. Composite Specimen

3.1 *Analisa dan Data Uji Bending*

Bending strength testing uses a bend test using the ASTM D790 testing standard, carried out at the Kampar Polytechnic Quality Control Laboratory after testing each composite fiber specimen. The composite specimen has fractures or curves because its material composition consists of alkalized areca nut and pineapple leaf fiber.

The data will be displayed in Table 1 and Figure 2.

Table 1. Bending strength test results data

Specimen	*Area* (mm^2)	*Max Force* (N)	*Bending Strengh* (MPa)	Rata-rata *Bending Strengh* (MPa)
Sampel 1	60.685	130.2	42.50	
	57.551	190.3	65.51	52.60
	60.594	152.3	49.80	
Sampel 2	49.280	91.4	44.24	
	53.628	129.4	57.62	51.01
	49.397	105.9	51.18	
Sampel 3	56.628	187.3	71.75	
	57.133	105.9	40.21	50.29
	50.669	90.8	38.91	

Table 1 then inserts it into figure 2 as follows.

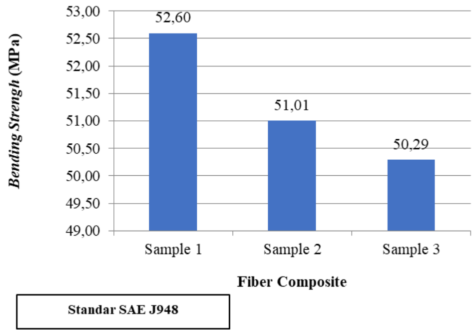

Figure 2. Bending strength test results

After carrying out the bending test, the bending strength results obtained in the graph above show that the bending test used three variations of specimens, each of which had a different composition. Test sample 1 used 20% betel nut fiber and 30% pineapple leaf fiber and resin. 50% polyester with bending strength testing has a value of 52.60 MPa, sample 2 using 25% areca nut fiber and 25% pineapple leaf fiber and 50% polyester resin has a bending strength value of 51.01 MPa, and sample 3 using areca nut fiber 30% and 20% pineapple leaf fiber and 50%

polyester resin have a bending strength of 50.29 Mpa.

Based on Figure 1, the diagram shows that as the areca nut fiber and pineapple leaf fiber increase, the bending strength can decrease, as seen from samples 1, 2, and 3. The highest bending strength value is found in sample 1, namely 20% areca nut fiber and 20% areca fiber. 30% pineapple leaves and 50% polyester resin have a tremendous value, namely 52.60 MPa. Meanwhile, sample 3 had the lowest bending strength value, with a bending value of 50.29 MPa, which was 30% betel nut fiber, 20% pineapple leaf fiber, and 50% polyester resin. This is because the value of the bending elastic modulus is influenced by the elastic strain, which is caused by the mechanism that occurred in sample 1. The more areca nut fiber composition, the higher the bending strength, with a value of 52.60 MPa.

3.2 Analysis and Impact Test Data

Impact testing was carried out using Wolfrund brand impact testing equipment, using the ASTM D 6110 testing standard, which was tested at the Islamic University of Riau Mechanical Engineering Laboratory. After testing each composite fiber specimen, there are fractures or indentations because the material composition consists of alkalized areca nut fiber and pineapple leaf fiber. The data will be displayed in a table and graph form.

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Table 2. Data from impact testing results

Specimen	*Area* (mm²)	*β°*	Energy (Joule)	Impact (Joule/mm²)
Sample 1	80°	130°	0,449	0,379
	80°	135°	0,318	
	80°	133°	0,370	
Sample 2	80°	134°	0,344	0,370
	80°	130°	0,449	
	80°	135°	0,318	
Sample 3	80°	133°	0,370	0,335
	80°	135°	0,318	
	80°	135°	0,318	

From Table 2, the highest impact value in specimen 1, made from 20% betel nut fiber, 30% pineapple leaf fiber, and 50% polyester resin, is 0.379 Joules/mm2. Then, it is shown in Figure 3.2, as follows.

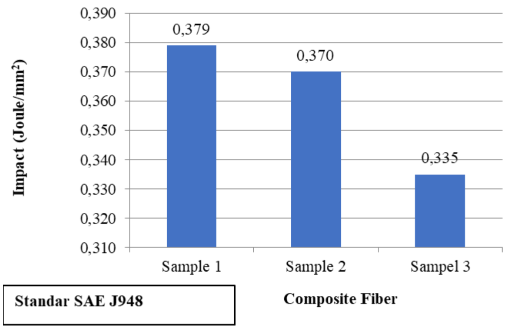

Figure 3. Impact test results

After carrying out impact testing, the results shown in Figure 3 show the impact price for sample 1 with 20% betel nut fiber composite: 30% pineapple leaf fiber with 50% polyester resin. The impact price results were 0.379 joules/mm2. There was a decrease in the sample. 2 with a composite of 25% betel nut fiber, 25%

pineapple leaf fiber, and 50% polyester resin compacted. The impact price was 0.370 joule/mm^2. In sample 3, the graph decreased with a 30% betel nut fiber composite and 20% pineapple fiber composite. Also, 50% polyester resin has an impact price of 0.335 joule/mm^2. This is because there is the influence of a mixture of betel nut fiber as well as pineapple leaf fiber and polyester, where the variation in the mix is a factor that influences the impact price value of the composite board.

3.3 Analysis of Macro Observation Results

Macro observations were carried out using the Android Camera. After testing each composite fiber specimen, fractures or curves can be seen because the material composition consists of alkalized areca nut fiber and pineapple leaf fiber. This data will be displayed in the following image. Macro observation results in sample 1 with 20% betel nut fiber, 30% pineapple leaf fiber, and 50% polyester resin.

Figure 4. Macro Observation Results of Specimen 1

The microstructural observations from Figure 4 show that sample 1 of 20% areca nut fiber, 30% pineapple leaf fiber, and 50% polyester resin experienced fiber pullout, possibly due to imperfect loading. When the fiber can still accept the given load, but the matrix can no longer take it, the matrix breaks, but the fiber can still withstand it. The highest mechanical strength value in the composite of 20% areca nut fiber and 30% pineapple leaf fiber can also be seen in how there is more pineapple leaf fiber than areca nut fiber. Results of macro-observations on sample 2 with a composition of 25% betel nut fiber, 25% pineapple leaf fiber, and 50% polyester resin

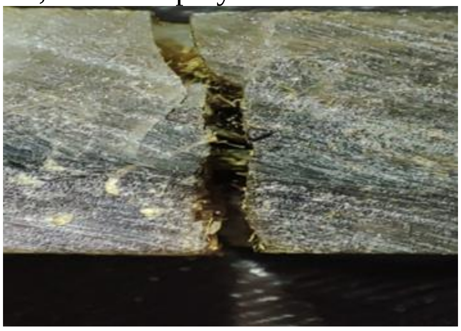

Figure 5. Macro Observation Results of Specimen 2

The results of macro-observations from Figure 5 show that sample 2 contains 25% betel nut fiber, 25% pineapple leaf fiber, and 50% polyester resin. Based on the macro composite fracture, the areca nut fiber is visible, and the pineapple leaf fiber is minimal. Because it is influenced by the composite amount of 25% areca nut fiber and 25% pineapple leaf fiber, the fiber can fill the area, and there is a physical interaction between areca nut fiber and pineapple leaf fiber. Results of macro-observations on sample 3 with a composition of 30% betel nut fiber, 20% pineapple leaf fiber, and 50% polyester resin.

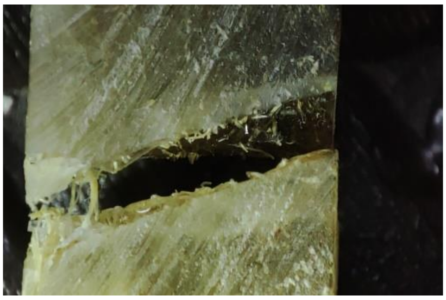

Figure 6. Macro Observation Results of Specimen 3

The results of macro-observations from Figure 6 show that in specimen or sample 3, fewer betel nut fibers are visible at the fracture. This is because the pineapple leaf fibers dominate the volume of this specimen. It can also be seen that there are voids (air holes) in the composite.

CONCLUSION

In the bending test, we see the highest bending strength results were in sample 1, with 20% areca nut fiber, 30% pineapple leaf fiber, and 50% polyester resin, 52.60 Mpa. This is because the elastic strain influences the value of the bending elastic modulus, following the mechanism that occurred in sample 1. The more areca nut fiber composition, the higher the bending strength.

The highest impact price in sample 1 was 0.379 joule/mm^2. The larger the pineapple fiber mixture and the smaller the areca nut fiber mixture, the higher the impact price. This is because there is an influence on the density of the fiber, where the smaller the density value, the higher the impact price, and conversely, the greater the density value of the fiber, the lower the impact price.

3. Sample 1 shows fewer betel nut fibers at the fracture. This is because the pineapple leaf fibers dominate the volume of this specimen. The composite also has voids (air holes).
4. Sample 2 shows tiny betel nut and pineapple leaf fiber. Because the composite amount of 25% areca nut fiber and 25% pineapple leaf fiber influences it, the fiber can fill the area, and there is a physical interaction between areca nut fiber and pineapple leaf fiber.
5. Sample 1 of 20% betel nut fiber, 30% pineapple leaf fiber, and 50% polyester resin experienced fiber pullout, which may have occurred due to imperfect loading.

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