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Research Paper

Fiber Laminate Adding Effect to Tensile Strength, Hardness, and Fault Surface of Teki Grass (Cyperus Rotundus) Composite

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Abstract

The aim of this research is to know the fiber laminate adding effect to tensile strength, SEM photo, and hardness of teki grass (cyperus rotundus) composite specimen. Tensile and hardness test specimens were prepared by hand lay-up method with variations of 1, 2, and 3 fiber layers. Test results showed the highest tensile strength occurred in 1 layer fiber of 21.83 MPa and decreased in 2 layers of fiber and 3 layers of fiber of 17.95 MPa and 16.17 MPa. This is caused by random fibers that spread in all directions so that many fibers are not aligned with the tensile force. Addition of the fiber layer results in reduced resin volume so that the bond between fiber and matrix also decreases, which in turn will make the fiber cannot withstand tensile well. Analysis of SEM photographs also proves that the reduced volume of resin causes the bond between fiber and matrix to decrease resulting in cavities in 2 layer and 3 layers of composite. The results of the hardness test show that the addition of fiber layer decreases the hardness value. This is due to the soft grass fiber that is softer than the resin polyester, so that the added layer of fiber will reduce the hardness value.

Keywords: *Fiber laminate, Tensile Strength, Hardness, Fault surface, Teki Srass Composite*

1. Introduction

According to Diharjo[1] the characteristics of composite materials are very dependent on the fiber, because most of the load will be retained by the fiber. Fiber will also provide the properties of stiffness, strength, hardness, and other properties in composites.
The fiber strength lies in its very small size, the fiber that holds most of the forces acting on the composite, while the matrix protects and binds the fibers in order to work properly. One of the advantages of composite materials is the ability of the material to be directed so that its power can be adjusted only in the particular direction we want. In addition to strong, rigid and lightweight composites also have high corrosion resistance as well as having high resistance to dynamic loads [2].
Research on the use of natural materials as composite filler has been done. The use of corn husk as filler and polylactid acid with the use of corn skin composition 10%, 20%, 30%, 40% and with the use of variation of 50 mesh, 100 mesh and 300 mesh shows the tendency of decrease of tensile strength, strong curve, and impact strength, but increase the modulus of composite elasticity. Smaller particle size results in a stronger interfacial bond between the matrix and a stronger particulate dispersion resulting in improved mechanical properties [3].
Other studies use natural materials as filler material in the manufacture of polymer bematolic composites such as with the use of banana peel [4], wood powder[5]–[8], leaf Pandan Alas [9], pineapple leaves [10], bamboo fiber [11], and rice husk [12] showed significant influence on composite generated.

The fiber to be used in this study is the teki grass fiber (cyperus rotundus). Teki grass is a plant that is very adaptive to the environment and is a very difficult to control weeds. It forms a bulb that can reach a depth of one meter. Teki spread all over the world, grow well when there is enough water, tolerance to puddles, and can withstand drought conditions.

2. Methodology

The tensile test specimen was prepared by hand lay up method with ASTM D 638-02a type IV. The matrix used in this research is Polyester Resin BQTN 157 EX, while fiber is taken from the teki grass (cyperus rotundus). The method of making composite specimens can be seen as below:

1. Teki grass is pulled from the ground and then washed with water, then soaked in 5% NaOH solution for 1 hour to remove the sap and dirt that can reduce the bond between the matrix and fiber (figure 1).

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Figure 1. Grass soaked in 5% NaOH

2. After that the grass is dried by drying in the hot sun for 5 days to remove the water content.
3. After the grass is dried, then weighed and cut to the desired size to be used in the manufacture of the specimen.
4. Molds made of metal smeared with wax agar after hardening the specimenwill be easily removed from the mold. While the bottom of the mold is coated with a glass that is also smeared wax.



Figure 2: Molds and glass that have been coated Ajax

5. Polyester Resin BQTN 157 EX that has been mixed with hardener with a ratio of each 100 : 1 stirred until evenly and poured into the mold.



Figure 3: Polyester resin with hardener

6. Fiber grass is placed on the resin.
7. After that the resin polyester is poured over the fiber.



Figure 4: Resin poured over fiber

8. After the resin mixture and the fibers begin to coagulate then put the glass on the top of the mold and pressed with ballast to remove the void (air bubbles) are trapped at once to flatten the surface of the specimen.
9. Allow the specimen to harden for 12 hours, after which the mold is opened and the specimen has been formed (figure 5).

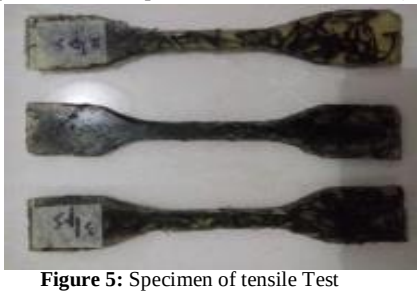


Figure 5: Specimen of tensile Test

10. The preparation of hardness test specimens is similar to the above tensile test, only different mold. Hardness test use micro vickers FM 800.



Figure 6: Micro Vickers FM 800

11. The tensile test of composite specimens with was performed with a servopulser machine in the laboratory of the USU Department of Mechanical Engineering, with a force of 2000 kgf and a speed of 0.01 mm / s.



Figure 7: Tensile Test Machine

3. Results and Discussion

Tensile strength of 1, 2, 3 layer fiber layer can be seen as follows:

Table 1: Tensile strength

Fiber layer	Specimen N	Tensile Strength (MPa)	Average Tensile Strength (MPa)
1	Specimen 1 Specimen 2 Specimen 3	19.5 22.1 23.9	21.83
2	Specimen 1 Specimen 2 Specimen 3	18.74 21.17 19.3	17.95
3	Specimen 1 Specimen 2 Specimen 3	16.4 17.3 14.8	16.17

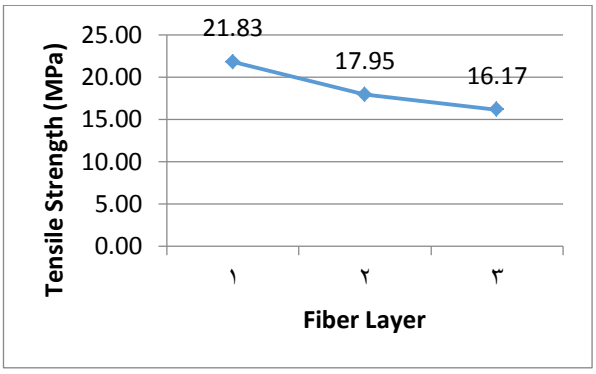


Figure 8: Tensile strength graphic

In this section, random fibers such as fiber weight variations are used, so the highest average tensile strength occurs in 1 fiber layer of 21.83 MPa and decreases in 2 fiber layer and 3 fiber layer by 17.95 MPa and 16.17 MPa. This is caused by random fibers that spread in all directions so that many fibers are not aligned with the tensile force. In addition, the addition of fiber layers results in reduced resin volume so that the bond between fiber and matrix also decreases, which in turn will make the fiber can not withstand tensile well. Analysis of fault surface by SEM photographs also proves that. Reduced volume of resin causes cavity in 2 layer and 3 layer composite, so the bond between fiber and matrix is reduced.

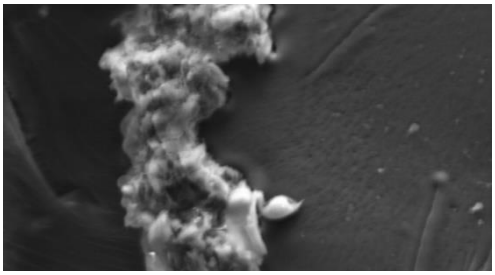


Figure 9: Fault surface of 1 layer specimen

The picture above is a photo of a composite fault surface with 1 fiber layer and a tensile strength of 21.83 MPa. From the SEM photograph it can be seen that the fiber is broken and there is no cavity between matrix and fiber. This photograph shows that the bonds between the matrix and the fibers occur well so that the composite tensile strength becomes the highest compared to the other 2 specimens.

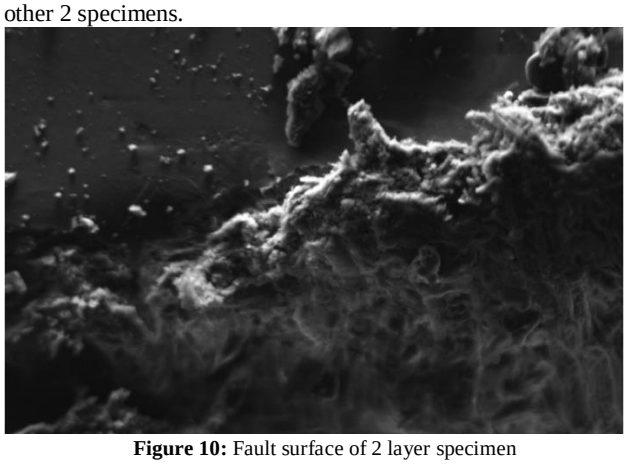


Figure 10: Fault surface of 2 layer specimen

The picture above is a photograph of a composite fault surface with 2 fiber layer and a tensile strength of 17.95 MPa. From the SEM photograph it can be seen that the fiber is broken, but there is still a cavity between the matrix and the fibers causing its tensile strength to be lower than the 1 layer fiber.

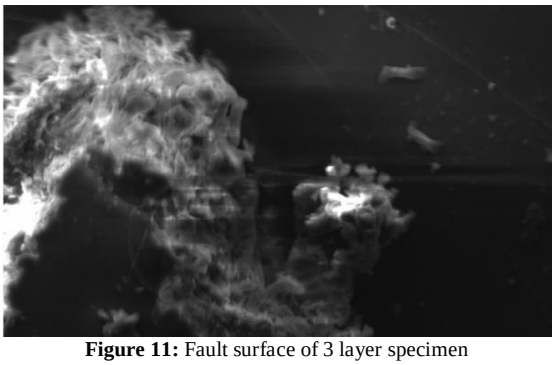


Figure 11: Fault surface of 3 layer specimen

Results of SEM photograph for 3 layers of fiber can be seen in the picture above. From the photo it appears that there is an open cavity, this cavity shows that there is no perfect bond between the matrix and the fiber. So although from the photograph seen that the fiber break, but the cavity still reduces the composite tensile strength to be the lowest of 16.17 MPa. The results of hardness testing can be seen below :

Table 2: Hardness

Fiber layer	Specimen N	Hardness	Average Hardness
1	Specimen 1 Specimen 2 Specimen 3	1.2 1.3 1.1	1.2
2	Specimen 1 Specimen 2 Specimen 3	1.0 0.9 1.1	1.0
3	Specimen 1 Specimen 2 Specimen 3	1.0 0.8 0.9	0.9

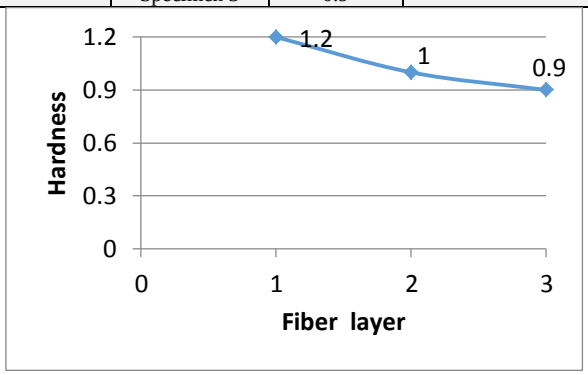


Figure 12: Hardness graphic

Hardness test results show the addition of fiber layer decreases hardness value. This is due to the soft grass fiber that is softer than the polyester resin, so that the added layer of fiber will reduce the hardness value.

4. Conclusion

a. The highest tensile strength occurs in 1 layer fiber of 21.83 MPa and decreases in 2 layers of fiber and 3 layers of fiber by 17.95 MPa and 16.17 MPa. This is caused by random fibers that spread in all directions so that many fibers are not aligned with the tensile force.
b. The addition of the fiber layer results in reduced resin volume so that the bond between fiber and matrix also decreases, which in turn makes the fiber unable to withstand tensile well.
c. Analysis of SEM photograph also proves the conclusion of number 2. Reduced resin volume causes bond between fiber and matrix is reduced so that there is cavity in composite 2 layer and 3 layer.
d. Hardness test results show the addition of fiber layer decreases hardness value. This is due to the soft grass fiber that is

softer than the polyester resin, so that the added layer of fiber will reduce the hardness value

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