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Effect of volume fraction hybrid composite duck feathers (anas plathycus borneo) - rat purun fiber (eleocharis dulcis) with matrix polyester on tensile and bending strength

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Abstract. Alabio ducks (Anas Plathycus Borneo) developed in the Alabio area of Hulu Sungai Utara Regency, South Kalimantan, with a duck population in 2006 recorded at 3,487,002 heads. So far, alabio ducks have only been used for meat and eggs, even though the feather part of this one poultry can also be used as a composite raw material because of its relatively strong and elastic nature. To improve the quality of the composite, duck feathers are combined with rat purun fibers (eleocharis dulcis) to become Hybrid composites. Fraksi volume Hybrid composite Duck Feathers and Rat Purun Fiber are as follows 10% : 90 %, 20% : 80%, 30% : 70%, 40% : 60%, 50% : 50%, 60% : 40%, 70% : 30%, 80% : 20%, 90% : 10%. This study used experimental methods. From the results of the study, it is known that the value of tensile and tensile strength stress and bending strength decreased as the percentage of rat purun fibers decreased compared to the percentage of duck feathers.

Keywords: Alabio ducks, Purun rats, Hybrid composite, Tensile strength, Bending strength,

1. Introduction

Alabio ducks are flasma nutfah in the South Kalimantan region that developed in the Alabio area of Hulu Sungai Utara Regency of South Kalimantan, with the population of alabio ducks in South Kalimantan in 2006 recorded at 3,487,002 head. Alabio ducks are one of the local Indonesian duck families with a geographically original distribution in South Kalimantan Province. They have been determined through the Decree of the Minister of Agriculture Number 2921/Kpts/OT.140 /6/2011 dated June 17, 2011. Alabio ducks have distinctive characteristics that are not possessed by ducks from other nations, as seen in Figure 1. Therefore, they are a genetic resource for Indonesian livestock that needs to be maintained and preserved.

Figure 1. Male Alabio Ducks

So far, the focus of using alabio ducks has only been on the meat and eggs, while other parts, such as the fur are not used at all and are often only considered waste and burned. Even though the feather part of this one poultry can also be used. Duck feathers can turn out to be able to bring profits for duck breeders who are creative in utilizing duck feathers [1]. Alabio duck feathers can be used as composite raw materials with the Purun Tikus plant (Eleocharis Dulcis).

The mouse purun plant is an upright perennial herbaceous with an elongated stem, brownish to black. It has roots, stems, reducing leaves, and flowers. Erect stems are unbranched, grayish to shiny green in color, with a length of 50-200 cm with a thickness of 2-8 mm [2]. The leaves shrink to the basal part of the midrib, like a membrane, and the tip is asymmetrical, reddish-brown to mauve, as seen in Figure 2.

Figure 2. Rat Purun Plant

Traditionally, the rat purun plant is used for industrial raw materials for furniture (chairs and tables) and household crafts (mats and woven bags). However, with the development of science and technology, the rat purun plant can be used as a composite raw material by taking the fibers contained in the stems and leaves [3].

Rat purun fibers and duck feathers as reinforcing elements largely determine the mechanical properties of the composite because it passes on the load distributed by the matrix. Volume orientation is a factor affecting the mechanical properties of composites [4]. Rat purun fibers in the form of continued and duck feathers combined with polyester as a matrix are expected to produce maximum composite mechanical properties to support the concentration of alternative composites [5]. To find out the mechanical properties of composites, bending and tensile testing can be carried out.

Tensile testing is the most frequently carried out on an object. Usually, in a material is listed the value of strength or tensile grace and the hardness number tensile testing is carried out on a separate or universal tensile testing machine for the principle of testing is that on a test object of a certain size is given a regular and even tensile load. [6]

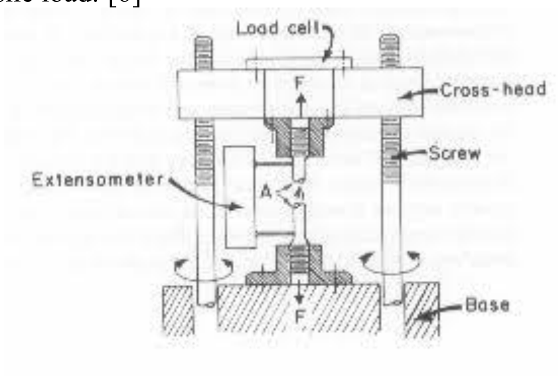

Figure 3. Tensile Testing Machine

The tensile strength can be calculated by the equation: [7]

$$\sigma = \frac{F}{A_0}\left(\frac{N}{mm^2}\right) \tag{1}$$

Where:
σ = Engineering stress (Voltage) (MPa),
F = The load exerted in the direction perpendicular to the specimen (N),
Ao = The initial cross-sectional area before the specimen is given a load (mm^2).

The equation can calculate composite strain:

$$\varepsilon = \frac{\Delta L}{l_0} \times 100\% \tag{2}$$

Where:
ε = Enginerring Strain (Strain) (%),
Lo = The length of the first specimen before being given a charge (mm),
ΔL = Length gain (mm).

Based on the curve of the test results, the elastic modulus, E (GPa), can be calculated by the equation:

$$E = \frac{\sigma}{\varepsilon} \tag{3}$$

Where:
E = Modulus of elasticity (GPa),
σ = Engineering stress (voltage) (MPa),
ε = Enginerring strain (strain) (%).

The test aims to determine the bending strength of a material by bending testing the composite material. Bending testing refers to the ASTM D790 standard with static test conditions. Bending strength or curved strength is the largest bending stress that can be accepted due to external loading without undergoing large deformations or failures. The magnitude of bending strength depends on the type of material and loading. As a result of bending testing, the upper part of the specimen is subjected to pressure, while the bottom will experience tensile stress. In composite materials its compressive strength is higher than in its tensile strength. Unable to withstand the received tensile stress, the specimen will break. It resulted in a failure in the composite test. The bending strength on the upper side equals the value of the bending strength on the lower side.

Bending strength can be formulated as follows:

$$\sigma = \frac{3FL}{2bd^2} \tag{4}$$

The following formula can calculate the modulus of bending elasticity:

$$E_b = \frac{L^3 \times m}{4bd^3} \tag{5}$$

2. Materials and Methods

2.1 Materials

In this study, researchers used duck feather waste and rat purun fibers from Alabio, Sungai Pandan District, Hulu Sungai Utara Regency, South Kalimantan Province, to become composite reinforcing raw materials. Duck feathers wasted on every duck meat sold in the market is one of the global issues in almost every country. The duck feather waste produced by the livestock industry is between 2 million and 3 million pounds annually. Most of them burn the waste, burying it and mixing it back into animal feed—those methods are costly and contradictory. In Indonesia itself, duck livestock is a popular business, so the duck fur waste produced is quite a lot. However, duck feather waste in Indonesia still sounds new and cannot be utilized optimally.

Rat Purun Fiber (Eleocharis Dulcis) is one of the alternative natural fibre materials. In the scientific manufacture of composites, composite materials with these materials have not yet existed, so this composite is expected to provide added value economically [8]. Traditionally it is only used for industrial raw materials furniture (chairs and tables) and household crafts (mats and woven bags). [2]

The stems in rat purun differ from rice straw stalks, where rice straw stalks have bones of air cavity segments. But generally, it can be equated in its use as a composite manufacturing material. As for the good requirements to use:

1) Have a sufficient level of drought (water content is only 14-16% only). Please don't get it exposed to rain or splashing water though. Because when it contains too much water, it has the potential to live mushrooms and small insects.
2) It looks brilliant on his skin as a sign that he has sufficient strength and has not deflated his air cavity. When stored for too long, the color changes to pale or older, depending on how it is stored. A long storage period can cause the air cavity to deflate. Density checks can also be done by stacking them and then stepping on them; if they deflate immediately, the quality is not good. But the quality is good if it deflates for a moment and then comes back again.
3) The thickness (diameter of the cavity), on average, is the same, therefore, what needs to be chosen is the length of the main stem. It is estimated that it takes the main trunk length to be about 20 cm after cleaning from the branches.
4) Have the same weight on average. [3]

2.2 Methods

The material is washed thoroughly with water and dried. Then the selection of duck feathers and rat purun fibers with an average diameter of 0.5 mm was carried out. The process of making hybrid composites, all fibers are made with a random model, by the hand lay-up method, the volume fraction of hybrid composites from duck feathers and rat purun fibers, namely (10% : 90%), (20% : 80%), (30% : 70%), (40% : 60%), (50% : 50%), (60% : 40%), (70% : 30%), (80% : 10%), (90% : 10%). The volume fraction of polyester used is 50% of the mold volume. After completing the manufacture of the hybrid composite, tested its mechanical properties, including tensile and Bending strength testing.

2.2.1 Research Procedures

The material that will be used as a filler is in the form of duck feathers and rat purun fibers that have been cleaned using clean water and dried. For rat purun fibers it is pounded using wood until it becomes fiber, then dry it again, and then decomposed it using a comb or hand.

The material used for this mold is glass with a thickness of 10 mm; this is because the printout is easier to remove. The test specimens were made one by one, as many as 54 pieces, with details of 27 pieces for tensile tests and 27 pieces for bending tests. The standard test carried out is ASTM with the following details: [9]

1) Tensile Test using ASTM E8 standard. The size of the mold made is a length of 200 mm, a width of 185 mm, and a thickness of 10 mm
2) Hardness test using ASTM D 790-2 standard. The size of the mold made is a length of 205 mm, a width of 200 mm, and a thickness of 10 mm
3) In order not to make errors in the manufacture of the test object, the mold size is made a little larger, which is 1-5 mm

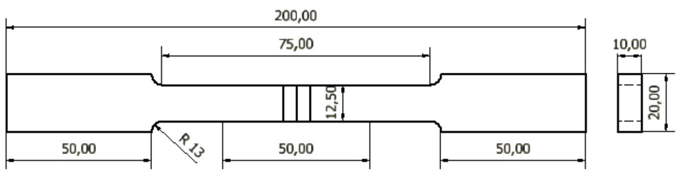

Figure 4. Tensile Test Dimensions Tensile Test ASTM E8

Based on the test standard used, namely ASTM D790, the shape of the specimen and its size can be seen as shown below: [9]

Figure 5. Dimensions of ASTM D790 Bending Test Specimen

3. Result and Discussion

The research that has been carried out shows the results in Figure 6 for tensile strain testing. This test shows that the strain occurring in the tensile test process is formed from the stress applied to the loading test specimen from the outside.

From Figure 6. a graph of the relationship between the volume fraction of duck feathers and rat purun fibers to the tensile strength of *hybrid composite* obtained that the highest tensile strength of 4.37 MPa was obtained at the volume fraction (10%: 90%). In comparison, the lowest strength of 3.70 MPa was obtained at the volume fraction (90%: 10%).

The above results show that the volume fraction of duck feathers and rat purun fibers (10%: 90%) provides greater tensile strength than in other more volume fractions. It shows that the volume fraction (10%: 90%) of rat purun fibers and matrices can be distributed properly and evenly at the time of the composite manufacturing process so that the bond between rat purun fibers and their matrices can take place perfectly. Therefore, it can directly increase the tensile strength of the rat purun fiber-reinforced composite. The volume fraction (90%: 10%) provides a smaller tensile strength than the other volume fractions. It is because rat purun fibers can *withstand* large loads while duck feathers cannot withstand large loads and have the potential to reduce the strength of composites when combined with rat purun fibers into hybrid *composites* [10].

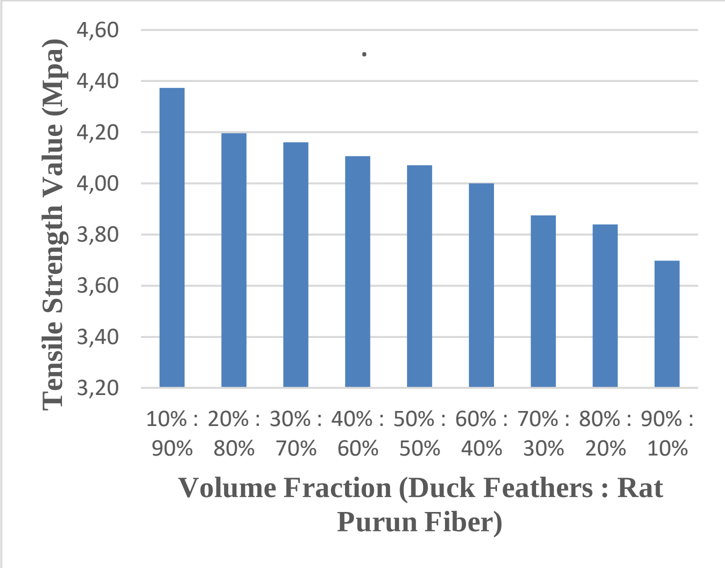

Figure 6. Graph of the Relationship of Volume Fractions To Tensile Strength

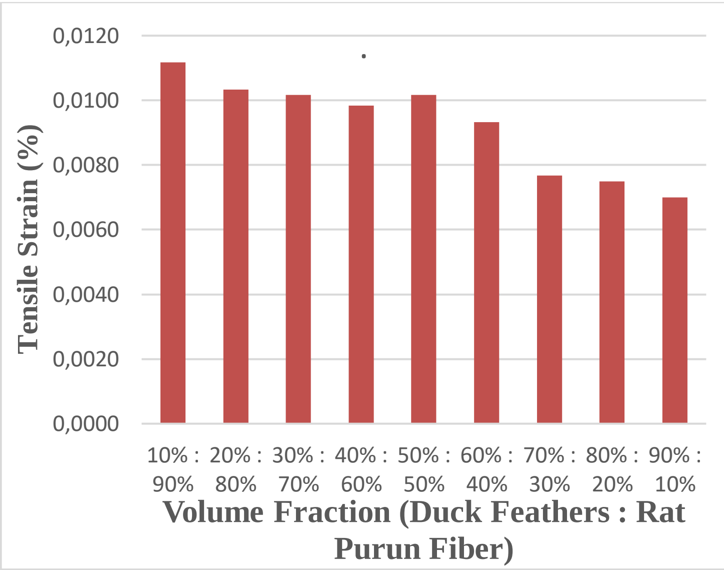

Figure 7. Graph of the Relationship of Volume Fractions To Tensile Strain

Figure 7 shows that the highest tensile strain of 0.0112% is obtained at the volume fraction (10%: 90%), while the lowest tensile strain of 0.0070% is obtained at the volume fraction (90%: 10%). Based on the results above, it is known that the greater the fraction of rat purun fiber, namely at a fraction of 90%, the greater the tensile strain value increases. This large strain indicates that in composites with a larger fraction of fibers, there is a good fiber interface bond [11] so that when given the loading, it does not immediately break [12].

Figure 8 shows that the highest modulus of elasticity of 528.25 GPa was obtained at the volume fraction (90%: 10%), while the lowest of 391.64 GPa was obtained at the volume fraction (10%: 90%). The volume fraction (90%: 10%) produces a good composite material.

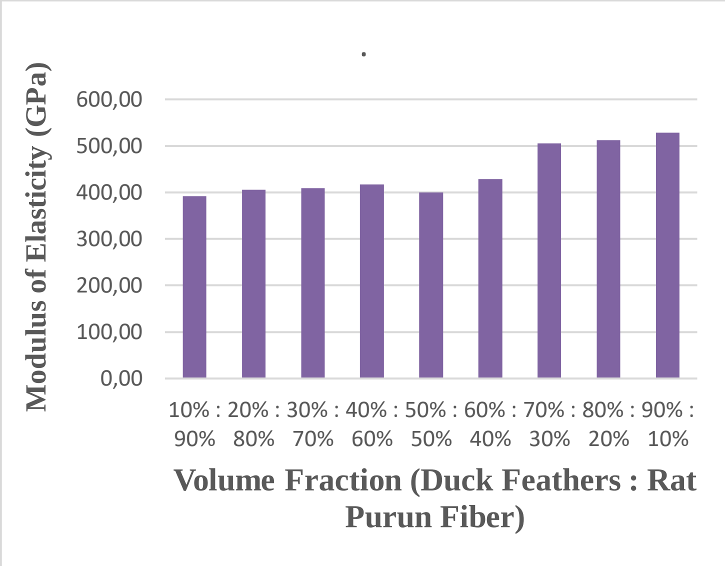

Figure 8. Graph of the Relationship of Volume Fractions To The Modulus of Elasticity

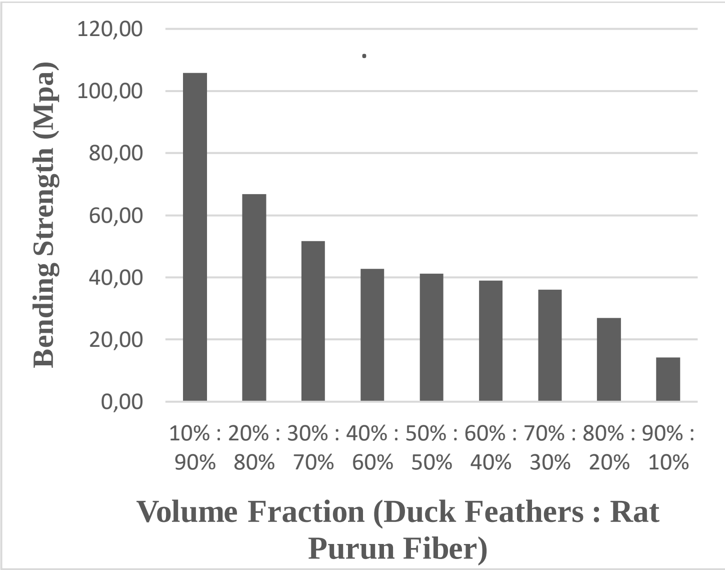

Figure 9. Graph of the Relationship of Volume Fractions To Bending Strength

Figure 9 is a graph of the relationship between the Volume Fraction to the Bending Strength obtained; the result is that at the volume fraction (10%: 90%), a bending strength value of 105.5 Mpa was obtained, but after the volume fraction (10%: 90%) there was a decrease in bending strength. The lowest volume fraction (90%: 10%) with a value of 14.25 MPa. The increased volume fraction of duck feathers does not change the bending strength but instead experiences a decrease in bending strength [13]. Duck feathers cannot withstand large loads when combined with rat purun fibers into a hybrid composite [14].

In figure 10. Graph of the Relationship of Volume Fractions to Modulus of Bending Elasticity shows that composites with a volume fraction of 90%: 10% have the highest modulus value of elasticity of 0.0060 Gpa, and the lowest value of the modulus of elasticity is found in the volume fraction of 10%: 90% with a modulus value of elasticity of 0.0016 Gpa.

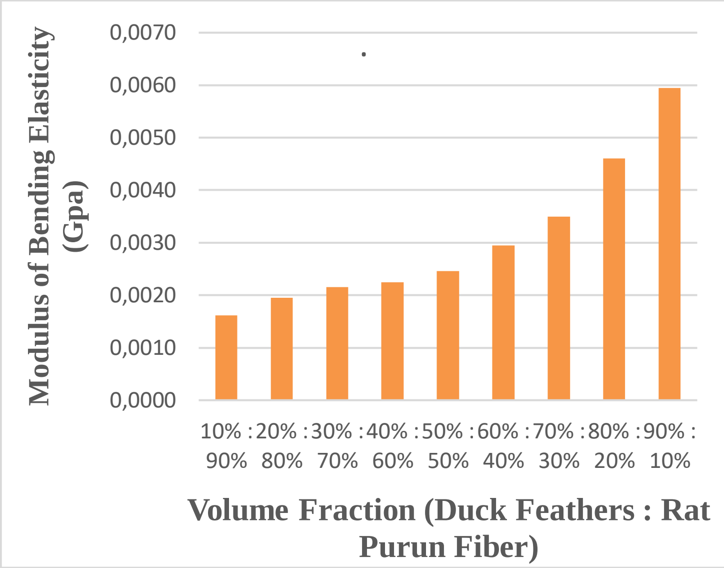

Figure 10. Graph of the Relationship of Volume Fractions to Modulus of Bending Elasticity

The modulus of elasticity of hybrid composite duck feathers and rat purun fibers increases as the volume fraction of rat purun fibers decreases. The above shows that the increasing volume fraction of rat purun fibers produces a brittle or rigid composite material [15], which is due to the process of forming composites in sheet form so that the mixing process is uneven, and the number of catalysts is large and also the fabrication process is still manually [16].

The fault that occurs in tensile testing is a brittle fault with fibers pulled out; in bending tests, the fault's shape is a tenacious fault with shorter pull-out fibers. It can be seen in Figures 11 and 12.

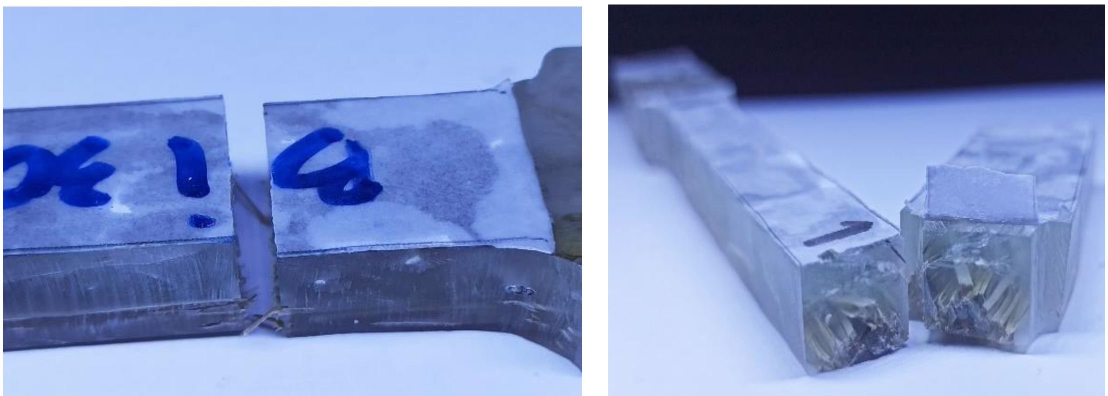

Figure 11. Macro Photo of Fault Form Tensile Testing Specimen

Figure 11 of the composite fault cross-section with a volume fraction of 10%: 90% shows that the composite has the highest strength value with a tensile strength value of 4.37 Mpa. Above there appears to be a brittle fracture; when the matrix breaks, the fibers also break along with the matrix. It is due to the lack of perfect fiber bonding, and this event matrix is marked with many fiber pull-outs. Fiber pulls out is a way to measure the strength of the interface bond between a single fiber and a matrix. Pull-out fiber tests; the ends of the fibers are embedded in the matrix. The fibers are pulled, and the matrix is held or pulled in the direction opposite the direction of the fiber pulling. Where this fiber pull-out mechanism occurs because the bond between the fiber and the matrix weakens when the load given continues to increase [17]. When the matrix fails, the fibers can still bear the load, so the faulting process does not occur simultaneously [18].

Figure 12. Macro Photo of Bending Test Specimen Fault Shape

Figure 12 composite fault cross-section with a volume fraction of 10%: 90% is that the composite has the highest strength value with a bending strength value of 105.5 Mpa. At the volume fraction of 10%: 90% is still visible at some point, there is a pull-out failure shown in figure 4.6; in addition to the pull-out found in the composite that reduces the bending force, it turns out that after the implementation of different magnification, debonding is seen in the composite [19]. Debonding is the release of binding force between the fiber and the matrix. Debonding occurs due to the lack of binding power between the fiber and the matrix. So that when there is pressure, the matrix is separated from the fiber [20].

4. Conclusions

The study results concluded that the value of tension and strain tensile strength and bending strength decreased along with the decrease in the percentage of rat purun fibers compared to the percentage of duck feathers. The form of fault that occurs in tensile testing is a brittle fault with fibers pulled out; in bending testing, the shape of the fault that occurs is a brittle fault with shorter pull-out fibers.

Acknowledgements

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