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Type on the Sound Absorption Coefficient Chicken Feather Composite

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ABSTRACT

The efficiency and suitability of recycling chicken feather fiber waste to the type of matrix used has the potential to be a composite reinforcement and increase sound absorption through the Chemical Pulping process. This study aims to investigate the alleged influence of the use of matrix type on the strength of sound absorption in chicken feather fiber composites. The research method used is experimental research with the manufacture of composite specimens that vary the volume fraction of composite fibers with various types of matrices. Sound absorption testing using impedance tubes. Data analysis techniques in this study use descriptive data analysis. The results of this test show the effect of using matrix type on increasing the absorption coefficient of SBA composites. The maximum absorption coefficient is found in the SBA-K composite (Chicken Feathers – Kanji).

Keywords: matrix type; chicken feather; absorption coefficient; chemical pulping.

INTRODUCTION

Composite materials can be natural fiber composites and synthetic fiber composites. Several researchers stated that composites with natural fiber as the main ingredient are promising materials in the future, because they have basic characteristics such as biodegradability, low use of chemicals in the process, renewability, easy processing and abundant availability, and cheap (Habibie et al., 2021). When viewed based on their chemical properties, natural fibers can be divided into plant fibers which contain cellulose (carbon, hydrogen and oxygen), while animal fibers contain protein (keratin) (Brebu and Spiridon, 2011; Das et al., 2017; Athijayamani et al., 2010). The classification of natural fibers is based on fiber form, namely seed fibers (cotton and kapok), stem fibers (jute, flax, hemp, kenaf), and leaf fibers (sisal and abaca). (Habibie et al., 2021).

The potential for animal fiber from chicken feathers to be used in making fiber composites has previously been widely studied. The use of chicken feather fiber as a composite material is considered a new material source that is economical, environmentally friendly and can be recycled. Apart from that, chicken feather fiber can be used for various applications to replace the use of synthetic fiber. Chicken feather fiber composition at levels of 5% and 10% with UPR reinforcement can improve mechanical properties (Farhad Ali et al., 2021). Keratin hydrolyzed protein extract from chicken feather waste can be considered as a potential raw material for the production of environmentally friendly wood composite bio-binder (Fagbemi and Sithole, 2021). Composites based on chicken feather fiber treated with Zinc Oxide (ZnO) mixed with Unsaturated polyester resin (UPR) show relatively good properties in terms of tensile strength, tensile modulus, percentage of elongation at break, flexural strength and flexural modulus (Ali et al., 2022).

The strength of composite materials apart from the use of fibers also depends greatly on the type of matrix used. The function of the matrix in composite materials is as a fiber binder to distribute loads. There are various types of matrices in composite structures including Polymer matrix composite (PMC), Metal matrix composite (MMC), Ceramic matrix composite (CMC). The matrix has the largest (dominant) part or volume fraction in the composition of the composite (Vietanti, Basuki and Ma, 2022). Composite materials basically consist of a binder (reinforcement) and reinforcement (matrix). The matrix that is often used in research is the polymer matrix, which has several types, such as epoxy, polyester, bhispenol, and repoxy (Kurniawan et al., 2019). Composite materials with the main element being fiber, the binding material can be a polymer which has properties including being light, corrosion resistant, strong enough, cheap, non-magnetic and easy to shape into complex shapes. The manufacturing process is easy, namely the press molding process and as a flask in a sand mold (Wiranegara, Salahudin and Hastuti, 2022).

In order to realize a green society, the use of biodegradable, biocompatible and non-toxic natural raw materials has emerged to make porous sound absorbers. However, most bio-based porous materials have poor mechanical properties and thus additional reinforcing components are required to improve their mechanical performance (Zou et al., 2023). Processing conditions, weight percentage of reinforcing fiber, thickness and density have a significant impact on the NRC value (Saravanan and Prakash, 2021). This research aims to investigate the alleged influence of the use of matrix type on the sound absorption strength of chicken feather fiber composites. The efficiency and suitability of recycling chicken feather fiber waste for the type of matrix used, which has the potential to strengthen composites and increase sound absorption capacity, is considered to contribute to the novelty of this research.

Composite materials for lightweight concrete are an important innovation in the construction industry that aims to produce building materials with superior properties, such as adequate strength, light weight and energy efficiency. Lightweight concrete is generally made from a mixture of traditional materials such as cement, sand and water, with the addition of special ingredients which function to reduce total weight and improve performance (Artawan IP et.al, 2023; Verdian R, Muin RB, 2023; Paikun P et.al, 2023).

One of the composite materials often used in lightweight concrete is lightweight aggregate. This aggregate can come from various sources, such as pumice, perlite, vermiculite, or artificial products such as Expanded Clay and Expanded Shale. Lightweight aggregates have a lower density than conventional aggregates, thereby significantly reducing the weight of concrete without compromising its structural strength. Pumice, for example, is a natural, porous material, giving lightweight concrete good thermal insulation properties (Sitompul ST, Pariatmono P, 2022; Romadhon ES et.al, 2022; Widodo S et.al, 2022; Astariani NK et.al, 20223).

Apart from lightweight aggregates, the use of additives also plays an important role in lightweight concrete formulation. Additives such as superplasticizers can increase the workability or ease of working with concrete, allowing for mixing more fluid concrete without adding excessive air. This is important because high air content can increase the strength of concrete. Other additives such as entraining agents are used to introduce microscopic air bubbles into the concrete mix. Processing this air helps reduce the weight of the concrete while improving its thermal properties and resistance to freeze-thaw cycles (Argoanto Y et.al, 2023; Baggio EY et.al, 2023; Bachtiar E et.al, 2022; Priastiwi YA et.al, 2021).

The use of fiber in lightweight concrete is also common. Fiber can come from various materials such as polypropylene, glass, or even natural fibers such as bamboo. The addition of these fibers increases concrete toughness, reduces cracking, and increases resistance to dynamic loads. Polypropylene fibers, for example, help prevent the fine cracks that often occur during the initial curing process (Bagio TH et.al, 2021; Gumilang PD et.al, 2021; Sutarno S et.al, 2021).

Aeration technology is also often applied in making lightweight concrete. This technology involves mixing cement paste with very fine air bubbles, resulting in a cellular structure with many air voids. This process produces very light concrete with good thermal coverage. Aerated concrete or aerated concrete is widely used in industrial construction for building elements such as walls and floors, with a light weight and is very desirable (Mubarak M et.al, 2020; Marwahyudi M, 2020).

RESEARCH METHODS

Material

Materials used in this research:

1. SBA = Chicken Feather Fiber as reinforcement

2. KJ = Kanji as a matrix

3. PVC = PVC glue as matrix

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The chicken feather fiber used is waste from broiler chickens from slaughterhouses or markets. SBA cut into 2 cm lengths was washed using detergent then soaked in 5% NaOH solution for 2 hours then dried. Alkaline treatment with SBA aims to remove lignin and dirt.

Composite Fabrication

The volume fraction used in composites is a variation of fiber volume fraction 35%-SBA: 65%-KJ, 35%-SBA: 65%-PVC and 100%-SBA: 0%-Matrix. The matrix and fibers are varied in such a way as to suit the volume fraction.

Methods

The research method used is experimental research to find the effect of certain treatments on others under controlled conditions by making composite specimens that vary the volume fraction of composite fibers with various types of matrices. Then testing is carried out using an impedance tube or Kundt Tube method (ISO 10543-2). Data analysis uses descriptive data analysis, namely describing research results graphically in graphs.

Composite Manufacturing

The first composite manufacturing process prepares tools, materials and molds. The next step is to weigh the materials to be used with a volume ratio of matrix and filler (fiber) at a low density, namely 0.27 gr/cm3. Next, the dried fiber is mixed with the matrix and water in a blender until it becomes pulp. Then it is printed (cold press) and flattened so that it becomes one layer at a thickness of 0.75cm/layer, each layer is made into 4 layers and then dried under the sun (Figure 1). The final step, after drying, is that the fiber layers are arranged and applied with PVC adhesive until they reach a thickness of 3 cm. They are dried again using an oven. Then, for laboratory testing, they are cut to form a test object measuring 10 cm in diameter.

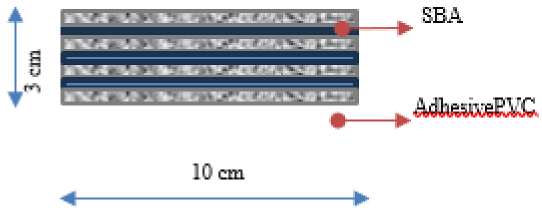

Figure 1. Arrangement of SBA composite layers

RESULTS AND DISCUSSION

The experimental results of this research are 3 SBA composite test samples with a thickness of 3 cm and a diameter of 10 cm (Figure 2). The sample code provided is:

1. SBA-K (Chicken Feather - Kanji);
2. SBA-N (Chicken Feather – Non matrix)
3. SBA-P(Chicken Feather – PVC),

Two samples were printed for each sample to prevent damage to the sample during testing in the laboratory.

Figure 2. Sample of chicken feathers with a diameter of 10 cm

Carrying out testing of SBA composite samples in the acoustics laboratory of the Architecture Department, UNHAS, by measuring the level of absorption coefficient of each test sample. The measurement results are presented in graphical form as follows. The SBA-K absorption coefficient level can be seen in Figure 3, the SBA-N absorption coefficient graph is in Figure 4 and the SBA-P absorption coefficient is in Figure 5.

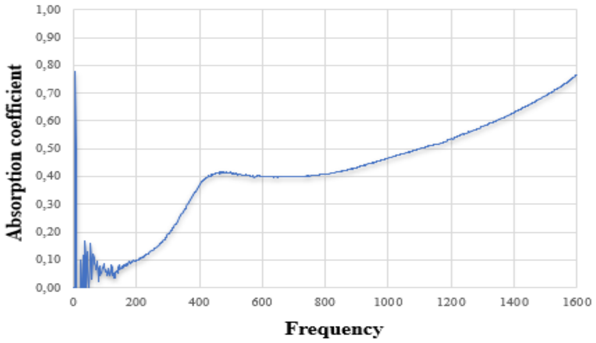

Figure 3. SBA-K absorption coefficient level

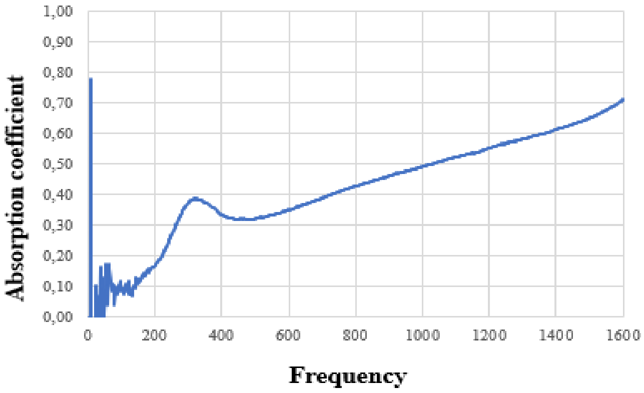

Figure 4. SBA-N absorption coefficient level

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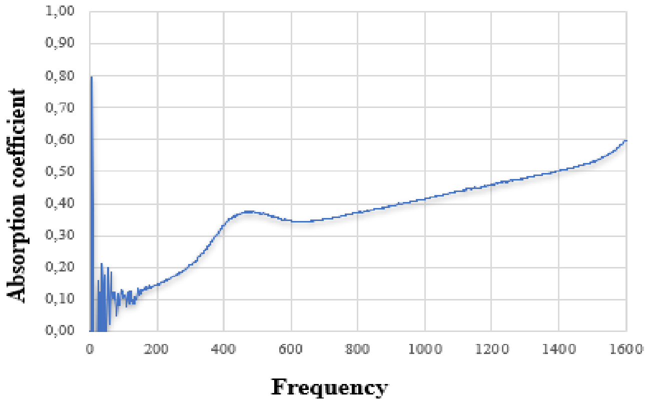

Figure 5. SBA-P absorption coefficient level

The results of the three graphs show that there are differences in the level of absorption capacity of each sample. A significant difference can be seen in the SBA-P code sample where the absorption coefficient level at the 1600 frequency is below 0.6, while in the SBA-K and SBA-N code samples the absorption coefficient level at the 1600 frequency is above 0.7 for both. Of the three test samples, the maximum absorption coefficient level was found in the SBA-K (Chicken Feather - Kanji) sample.

The test results also show that the SBA composite has a fairly good absorption coefficient value with a minimum value of 0.3 and a maximum value of 0.7 in the frequency range of 400 Hz to 1600 Hz. This data shows that SBA composites with various types of matrices have good absorption coefficient levels and are worthy of being recommended as indoor acoustic absorbing materials.

CONCLUSION

The results of this test show that there is an influence of the use of matrix type on increasing the absorption coefficient of SBA composites, although the change is not significant. The maximum absorption coefficient level is found in the SBA-K (Chicken Feather - Kanji) sample with a minimum absorption coefficient value of 0.4 and a maximum of 0.75 in the frequency range of 400 Hz to 1600 Hz.

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