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The Effect of Gebang Midrib Fiber (Corypha Utan Lamarck) Length Variations for the Strength of the Composite Impact

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***Abstract*—The utilization of natural fiber as a composite material filler is currently developing, along with the increasing use of these materials which is increasingly widespread ranging from simple ones such as household devices and appliances to the industrial sector. This composite research reinforced *Gebang Midrib Fiber (Corypha Utan Lamarck)* aims to determine the effect of composite impact strength with fiber length variations of 10 mm, 20 mm, 30 mm, 40 mm and 50 mm using a 30% fiber volume fraction and 70% polyester matrix. Here, the method used was an experimental one, by stamping Hand Lay Up material, then doing laboratory investigation. Its results showed that the highest Impact Energy is owned by composite with a fiber length of 50 mm which is 3.933 Joules and the highest Impact Strength 0.0298 J / mm square. And then, the lowest Impact Energy is owned by composite with a fiber length of 10 mm which is 2.1667 Joules, with the lowest impact strength 0.0164 J / mm square.**

Keywords—gebang midrib fiber, fiber length, impact strength

I. INTRODUCTION

Buri palm tree or gebang tree (*Corypha Utan Lamarck*) in East Nusa Tenggara is a type of tree known as the tree of life for the society. Almost all parts of this tree are beneficial to human life, including as food, buildings, household furniture and artistic and cultural goods. Various benefits can be obtained from various parts of this tree, such as the trunk to make a house pole, and the midribs are used to make a fence, a seat and livestock stables.

Based on the reported data, the area of natural grazing land on Timor Island is 24,382.04 ha and it is estimated that around 5-10% of it is covered with gebang trees. Thus, it can be said that the population of those trees is quite developed in East Timor. However, it can be said that gebang is remain one of Indonesia's flora, especially in the East area of East Nusa Tenggara that has not been used optimally up to now. So far, the management of gebang tree's parts such as its midrib, has only been used as organic waste or as a kerosene substitute fuel for cooking. It has only been used also as a seat cover and a simple tool for carrying water. This is because its midribs are flexible and not easily broken.

Looking at the use of gebang trees and the mechanical properties of its midribs, it is very good if the fibers in the midribs are used as reinforcement for composite materials. The reason for choosing gebang midrib fiber as a composite raw material is that it has flexible properties, it is also easily obtained in large quantities and prepares opportunities for wood replacement raw materials that are increasingly reduced due to utilization in all sectors.

Composite is a combination of two or more different materials in which one material functions as a reinforcement and the other one functions as a binder to maintain the unity of its elements [1]. Likewise, Matthews and Bawlings [2] composite materials are materials that are formed from a combination of two or more forming materials through a mixture that is not homogeneous, where the mechanical properties of each forming material are different.

Research on composite has also been conducted by several researchers, including analysis of the impact strength on pineapple leaf fiber composites as the basic material for making SNI helmets. Then, by increasing the volume of fiber in the composites, it can increase the absorption energy and impact strength of the composite [3].

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The advantages of composite materials compared to metals are that they have good mechanical properties, they are not easy to corrode, raw materials are easily obtained at lower prices, and they have lower density compared to mineral fibers. Natural fiber composites have other advantages compared to synthetic fibers, natural fiber composites are more environmentally friendly because they are able to degrade naturally and the price is cheaper than synthetic ones.

Composite material has several factors that greatly affect its mechanical strength, for example fiber volume fraction in fiber length variation. The greater the volume fraction of the fiber in the matrix, its strength increases. Likewise, if the length of the fibers in the matrix is greater, then the mechanical strength will also increase. This is because the greater the length of the fiber in the matrix, the surface of the fiber that bears the burden given by the matrix becomes large, otherwise, if the shorter the fiber in the matrix, the surface of the fiber that bears the burden given by the matrix becomes smaller, so that its strength also getting lower [4].

This research aims to determine the effect of the length variation of the midrib fibers to the strength of the composite impact. Hopefully, the researcher can find out how big the effect of the length variation of the midrib fiber to the maximum value of the impact strength on the composite.

II. Research Methodology

The method used to conduct this research is an experimental one that aims to investigate the effect of the gebang midrib fiber (Corypha Utan Lamarck) length variation to the impact strength of a polyester matrix composite.

This research utilizes Gebang midrib fiber (Corypha Utan Lamarck) as a composite reinforcement material and polyester as a matrix. Previously, the fibers were treated with immersion in Alkali (NaOH) as much as 5% per 1 liter of distilled water to improve the adhesive properties so as to increase the impact strength of the fiber composites they formed.

The fiber used is an average diameter of 0.7 mm, with the method of hand layup printing and random fiber arrangement. The mechanical strength of the epoxy composite strengthens the gebang midrib (Corypha Utan Lamarck). An impact test is also conducted to determine the maximum mechanical strength.

Then, the type of variables in this research are:

1. Independent variable is a variable that has been determined before conducting research.
2. Fiber volume fraction: 30%
3. Alkali (NaOH) treatment of 5% palm fiber per 1 liter of Aquades with an upset time of 120 minutes.
4. Dependent Variables are Impact Strength.
5. Controlled Variables are:
    - *Methyl ethyl ketone peroxide* (MEKP) / hardener 1 %
    - Resin: Polyester
    - Average fiber diameter (d) = 0,7 mm
    - Fiber length L = 10 mm, 20 mm dan 30 mm, 40 mm, 50 mm for Impact test specimens.
    - Dry the composite at a room temperature until it dries.
    - Cure the fiber at a room temperature until it dries.

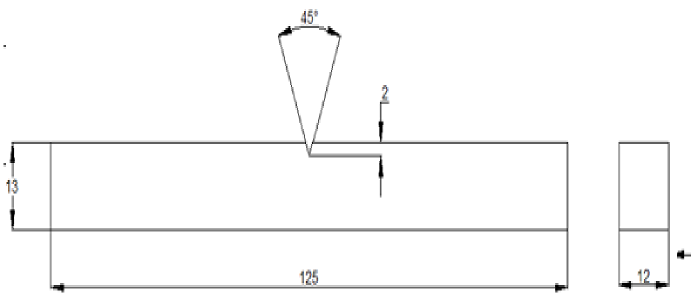

Fig. 1. Impact Test Specimens ASTM D6110.

Impact strength is known by using a charpy impact testing machine with ASTM D6110 [5] specimen standard, as shown in Figure 1. To measure the impact test data used the formulas as follows [6]:

E_{serap} = initial energy – remaining energy

$= m.g.h - m.g.h'$

$= m.g.(R\text{-}R\cos\alpha) - m.g.(R\text{-}R\cos\beta)$

$E_{serap} = m.g.R.\ (\cos\beta - \cos\alpha)$

With:

Esrp = Energy Absorption (J)

m = Pendulum Weight (kg)

g = Gravitational Acceleration (m/s2)

R = Sleeve Length (m)

α = The angle of the pendulum before swinging (°)

β = Swing angle of the pendulum after breaking the specimen (°)

The impact price can be calculated by:

$$HI = \frac{E_{srp}}{A_o}$$

With:

HI = Impact's price (J/mm^2)

E_{srp} = Energy Absorption (J)

A_0 = Cross-sectional area (mm^2)

III. Results and Discussion

A. Results

TABLE I. DATA ON COMPOSITE IMPACT STRENGTH TEST RESULTS

Fiber Length (mm)	Sample	Impact Energy (joule)	Impact Strength (J/mm²)
10	1	2	
	2	2.1	0.0164
	3	2.4	
Average		2.1667	
20	1	2.9	
	2	3	0.0225
	3	3	
Average		2.9667	
30	1	3.2	
	2	3.3	0.0245
	3	3.2	
Average		3.2333	
40	1	3.5	
	2	3.3	0.0260
	3	3.5	
Average		3.4333	
50	1	3.8	
	2	4	0.0298
	3	4	
Average		3.933	

B. Discussion of Impact Strength

Based on table 1, then we can see the impact energy and composite impact strength data from the midrib fibers which are shown by Figure 2 and 3 below.

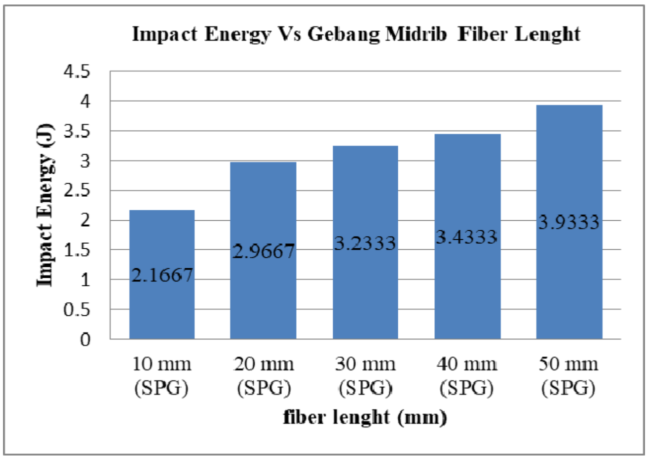

Fig. 2. Graph of the correlation between Impact Energy and Gebang Midrib Fiber.

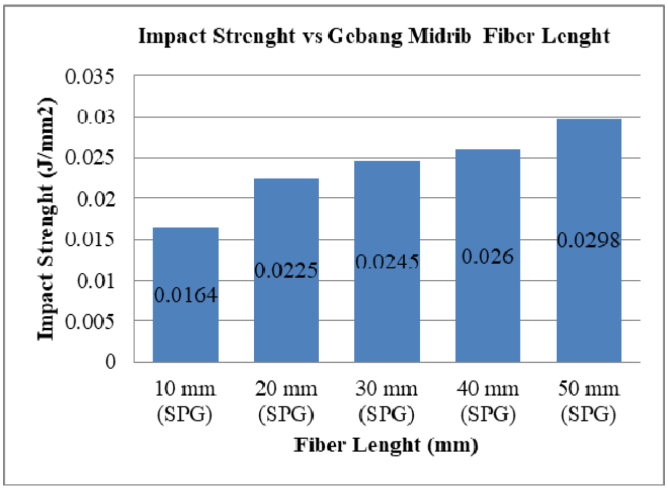

Fig. 3. Graph of the correlation between Impact strenght and Gebang Midrib Fiber Length.

From Figure 2 and 3, it is known that the impact energy and impact strength increase with increasing fiber length in the composite material. The maximum impact energy is on composites with a fiber length of 50 mm at 3.9333 Joules, with the highest impact strength of 0.0298 J / mm^2 while the lowest impact energy is on composites with a fiber length of 10 mm which is 2.1667 Joules with the lowest impact strength 0, 0164 J / mm^2.

As for several supporting factors that increase the impact energy and impact strength, namely the adhesion between the fiber and the good matrix, resulting in a strong bond the length of the fiber that is on the composite, so as to be able to withstand the amount of energy passed from the matrix when getting a sudden load and the strength of the composite evenly in each place so that cracks occur, even to the point of breaking, only at the point where voltage concentrations and fiber orientation are present in all parts of the composite, there by supporting energy absorption.

C. Macro Photograph of Composite Fault Surface

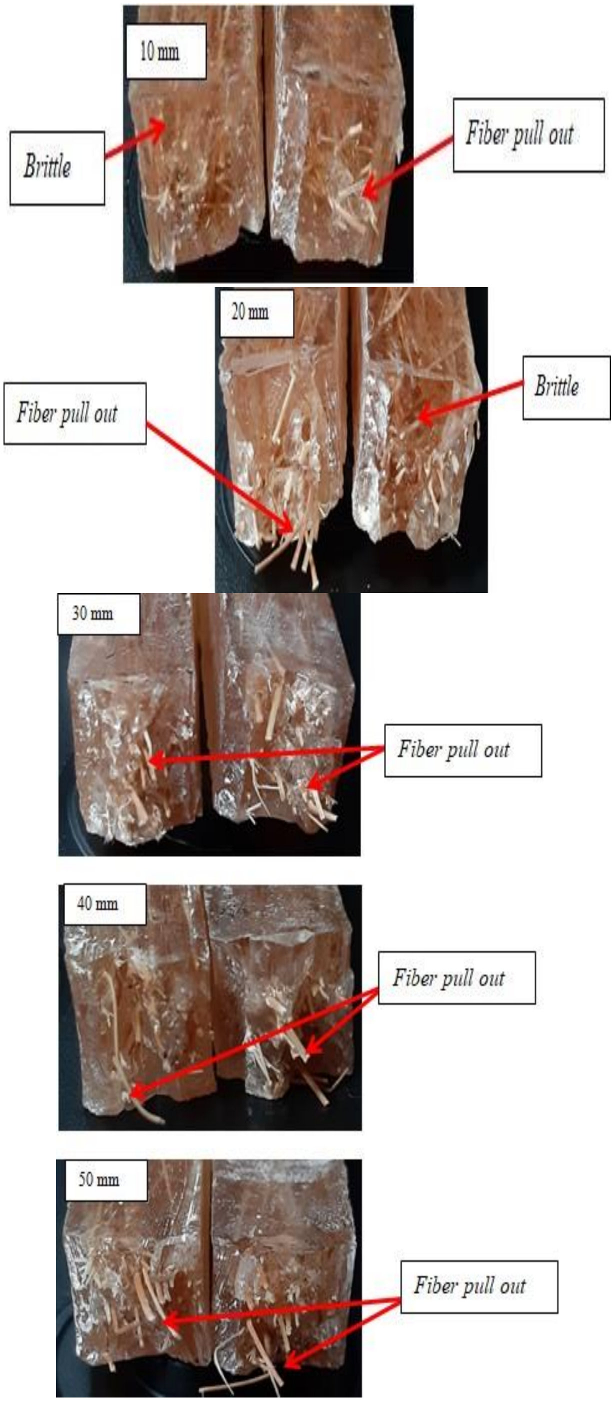

Fig. 4. Fracture surface on composite materials with fiber lengths of 10 mm, 20 mm, 30 mm, 40 mm, 50 mm.

Figure 4 shows the fracture surfaces of all composite materials. The fracture pattern that occurs is brittle, which is seen on the surface of the fracture that looks shiny like light. Then the bond between the fibers in all the composite materials is quite good, so that the fiber pull out in the composite is relatively small.

IV. Conclusion

- There is an Enhancement in the length of gebang midrib fibers in the composite material, so that the impact strength is higher. This is because the fiber is able to hold the energy that is passed from the matrix when getting a sudden loading. The highest impact strength is 0.0298 J / mm^2 at 50 mm^2 fiber length and the lowest one is at 10 mmfiber length at 0.0164 J / mm^2
- The fracture pattern that occurs in the composite material is brittle with a fiber pull out mechanism.

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