Acoustic characteristics board of areca nuts fiber composites

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Abstract. This research aimed to determine the ability of Areca nuts fiber composite in sound absorption. The Areca nuts fiber composite board uses polyester resin as a binder. The Areca nuts fiber used in this research is fiber obtained from Areca nuts which are old and are not being used anymore. The sample was made by varying the concentration of fiber used (30, 40, 50, 60 and 70) %. The result of the absorbency coefficient of the composite is proportional to the concentration of fiber used. The Areca nuts fiber composite board is excellent to be used as a sound absorbance material because it has the highest absorption coefficient of 0.77, higher than the absorbency coefficient of ISO 11654 standard; 1997 (E) of 0.15. Sound absorption is obtained from measurements using impedance tube by standardizing ASTM E1050-1990. The addition of Areca Nuts concentration makes the composite the higher the level of absorbance that makes the quality of the composite as an absorber the higher the quality. It was found that this composite has the characteristic of being able to absorb sound high enough at the sound frequency despite the high frequency.

1. Introduction

Today’s composite technology is progressing rapidly, in line with its increasingly widespread use, ranging from as simple as household appliances to industrial sectors such as aircraft and shipbuilding, automotive, oil and gas industries. In addition, composites have also been used in the fields of medicine, sports, and buildings. The development of composites is not only a synthetic composite but also leads to natural composites due to its renewable properties [1].

In the composite, there is a material called a reinforcement material and an adhesive (matrix). The composite reinforcing material may be either particles or fibers of both natural and synthetic fibers. The adhesive (matrix) functions to bind the fibers into a single structure, protecting the fibers from damage due to environmental conditions, distributing the load to the filler and providing properties such as stiffness, resistance, and electrical resistance [2].

Based on the constituent material, the adhesive can be divided into two kinds: organic and inorganic adhesives. In this research, this have been selected inorganic adhesive in the form of Polyvinyl Acetate (PVAc) which has the advantage of heat resistance, high strain, and soluble in organic solvent [3], [4], [5], [6], [7] indicating that a banana composite board can be produced. A single coconut fiber-based composite board has been studied and the result shows that coconut fibers have the potential to be produced as composite boards [8],[9], [10], [11], [12].
In the manufacture of composites, Natural fibers not only serve to increase strength and stiffness but also can reduce the weight of the resulting composite material. Physical properties are dependent on the source of fiber used. In order to increase composite strength, it is necessary to modify the matrix or amplifier. Previous Areca nuts fiber research studied the effect of the addition of areca catechu fibers to the mechanical properties and physical properties of cement mixed gypsum materials [13].

The research was carried out by coating the areca nut with matrix materials namely cement and gypsum, where the Areca nuts fiber is used as the reinforcing material of the matrix band. The addition of Areca nuts fiber affects the mechanical properties and physical properties of the gypsum cement composite material. A good percentage of betel fiber and make betel nut as an alternative choice of material in making plywood or cement-gypsum board. From the research on the concentration of the fiber, it was found that the optimum value of compressive strength was obtained on the board with the percentage of fiber 0.6% that is 108.08 kg/cm², higher than the board which is not added with areca nuts fiber which only has compressive strength 59.37 Kg/cm². While the optimum bending strength was obtained on board with the percentage of fiber 0.6% that is 30.33 kg/cm². It shows more flexible than the sample without given areca nuts fiber (0%) that is equal to 19.6 kg/cm². This indicates that the addition of areca nuts fiber can increase the bending strength of the gypsum cement board. The results of the study indicate that areca nuts fiber has the potential to be developed, and may be utilized by other commodities. On this occasion the researcher wanted to know whether the areca nuts fiber can be utilized the material in the manufacture of composite silencer material. This research will be done by making composites with various mixes of different percentages of fiber with resin to be used.

2. Method

The method used in this research is the descriptive-explorative research method. The stages of this research include the check before ready to be used as the base material of composite manufacture. The areca nuts sample was processed through several stages such as choosing an old betel nut, marked with a yellow areca nuts skin is slightly reddish and soak the betel nuts for three days, to facilitate the separation of fiber from betel nut. Then separate the fibers from betel nuts that have been soaked. The areca nut was then soaked with Natrium oxide fluid for two hours, to clean the remaining fruit flesh. After drying, the areca nut is then trimmed and then cut to two centimeters in size. After that the betel nut is ready for use. Betel nut obtained is weighed to know its density. This is done to facilitate the determination of the concentration of fiber to be used in research specimens. Furthermore the composite preparation is done by mixing the already weighed fiber with polyester resin. The mixture is then added with a hardener as a catalyst. All ingredients are then stirred until the mixture looks uniform and homogeneous. The mixture is then poured into the prepared mold (Figure 1).

Figure 1. Sample Process Product of Areca Nut Composite Fiber.
The prints used are adapted to the dimensions required for each measurement. Each specimen was made with a ratio of concentration of fiber and resin, (30: 70) %, (40: 60) %, (50: 50) %, (60:40)% and (70:30)%. Making one sample takes twenty-four hours from the manufacturing process to the drying process.

![Image](image.png)

**Figure 2.** The sample test of absorption sound coefficient of Areca Nuts Fiber composite.

The absorbent coefficient of the material using an impedance tube by standardizing ASTM E1050-1990. The toolset consists of Microphone, Power amplifier 2716 C to amplify sound waves, Impedance tube kit 4206, to measure a sample absorption coefficient, Computer to process and display test data.

The Sound sources generated by Acoustic material testing, amplified by the power amplifier, and then forwarded to the impedance tube. The sound interference that occurs is captured by both microphones, analyzed by Acoustical material testing and processed and displayed by the computer.

### 3. Result and Discussion

The measurement of the coefficient of sound absorption of the fiber pin composite uses the principle of the impedance tube method. The measurement is done by using sound level meter consist of Amplifier 2716C, impedance tube kit 4206, and signal generator in box acoustics. The sound absorbance coefficient is obtained by comparing the intensity of sound received after passing through the composite board with the intensity of the sound before passing the composite board of Areca Nuts fiber.

The measurement of the sound absorption coefficient is done by using frequencies of 340, 400, 450, 500 and 550 Hz. At concentration of 30% fiber the highest absorption coefficient $\alpha = 0.49$, at a frequency of 430 Hz. The high coefficient of absorption of the sound of the palm fiber composite board at a frequency of 430 Hz, indicates that the composite with a concentration of 30% fiber is either used as a low-frequency damper. Then for the composite of Areca Nuts fiber with fiber concentration 40%, the highest absorption coefficient is 0.44 at 500 Hz sound frequency.

In the test using the frequency of 500 Hz, the average coefficient of sound absorbs per Areca Nuts fiber composite was increased, meaning that the composite of Areca Nuts fiber has a better absorbing ability at higher frequency. Then for the sample absorption coefficient test with 50% fiber concentration, the highest absorption coefficient is 0.58 at 700 Hz sound frequency, meaning that the composite with 50% fiber concentration is good used as a noise damper for sound with medium concentration. Different results can be observed on the results of the test with a concentration of 60% fiber, composite Areca Nuts fiber with this concentration has the highest absorption coefficient 0.66 at low and medium frequency at the same time. This indicates that the composite of Areca Nuts fiber with this concentrationis good for both low and medium frequencies. From the results of all sound absorption coefficient tests at all fiber concentrations, the highest sound absorption coefficient values are composed of betel fiber composites with a 70% fiber concentration of 0.85. The coefficient shows
70% fiber concentration is the best composite to be used for absorbing material. Here is a graph showing the sound absorption coefficient values of each sample of Areca Nuts composite.

Figure 3 shows the sound absorption coefficient values of each sample of the betel nut composite. By repeating the highest absorption coefficient 0.88 for the sample with 70% concentration while the lowest absorption coefficient value was obtained at 30% fiber concentration, as shown in Figure 4 below. From the measurement results obtained the value of the absolute coefficient of the average composite pinang fiber has increased in proportion to the number of fiber concentrations used. The highest absorption coefficient is owned by the sample with a 70% concentration of 0.88.

Figure 4 shows that the more concentration of fiber used, the greater its ability to absorb sound. Mediastika (2009) states the ability of an object to absorb sound is determined by three factors, namely thickness, air cavity, and density. Based on the relationship between the frequency and sound absorption coefficient, it can absorb sounds because areca nuts fiber to form interconnected pores. Composite boards of Areca Nuts fiber can absorb sound well at low frequency (f <500 Hz), medium frequency (500 < f < 1000 Hz) or high frequency (f > 1000 Hz), according to applicable standard i.e. ISO 11654: 1997 standard (E), where the absorption coefficient of acoustic sound is at least 0.15.

At a low frequency of 450 Hz, the pinewood composite board has the highest absorbency coefficient value of 0.81 at 70% fiber concentration, while for medium frequency 500 Hz - 650 Hz, the optimum absorbs value is 0.85 at 70% fiber concentration. The highest absorption coefficient of sound is present at a 70% fiber concentration, this is due to a higher concentration of fibers, and a small fraction composed by resin. With more fiber concentrations the resulting cavities are formed more and absorb larger sounds.
Figure 3. Graph of Sound Frequency to Absorption Coefficient of Composite Areca Nuts Fiber with variation concentration Areca nut: (a) 30:70, (b) 40:60, (c) 50:50, (d) 60:40, and (e) 70:30%.

Figure 4. Coefficient of average absorption of the composite fiber of areca nut.

The surface of the porous material is able to absorb sound better than non-porous or porous materials. The denser a material the sound will tend to reflect. This is because the incoming sound is propagated by heat (Internal Heat), which is generated by friction between the air molecule and the material structure.

4. Conclusions
The areca fiber composite can be used as sound absorb the material, the presence of Areca Nuts fiber which has good mechanical properties makes the composite board become caustic and ductile. In addition, polyester resin is used as a rigid polymer, heat resistant, waterproof and corrosion resistant. Composite boards of Areca Nuts fiber have more pores that can absorb sound better. Areca Nuts fiber composite is a good soundproofing material at the low and medium frequency because it has a high absorbs coefficient of 0.88, exceeds ISO standard 11654; 1997 (E) which standardizes the absorption coefficient of 0.15.
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