Effect Of NaOH Treatment on Bending Strength Of The Polyester Composite Reinforce By Sugar Palm Fibers

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Abstract. The objective of this research is to investigate the effect of NaOH treatment on bending strength of lamina composite reinforced by sugar palm fiber. To know of mechanism fracture can be done with visual inspection of the fracture surface. The Materials used are random sugar palm fibers that have been in the treatment of NaOH, polyester resin and hardener. Sugar palm fibers after washed and dried then soaked NaOH with a long time soaking 0, 2, 4, 6 and 8 hours. The bending test specimens were produced according to ASTM D 790. All specimens were post cured at 62°C for 4 hours. The Bending test was carried out on a universal testing machine. The SEM analysis has conducted to provide the analysis on interface adhesion between the surfaces of fiber with the matrix. The result shows that polyester composite reinforced by sugar palm fiber has highest bending stress 176.77 N/mm² for 2 hours of a long time soaking NaOH, the highest flexural strain 0.27 mm for 2 hours of a long time soaking NaOH, elongation 24.05% for 2 hours of a long time soaking NaOH and the highest bending modulus 1.267 GPa for 2 hours of a long time soaking NaOH. Based on the results, it can be concluded that the polyester composite reinforced by sugar palm fiber has the optimum bending properties for a long time soaking 2 hours. The fracture surface shows that the polyester composite reinforced by sugar palm fiber pull out that indicate weakens the bond between fiber and matrix.

1. Introduction
The development of composite materials is increasingly widespread in various areas that effort innovation continuously. Composite materials have been applied in various areas such as sport, transportation in the land, water, and air so construction areas and the world of space because it had been many advantages application composite materials i.e ratio strength and specify density is high, cheap and simple production [2].

Composite with reinforced fiber more applied and development than composite with reinforced metal or other reinforced composite. This is due to the fiber has high tensile stress so it is suitable for reinforcing the material. Moreover, another factor that encourages for using natural fiber is abundant availability, light, corrosion resistant, water resistant, interesting performance and no machining
process. Because the characteristic composite is lightweight, then expenses load as a result of the construction can be eliminated.

Natural fiber is trying to shift synthetic fiber, as E-Glass, Kevlar-49, Carbon/Graphite, Silicone carbide, aluminum oxide, and boron. Although not fully shift, but the use of natural fiber replace synthetic fiber is a wise step in saving the environment from waste made and limited natural resources which are not renewable. However, the strength of natural fiber composites still lower than synthetic fiber composites, as E-glass fiber, S-glass as well as metal fiber such as aluminum. Treatment with an alkaline solution can improve the strength of the composite so that the strength of natural fiber composites able to approach synthetic fiber. The research with treatment soaked jute fiber in solution NaOH, it was able to in cease the strength of jute fiber up to 79% and toughness up to 46% [9].

The use of wood is continuously to raw materials for shipbuilding trigger illegal logging which resulted in the forest become disappear. Therefore, it is necessary to find an alternative solution substitute wood which is used raw material for making boats. One of the wise step is the use of polyester composite reinforcement with sugar palm fiber. In addition, the potential of sugar palm fibers that overflow needs to be optimized also keep environmental sustainability by not exploiting continuously the forest which can cause to environmental degradation. In order for the design of safe use, it is necessary to bending test adapted to real conditions where the real conditions, composite panels receive the load bending/press of waves.

2. Experimental
Sugar Palm fibers were washed with water then proceed drying in a closed room for 3 x 24 hours, as shown in Figure 1. Sugar Palm fibers that have been dried and then soaked in the alkaline solution NaOH 5% for 0, 2, 4, 6 and 8 hours, as shown in Figure 2. The materials used in this study is the sugar palm fibers that have been treated NaOH for 0, 2, 4, 6 and 8 hours, resin unsaturated polyester (UPRs) type 157 BQTN and hardener metil ethyl ketone peroxide (MEKPO).

The tools used in this study as mold, digital scales, Vernier calipers and a hydraulic jack. Free water content contained in the fibers removed by inserting it in the oven for 15 minutes. Manufacture of composite made with press mold. Manufacture of the composite is done by placing the fibers that have been soaked in NaOH for 0, 2, 4, 6 and 8 hours respectively then the surface of the fiber wet unsaturated polyester resin. Manufacture of composite made one process for each variable a long time soaking solution of NaOH (0, 2, 4, 6 and 8 hours).

Bending test specimen is prepared by cutting the polyester composite reinforced sugar palm fiber which has been processed using a grinder. Dimensions of specimen and test method designed according to ASTM D 790-02. Long span bending test is 60 mm. Bending test was conducted using TORSEE-universal testing machine. Photo fracture cross-section did with a macro photo and SEM (Scanning Electron Microscopy) to determine the mechanism and the type of fracture.
Figure 1  a. raw materials (sugar palm fiber)  b. Sugar palm fiber are washed with mineral

Figure 2  (a.) Sugar palm fiber immersion in a solution of NaOH; (b). pouring resin on the sugar palm fiber

Figure 3  (a). Specimens were ready to be tested; (b). Bending test process
3. Result

3.1. Bending Tests
The data obtained in the bending test then entry and processed into the equation 1, 2 and 3 than shown in table 1.

\[
\sigma_f = \frac{3PL}{2bd^2} \quad (1)
\]

\[
\varepsilon_f = \frac{6Dd}{L^2} \quad (2)
\]

\[
E_B = \frac{L^3m}{4bd^3} \quad (3)
\]

Table 1. Relationship the long time soaking NaOH with bending strength (bending stress, flexural strain, elongation and modulus of elasticity)

| A Long time soaking (hours) | Bending stress (N/mm$^2$) | Flexural strain (mm) | Modulus of elasticity(GPa) | Elongation (%) |
|-----------------------------|---------------------------|----------------------|---------------------------|----------------|
| 0                           | 95.225                    | 0.18                 | 0.461                     | 17.15          |
| 2                           | 176.771                   | 0.27                 | 1.267                     | 24.05          |
| 4                           | 157.402                   | 0.25                 | 0.790                     | 23.27          |
| 6                           | 152.727                   | 0.19                 | 0.680                     | 21.81          |
| 8                           | 152.531                   | 0.17                 | 0.532                     | 18.58          |

From table 1 above is then processed and presented in the form of the curve relationship between the long time soaking NaOH with bending stress, flexural strain, elongation and modulus of elasticity as shown in figures 4.

Figure 4 The curve relationship a long time soaking NaOH (a) with bending stress; (b) with flexural strain; (c) with elongation; (d) with modulus of elasticity
3.2. Photos of cross-sectional fracture

Figure 5 Fracture test samples NaOH 2 hours soaking time (a). Fracture surface appears on the front (b). Fracture surface appears on the top (c). Fracture surface with 60X magnification.

Figure 6 Fracture test samples NaOH 0 hours soaking time (a). Fracture surface appears on the front (b). Fracture surface appears on the top (c). Fracture surface with 60X magnification.

Figure 7 The result of the SEM photograph sugar palm fiber composite was soaked NaOH for (a) 2 hours. (b) 0 hours
4. Discussion
A long time soaking NaOH affects sugar palm fiber strength. This is evidenced by the longer time soaking NaOH, it also increases the bending stress. However, this condition only applies when NaOH long time soaking reaches 2 hours. If the longtime soaking NaOH followed by increasingly longer, then it will cause a decrease in fiber strength. This is evidenced by the length of time of immersion NaOH that the longer (more than 2 hours) then the trend-bending stress also decrease, as shown in figure 1.

Bending stress increases with the length of time immersion NaOH. It is strengthened from the long immersion time curve with flexural strain. As shown figure2 that the longer of immersion time then also increase the flexural strain. The flexural strain is defined as the composite ability to break up a composite failed so the higher flexural strain of a material’s ability to withstand the loads is also higher. At 2 hours soaking time NaOH, strength composite has the best performance in weight holding. Then the length of time immersion longer so sugar palm fiber properties decrease.

The ability to elongation of the composite material is also increasing with the length of time immersion NaOH. The most excellent elongation occurs in a long time soaking NaOH 2 hours, as shown in figure 3. At the time of immersion of NaOH with a longer time, it causes a decrease in sugar palm fiber properties. It happens on the properties of other sugar palm fiber composite (modulus of elasticity). Modulus of elasticity of composite polyester reinforced sugar palm fiber has the highest modulus of elasticity with long time soaking NaOH for 2 hours is equal to 1.267 GPa.

Fibers that have been soaked in a solution of NaOH 5% produce an effect on the properties and strength of the fiber. At the fracture test sample with fibers have been soaked in NaOH 2 hours presence fibers pull out from the matrix. It occurs when the bending load received test samples not fully passed on to the fiber due to the weak part (mechanical bonding fiber and matrix) no ability to hold bending load so that load should be forwarded to the fibers are not fully accepted by the fiber as a reinforce but a failure on the part between the fiber and the matrix. Fiber and matrix bond strength lower than the strength of the fiber itself, as shown in figure 4.

On test samples without soaking NaOH shows fiber strength much weaker. Dirt on the surface of the fiber suspected as the cause of the low strength of the fiber. Dirt on the surface of the fiber covers the bonding of the fiber and the matrix so that mechanical bonding between the fibers and the matrix becomes less strong, as shown in figure 5. Type of failure in the specimen without soaking NaOH is delamination fiber and matrix as a result weakens the bond between the fiber and the matrix.

In the test result SEM-ijuk fiber composite polyester soaked NaOH for 2 hours commonly found fiber pull out. This shows that the NaOH treatment provides effect strength fiber. Load received forwarded to the fiber composite through the matrix. If the load received over the fiber strength then it causes part failure is on the part of the fiber, as shown in figure 6. On the contrary, if the strength of the bond between the fiber matrix is greater than the strength of the fiber itself then the first failure is sugar palm fiber, as shown in figure 7.

5. Conclusion
Sugar palm fiber properties that are obtained in the treatment of NaOH for 2 hours with bending stress, flexural strain, elongation and modulus of elasticity respectively 176.771 N/mm², 0.27 mm, 24.05% and 1.267 GPa. Characteristics of fracture on sugar palm fiber in NaOH treatment for 2 hours is commonly found fiber pull out (withdraw of fiber from the matrix) whereas the fibers without soaking NaOH found any kind of failure of the laminate.

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