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To cite this article: Ridhwan Haliq et al 2019 IOP Conf. Ser. Mater. Sci. Eng. 494 012037

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The Effect of Filler Composition and Shape to Sound Capability Insulation and Modulus Elasticity Natural Fiber Galam Wood (Melaleuca Leucadendra) - Polyester

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Abstract. Making and testing for sound insulation materials from natural fiber composite (Galam wood fiber and polyester matrix) to analyze sound transmission loss and modulus of elasticity. Natural fiber that used is sawdust and wood chips and using polyester as matrix. Wood material chosen due to the availability of abundant so easily obtained and also a waste timber Galam is wasted in the process of building construction. Specimen made in disc shape with 10 cm of diameter and 1 cm thickness. Sound intensity measured in insulated room with sound level meter and speaker as sensor and source and run with variation in frequency of transmitted sound wave. With sound transmission loss theory, sound insulating capability could be analyzed. Measurement of modulus of elasticity is needed to determine deflection capability in loaded condition so it may be a consideration in their application. The result of this research is the best insulation properties is composite with 7% saw dust as filler on 800 Hz sound frequency and the highest value of Elasticity is composite material with 18% wood chip filler.

Keywords: filler, composition, shape, sound capability, modulus elasticity

1. Introduction

Neighborhood near the airport perhaps experiences hearing loss due to noise, In recent years, several studies have developed new materials and technologies to improve properties [1]. Research on the soundproofing properties of composites is very limited [7]. The island of Borneo has abundant natural resources to wood nature. Kalimantan's timber stocks are very fluid and very diverse. There is one type of wood that has a lower price and easily to find it, Wood is commonly called the wood Galam (Melaleuca leucadendra). this study was conducted to determine the insulation ability of the material by varying the volume fraction and forming the fiber by measuring the lost sound transmission of some frequency. the effect of sound resistance will also be supported through microstructural results [5]. The purpose of this research is to analyze the effect of volume fraction and fiber form on wood-based wooden composite Galam on polyester matrix to sound insulation properties based on sound transmission loss and analyzing the content of the volume fractions and the fiber type in the wood-driven fiber to its elastic modulus [6].

2. Materials and Experimental Setup
This study uses the basic material of Galam wood fiber which is waste that is wasted from the construction process of Building and using polyester resin with brand of Yukalac 157 - BQTN obtained commercially from UD. Glass Fiber Mahakam, Samarinda. The fibers used in preparing preparations for the purpose of selecting sizes using a sieve. carried out allowance for 30 mesh of wood powder, and wood shavings up to 10 mesh. There are two types of specimens in this test, ie specimens for sound insulation and specimen testing for elasticity modulus testing. The specimen has a volume of 78.54 cm³, the volume being a reference to the matrix and reinforcement composition. The specimens used for the elasticity modulus test have dimensions as shown in Figure1, with a volume of 75 cm³. Dimensions of sound insulation specimens refer to ASTM E90 and elastic modulus specimens referring to ASTM D790.

The specimens were made variations by modification of the volume fraction and modification of the fiber form with the research design as in Table 1.

### Table 1. Design of specimen variation

| No. | Fiber Shape | Volume Fraction | Test | Fiber Volume (cm³) | Weight (gr) | Test | Fiber Volume (cm³) | Weight (gr) |
|-----|-------------|-----------------|------|-------------------|-------------|------|-------------------|-------------|
| 1   | Polyster    | 0%              | √    | √                 | 0           | 0.00 | 0.00              |             |
|     |             | 7%              | √    | √                 | 15.70       | 5.00 | 6.39              |             |
| 2   | Wood Powder | 11%             | √    | √                 | 39.27       | 7.50 | 9.58              |             |
|     |             | 14%             | √    | √                 | 58.91       | 10.00| 12.77             |             |
|     |             | 18%             | √    | √                 | 74.61       | 12.50| 15.97             |             |
| 3   | Wood Shavings | 7%         | √    | √                 | 15.70       | 5.00 | 6.39              |             |
|     |             | 11%             | √    | √                 | 39.27       | 7.50 | 9.58              |             |
|     |             | 14%             | √    | √                 | 58.90       | 10.00| 12.77             |             |
|     |             | 18%             | √    | √                 | 74.61       | 12.50| 15.97             |             |

Material density can be known by measurement mass and volume measurement. The measurement begins by cutting the wood of Galam with a certain thickness and then measuring and can be known volume, after the volume is known, the material is weighed to know its mass and then it can be known its density value. The value of wood density of Galam is 0.81 gr/cm³.

2.1. **Sound Insulation Specimen**

Specimen preparation is done three times for each test, so get accurate result. The picture below (table 2) is a specimen testing sound insulation.

### Table 2. Sound Insulation Specimen

| No Sample | Sample | Composition          | No Sample | Sample | Composition          |
|-----------|--------|----------------------|-----------|--------|----------------------|
| X1        |        | Polystyrene          | B1        |        | Polystyrene + 7% wood shavings |
| A1        |        | Polystyrene + 7% wood powder | B2        |        | Polystyrene + 11% wood shavings |
| No | Sample | Composition         | No | Sample | Composition         |
|----|--------|---------------------|----|--------|---------------------|
| A2 |        | Polystyrene + 11% wood powder | B3 |        | Polystyrene + 11% wood shavings |
| A3 |        | Polystyrene + 14% wood powder | B4 |        | Polystyrene + 18% wood shavings |
| A4 |        | Polystyrene + 18% wood powder |    |        |                     |

2.2. Sound Insulation Test

Sound insulation test used the principle of transmission loss by measuring the reduced transmission of sound received by the sensor after through the material. This test adopts the ASTM E90 standard. Sound insulation test will end by giving sound waves on some frequencies and measuring them with a sound level meter on the back of the sample. A comparison of the sound results with another vote. Frequency variations are shown in Table 3.3. Then do the comparison results of sound by another sound. Frequency variations are 125 Hz, 250 Hz, 500 Hz, 800 Hz, and 1000 Hz.

3. Result and Discussion

The results of each variation into the changeable results as graphic shown on figure 1. From the experiment obtained a maximum value on X1 specimen at 2000 Hz and the maximum value of composite material obtained by sample A1 at 800 Hz with a sound insulation value of 20.3 dB. The comparison between the powder timber with wood shavings to determine the linear regression of both types of these amplifiers and produced between samples A2 with B2 is 12.45 dB and 11.15 dB. Wood powder has random fiber direction except for wood shavings. This proportion also yields an average difference of 3.2 dB for each fiber presentation with a static frequency of 800 Hz.

![Graph showing sound transmission loss](image-url)
Figure 1. The effect of wood type composition on sound insulation and sound insulation value on Static Frequency 800Hz

Specimen A1 has a loss of sound transmission Greater than A2 specimen for wood powder material in wood shaved material the value of loss of sound when transmitted is the greatest in B1 specimens and the lowest is B4. this indicates that the more noise is lost the material will be better as sound insulation. The static frequency indicates the value of the fluctuating sound insulation and more the filler composition of the composite material the more it can reduce the sound insulation value of the material in a nonlinear fashion.

3.1. Elasticity materials
All samples showed increased elasticity and also increased composition (figure 2). The increase occurs in wood-powdered composites up to three times greater than the composite elasticity of wood shavings with the same composition.

Figure 2. Materials elasticity test result

This indicates that the particle size of the filler also has an influence on the composite material. particle size affects the material's ability for dispersion and distribution, thus causing uniformity in the load distribution. The result of elasticity analysis of the above material does not show a direct relationship to the sound insulation capability. mechanical properties will not affect the value of sound insulation.

3.2. Microstructure
The morphology of the material used is the morphology of wood fiber on the condition has not been used as filler and after becoming composite material. Comparison of the morphological shape of the material can be observed in Figure 3. On wood powder and wood shavings have a rough and colored surface not too bright, since it has already saturated by polyester resins. The wood material Galam that has been given polyester resin undergoes a more shiny change of color and the surface looks rougher like wood without resin.
Figure 3. (A) wood powder composite morphology (B) wood shavings composite morphology

The above results show the effect of the reinforcement in the composite material containing the wood powder. This seems more equitable distribution and smaller particle size causes the elasticity value to increase significantly. The ability of binding resins (polyester) more binding sawdust which has a smaller size than the wood shavings having a larger particle size. The crack out first and then the adhesion between the matrix and the wood shavings starts breaking. Since, wood fibre has got a good strength that has broken collectively after the application of the tensile stress. Figure 6 shows the void present in the specimen like Air Bubbles and this can be rectified by proper hand lay method. Based on the method tested, shows that wood shaving has a large water absorption capability, therefore additional solvents such as H2SO4 or cleaning with acid and caustic before compaction with resin. required test scanning electron microscope (SEM) to observe the results of an impurity that is able to lead to intergranular stress on the material, intergranular crack could be make a crack shape after fracture. The conventional composite method was very useful if the application only as a scaffold or the supplementary material for small scale.

4. Conclusion
From the research, it was found that best insulation properties is composite with 7% saw dust as filler on 800 Hz sound frequency and the highest value of Elasticity is composite material with 18% wood chip filler.

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