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Sesame Oil Addition to Bamboo Reinforced Composite Matrix

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***Abstract*— Wooden ships use jati wood. Over time jati wood has become scarce. So that jati wood is relatively expensive. therefore bamboo is researched starting from the skin, bamboo meat, and bamboo internodes contained in the plant. In the structure of bamboo there are internodes. The bamboo segment is the weakness of the bamboo structure. The effect of bamboo segments in composite construction was investigated. Sesame oil replaces mineral oil and chemicals, because sesame oil is biodegradable, non-toxic, environmentally friendly, and renewable. To determine the effect of bamboo segments, tensile and bending tests will be conducted on the bamboo composite. The results of this research are expected to find alternative materials, namely bamboo fibre-based composites or so-called bamboo reinforcement plastics (BRP) as materials for making people's ships. This study found that the more layers of bamboo and bamboo segments are very influential in influencing the tensile and bending strength of a laminated material. The tensile testing value of layer 3 with segments reached 127.556 Mpa and without segments 933.333 as well as bending testing layer 3 with segments reached 113.889 Mpa and without segments 111.111 Mpa. From this value, the value has not met the standard of the Indonesian Classification Bureau (BKI).**

Keywords—Bamboo Branch, Sesame Oil, Polyester Resin, Tensile Test, Bending Test, Indonesian Classification Bureau (BKI)

I. Introduction

In addressing environmental concerns, waste generation, and depletion of non-renewable resources, there has been an increasing demand for products made from natural materials. Non-renewable resources will be replaced with renewable resources as a sustainable work programme. Vegetable oil-based polymers can compete on the basis of cost and positive impact on all aspects. Low cost, renewable, and environmentally friendly are the industry challenges in making materials with suitable properties from current chemicals (Sari, 2016). With the development of new innovations bamboo veneer reinforcement plastic (BVRP) will be the latest alternative as a substitute for fiberglass reinforced plastic (FRP) in the development of composite manufacturing material technology on non-ferrous vessels in the shipbuilding industry, especially fiberglass reinforced plastic (glass fiber reinforced composite material) vessels. The use of bamboo fibre as a composite reinforcement can later become a new alternative material as an alternative material for shipbuilding in Indonesia. Because bamboo material is known by the public to have good properties to be utilised, its stems are strong, straight, flat, hard, easy to split, easy to shape, and work with and easy to lift. In addition, bamboo is also relatively cheaper than glass fibre because it is widely found around rural settlements and this natural bamboo fibre can also be renewed compared to glass fibre which cannot be renewed. Tropical climate is the climate in Indonesia, and tropical climate is very good for bamboo growth. Bamboo is a plant that is rarely cultivated in Indonesia. Bamboo has an economic function that is widely used as construction, furniture, crafts, household appliances, and other bamboo processing. Bamboo has a very high absorption capacity and reduces air pollution substances and adds to the coolness of the air and nature [3].

In construction, bamboo is usually used as poles, beams or scaffolding, scaffolding (Idris, 1998; Krisdianto, 2000 and Surjokusumo, 1997). In Indonesia there are several types of bamboo species and the most widely used in construction is petung bamboo (Dendrocalamus asper). Bamboo has twice the tensile strength of wood, while its compressive strength is 10% higher than that of wood. When compared to steel which has a specific gravity of between 6.0 - 8.0 (while BJ of bamboo = 0.6 - 0.8), the tensile strength of reinforcing steel is only 2.3 - 3.0 greater than the tensile strength of bamboo. Thus bamboo has a tensile strength per unit of specific gravity that is 3 - 4 times greater than that of reinforcing steel [5].

Seeing the advantages of wood, bamboo and laminated materials, both in terms of technical and non-technical aspects such as material supply, the combination of wood and/or bamboo in the form of laminates will produce a combined material that has better mechanical properties compared to the mechanical properties of teak (solid) wood. Such wood and/or bamboo laminates have great potential to be used in structures both in civil construction and maritime construction such as for ship skins (hulls), decks, girder beams, keels and tusks [6].

Approximately 200 species of bamboo from 20 countries in Southeast Asia including 60 species of bamboo grow in Indonesia. From lowlands to an altitude of 300m above sea level, bamboo plants in Indonesia can

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grow well. Bamboo is a fast growing plant that is 3 - 4 years can be harvested and can be used as construction material. In addition, bamboo is a plant that is easily split, shaped, and relatively cheaper than wood at this time [7].

Basically, bamboo plants must have internode branches with a certain distance, besides that the internode has its own use in a bamboo, but not a few also think that the bamboo internode is one part of the bamboo that is very difficult to use rather than the bamboo stem itself.

Currently, in Indonesia, many shipbuilders still depend on wood materials. So a new innovation is needed in the process of building a ship made of laminate to replace wood which is starting to be difficult to find and even though there is a value of the price issued so very expensive.

As a result, many wooden shipbuilders are able to switch from wood materials to laminated materials. What is certain is that laminated materials are easily available and cheaper. This study aims to determine how much

The effect of bamboo segments on a laminate construction mixed with vegetable oil.

Sesame seeds are used for various industries, snacks, and edible oil producers, as well as raw materials for the pharmaceutical industry, plastics, margarine, soap, cosmetics, pesticides, and others. Sesame cake (pulp) is sesame that has been taken oil is very good for animal feed. In addition, sesame cake can also be used as a side dish called chili [8].

Vegetable oils have been widely used for the production of polymer composites incorporating organic or inorganic particles or fibres, both synthetic and natural and measured from macro-scale to micro-scale. Literature searches related to vegetable oil materials have shown an increase since the late nineties to the present day. This increased interest is not only academic but also industrial due to the emerging support for producing low-cost and environmentally friendly biodegradable-based materials [1].

In a previous study, examined the development of materials made of resin and mixed with various vegetable oils. From the research, it was found that the most effective and best results were mixed with sesame oil. Therefore, this research will be carried out again by adding bamboo reinforcement and at the same time examining bamboo segments that have been avoided by bamboo craftsmen in managing bamboo which is used as an object.

This research can find out whether bamboo will make the previous material will improve the mechanical properties, bamboo segments that we know have hard properties if mixed with oil will make them flexible and have excellent elasticity properties as well.

II. METHOD

A. Materials and Instruments

This research is to obtain data about the problem to be studied. The main materials used in this research are resin, wormy bamboo fibre (Gigantochloa apus), and sesame oil. The tools used are glass as a mould, gerenda, balance, stove, brush, cutter, metal ruler, and universal testing machine.

B. Method and Procedure

1) To be able to carry out the test, first the preparation of materials is carried out. Preparation of materials is very important because it can affect the test results and can affect the results of data analysis and discussion. Samples that have been made will be characterised using FTIR.

2) Manufacturing Stage This material combines bamboo fibre, sesame oil, and resin.

Stage of Manufacture of Test Objects (Specimen) The American Standards of Testing Materials (ASTM) ASTM D638-02 has determined the dimension size of each object to be tested so that the sheet of asphalt composite material with bamboo fiber needs to be adjusted again. Impact testing aims to determine the impact toughness value of a material in which the material is represented by several specimens to be tested for impact.

The process of data analysis using the ANOVA method or Analysis of Variance is a comparative test to test the average data of several groups with the help of SPSS software; from the test results will be analyzed the influence of the thickness of each specimen on the impact toughness value of the material so that later it can determine the conclusion of how the substantial impact test value of asphalt composite material with fiber apus (*Gigantochloa apus*) as a small shipbuilding material.

III. RESULTS AND DISCUSSION

In this chapter, data processing is carried out obtained from the results of tensile tests and bending tests of bamboo-reinforced composite materials with the addition of sesame oil, data that will be further analysed. The two tests carried out are grouped based on the type of reinforcement variation, each of which consists of a variety of layers, namely:

1. The first variant without segments (TR)
   a. Variation 1 (TR 1), composite material with one layer of internode-less bamboo as reinforcement with the addition of sesame oil
   b. Variation 2 (TR 2), composite material with two layers of internode-less bamboo as reinforcement with the addition of sesame oil.
   c. Variation 3 (TR 3), composite material with three layers of internode-less bamboo as reinforcement with the addition of sesame oil.
2. Second variant with segments (DR)
   a. Variation 1 (DR 1), composite material with one layer of branched bamboo as reinforcement with the addition of sesame oil.
   b. Variation 2 (DR 2), composite material with two layers of bamboo fibre as reinforcement with the addition of sesame oil.
   c. Variation 3 (DR 3), composite material with three layers of bamboo fibre as reinforcement with the addition of sesame oil.

A) Tensile Strength Values

Tensile testing was taken from 3 samples of each layer variation on each type of bamboo reinforcement, the results of which showed the maximum tensile force load

received by each test specimen. Before testing, the test specimens were measured first, the results of the test specimen measurements are shown in the table below as follows:

Based on the table 1, it shows that the tensile strength value obtained from each specimen is different. So that for the value of the first variant (TR) of the composite material reinforced with a layer of internode-free bamboo with the addition of sesame oil, the highest strength is obtained in the variant without 3 layers with an average tensile strength of 93.333 Mpa and the lowest strength in the variant without 1 layer with an average of 24.444 Mpa.

TABLE 1.
ULTIMATE TENGSILE STRENGTH

VARIAN	SPESIMEN 1	SPESIMEN 2	SPESIMEN 3	EVERAGE
WITHOUT SEGMENT PLY 1	26.667	14.667	32.000	24.444
WITHOUT SEGMENT PLY 2	30.667	32.000	34.667	32.444
WITHOUT SEGMENT PLY 3	80.000	105.333	94.667	93.333
	Data 1	105	31095	37.181
	Data 2	72	21221	18.834

TABLE 2.
ULTIMATE TENGSILE STRENGTH

VARIAN	SPESIMEN 1	SPESIMEN 2	SPESIMEN 3	EVERAGE
WITH ROADS PLY 1	12.000	10.667	13.333	12.000
WITH ROADS PLY 2	24.000	49.333	45.333	39.556
WITH ROADS PLY 3	97.333	172.000	113.333	127.556

Based on the table 2, it shows that the maximum tensile strength value obtained from each specimen is different. So that for the value of the second variant (DR) of the composite material reinforced with branched bamboo layers with the addition of sesame oil, the highest strength is obtained in the 3-layer branched variant with an average strength of 127.556 Mpa and the lowest strength in the variant without 1-layer segments has an average value of 12.000 Mpa.

B) Bending Strength Values

TABLE 3
ULTIMATE BENDING

VARIAN	SPESIMEN 1	SPESIMEN 2	SPESIMEN 3	EVERAGE
WITHOUT ROADS PLY 1	95.833	91.667	87.500	91.667
WITHOUT ROADS PLY 2	100.000	91.667	100.000	97.222
WITHOUT ROADS PLY 3	104.167	112.500	116.667	111.111

Table 3 shows the data from the three point bending test results using test equipment obtained from test specimens which shows the maximum compressive force of each specimen is different. So that for the value of the first variant (TR) of the composite material reinforced with a segmentless bamboo layer with the addition of sesame oil, the highest average bending strength is obtained in the variant without a 3-layer segment of 111.111 Mpa and the lowest average strength in the variant without a 1-layer segment of 91.667 Mpa.

TABLE 4
ULTIMATE BENDING

VARIAN	SPESIMEN 1	SPESIMEN 2	SPESIMEN 3	EVERAGE
WITH ROADS PLY 1	95.833	95.833	87.500	93.056
WITH ROADS PLY 2	95.833	104.167	104.167	101.389
WITH ROADS PLY 3	112.500	112.500	116.667	113.889

Table 4 shows the data from the three point bending test results using the test equipment obtained from the test specimens which shows the maximum compressive force of each specimen is different. So that for the value of the first variant (TR) of the composite material reinforced with a layer of segmentless bamboo with the addition of sesame oil, the highest average bending strength is obtained in the variant without a 3-layer segment of 113.889 Mpa and the lowest average strength in the variant without a 1-layer segment of 93.056 Mpa.

IV. CONCLUSION

From the research that has been carried out, the results of material testing, observations and data analysis of bamboo layer reinforced composite materials with the addition of sesame oil can be concluded.

1. Composite material reinforced with segmentless bamboo layers with the addition of sesame oil has the highest tensile value of 105.333 Mpa at 3 layers of fibre, while the lowest tensile value is 14.667 Mpa at 1 layer of fibre. It can be concluded that with the addition of bamboo fibre, the tensile strength will increase.
2. Composite material reinforced with a layer of bamboo fibre with the addition of sesame oil has the highest tensile value of 172,000 Mpa at 3 layers of fibre, while the lowest tensile value is 10,667 Mpa at 1 layer of fibre. It can be concluded that with the addition of bamboo fibre, the tensile strength will increase.
3. Composite material reinforced with bamboo layers without segments or brushes with the addition of sesame oil has the highest bending value of 116.667 Mpa in 3 layers of fibres, while the lowest bending value is 87.500 Mpa in 1 layer of fibres. It can be concluded that with the addition of bamboo fibre, the tensile strength will increase.
4. Judging from the tensile test results, the material using branched bamboo reinforcement is better than the bamboo reinforcement material without segments.
5. Increasing the percentage of variation in the number of fibre layers greatly affects the tensile strength and bending strength. The greater the variation in the number of fibre layers, the greater the tensile strength value obtained.Containing a thank you to those who deserve (donors/sponsors), materials contributor, and research facilities.

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