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Utilization of *Acacia* Leaf Litter (*Acacia Mangium*) as an Eco-Friendly Composite Material

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ABSTRACT

This study discusses the parameters of *Acacia* leaf litter fibers in environmentally friendly composite mixtures. This parameter is used as a reference for whether *Acacia* leaf litter fibers have the potential to be additives to composites. The composite sample used in this study was concrete. *Acacia* tree leaves are leaves that have strong fibers and high resistance. *Acacia* trees are trees that grow rapidly and can multiply rapidly throughout the annual season in the tropics. *Acacia* leaf litter fibers are used as additives to produce strong and environmentally friendly composites. Testing *Acacia* leaf litter fiber parameters in the form of particle distribution in samples and fiber tensile tests using a Universal Testing Machine (UTM). *ImageJ* software carried out an analysis of the distribution of concrete constituent particles. From the analysis results, the average distribution of fine aggregate particles was 0,20 mm², coarse aggregates were 92.69 mm², and *Acacia* leaf fibers were 0.162 mm² for powder particles and 0.174 mm for thread-shaped particles (fiber diameter). The study results show that *Acacia* leaf fiber has a tensile test with a value of 6.38 kg/cm², which has good elasticity and durability so that it can be used as a composite mixture material.

Keywords: Environmentally Friendly, Composite, Fiber, Particle Distribution, Tensile Test.

INTRODUCTION

Technological progress at present has developed very rapidly. But the negative effects of these advances can lead to massive environmental damage and exploitation of natural resources. Green technology needs to be developed and applied in everyday life. The application of environmentally friendly technology, very low cost, and raw materials of natural origin are the main objectives of using eco-friendly green technology. Many uses of advanced material technology, for example, in building materials; at this time, the community has applied a lot of building materials that are environmentally friendly, cheap, and of natural origin. Technology in manufacturing concrete also receives attention, especially in the innovation of its mixed materials. Many researchers have developed concrete mixing techniques so that the concrete has the characteristics of being strong, cheap, and impervious to sound and temperature.

The *Acacia* plant (*Acacia Mangium*) is a plant that grows rapidly throughout the annual season. *Acacia* plants are on average 0.48 m in diameter and 18.23 m in height (Karlinasari et al., 2021). It has a rough and hard skin surface with a golden brown to dark brown color (Savero et al., 2022). There are many benefits from the *Acacia* tree, from the trunk to the leaves. *Acacia* bark waste produces activated carbon using the phosphoric acid activation method (Zhang et al., 2021). Tannin extract from *Acacia* bark makes resins and reinforcements for composite materials (Aristri et al., 2022; Viza et al., 2021). *Acacia* rods can also be used for adhesive materials (Mohd Yusof et al., 2019; Solihat et al., 2022). Because it is easy to grow, its adaptability is high, and it can accumulate soil physicochemical properties to increase its growth (Hamad-Sheip et al., 2021). *Acacia* leaves are leaves that have very strong fibers and wax so that they are resistant to weathering. Several studies have used *Acacia* leaves as metal absorbers in waste (Hasfita, 2012) and the development of *Acacia* leaf fibers into advanced materials such as supercapacitor materials (Taer et al., 2020).

Concrete consists of cement as the main material and is added with coarse and fine aggregations, for example, sand, gravel, and rocks. Then this mixture is given enough water and reacts with cement so that the cement will become adhesive. According to SNI 03-2834-2000, concrete is a mixture of Portland cement or other hydraulic cement, fine aggregate, coarse aggregate, and water and forms a solid mass (SNI 03-2834-2000, 2000). The result of the strength and quality of concrete is seen from the constituent compositions of the concrete mixing technique. This concrete mixing process can also be mixed with other additives to meet concrete specifications with certain properties. Added aggregates and natural fibers to the concrete mixture to obtain high-quality concrete has been done a lot. Marpaung R's research concluded that giving coconut husk to the concrete mixture can increase the concrete compressive test by 5.22 Mpa and increase sound absorption with a coefficient absorption value of 0.96432 at a frequency of 1500 Hz (Marpaung & Karolina, 2014). The addition of *Acacia* tree leaves in this concrete mixing can make concrete stronger, sound damping is better, and can reduce the use of bone iron. In this study, adding *Acacia* leaf fiber to concrete can increase the strength of concrete by 13.44%.

This study examines the parameters of *Acacia* leaf litter as a mixture for making environmentally friendly composites. By knowing the parameters of this fiber, you can see the potential of this material as the development of advanced materials such as composites.

METHODS

This research is a type of experiment in the laboratory. *Acacia* leaf litter samples were taken in the Jambi Province area, and fiber parameter measurements were carried out at the Physics Laboratory of UIN Sulthan Thaha Saifuddin Jambi. The stages of research are described into several stages:

1. The stage of making composite sample moulds. The test sample container used is the SNI 03-1974-1990 standard (Badan Standardisasi Nasional, 1990), a cylindrical type test container with a diameter of 15 cm and a height of 30 cm.
2. The stages of collecting *Acacia* leaf litter and synthesizing fibers from the leaf litter.
3. The manufacturing stage of a basic concrete sample with a strong quality of 14.5 Mpa (Quality K 175) according to SNI 03-2847-2002 (SNI 03-2834-2000, 2000).
4. The concrete treatment stage is carried out by soaking water for seven days.
5. Shooting stage with a digital microscope to see the structure of fine aggregates, coarse aggregates, and *Acacia* leaf fibers on concrete composite samples.
6. Microscope digital *ImageJ* analysis stage using *ImageJ* software.
7. Tensile test stage of *Acacia* leaf litter fiber with Universal Testing Machine (UTM) tool. The UTM used is to have a maximum tensile test strength of 5 Kg with a resolution of 0.001 Kg.

The stages of fiber synthesis from *Acacia* leaf litter are as follows:

1. Collection of *Acacia* leaf litter, the leaves taken are clean and already subjected to drying.
2. The washing stage of *Acacia* leaf litter to remove impurities attached to the *sarasah*.
3. The stage of rough cutting of the *Acacia* leaf *sarasah* and the fine destruction stage of the *Acacia* leaf *sarasah*.
4. The screening stage results from the process of crushing *Acacia* leaves.
5. The drying of the fibers of *Acacia* leaves is carried out by irradiation of sunlight.
6. The stage of neutering *Acacia* leaf fibers using UV irradiation to make them durable.

Figure 1. The result of the synthesis of *Acacia* leaf fiber.

The next stage is the manufacture of concrete composite samples. The basic concrete material uses Portland Composite Cement (PCC) cement branded Semen Padang. By using a cylindrical sample mould with a diameter of 15 cm and a height of 30 cm, the composition needed in making concrete is cement as much as 1.73 Kg, sand (fine aggregate) as much as 4.03 Kg, gravel (coarse aggregate) as much as 5,456 Kg, water as much as 1.14 litres. These samples were then analyzed for particle distribution parameters and fibre tensile testing.

RESULTS AND DISCUSSION

The fine aggregate used in this study is sand derived from mining the Batanghari River, Jambi City. The sand used has a sludge content of 2.78%. This value is taken from measuring sludge with a weight ratio after washing. The results of the *ImageJ* analysis obtained a size distribution of fine aggregate particles, with the largest value being 1.149 mm² and the smallest being 0.012 mm². More details can be seen in Fig 1 below.

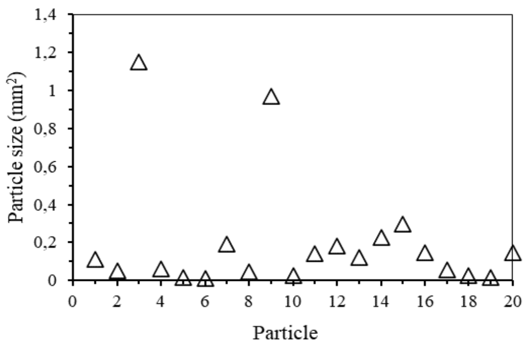

Figure 2. Fine agrete distribution on concrete

The coarse aggregate used in this study is gravel derived from the sand mining of the Batanghari River, Jambi City. The gravel used has a sludge content of 3.53%. From the results of the *ImageJ* analysis, the size distribution of coarse aggregate particles was obtained with the largest value being 227.54 mm² and the smallest being 4.89 mm². The coarse aggregate used in this study is gravel derived from the Batanghari River, Jambi City. The gravel used has a sludge content of 3.53%. The results of the *ImageJ* analysis obtained the size distribution of coarse aggregate particles, with the largest value being 227.54 mm² and the smallest being 4.89 mm². The *Acacia* leaf fibers used in the concrete mixture were also analyzed for particle size. The observation of the shape of fibers or particles of *Acacia* leaf fibers is divided into powder-shaped *Acacia* leaf fibers and *Acacia* leaf fibers in the form of fine threads (fibers).

The results of the *ImageJ* analysis found that the particle size distribution of powder *Acacia* leaves with the largest value was 0.503 mm² and the smallest was 0.022 mm². And the *ImageJ* analysis results for fine thread *Acacia* leaves with the largest fibre diameter distribution is 0.623 mm and the smallest is 0.01 mm. More details can be seen in Fig 2, Fig 3, Fig 4, and Fig 5 below.

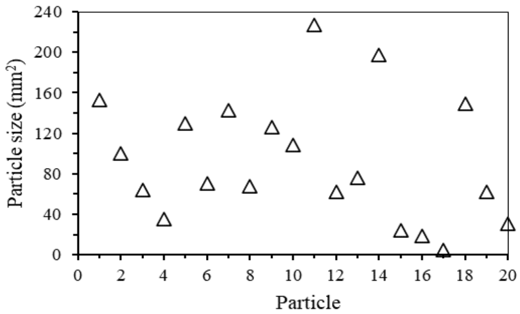

Figure 3. Distribution of coarse agrerates on concrete.

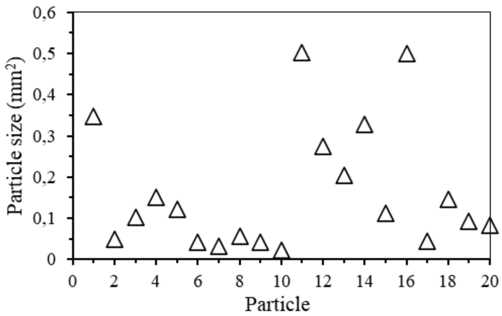

Figure 4. Distribution of powder-shaped *Acacia* leaf particles on concrete.

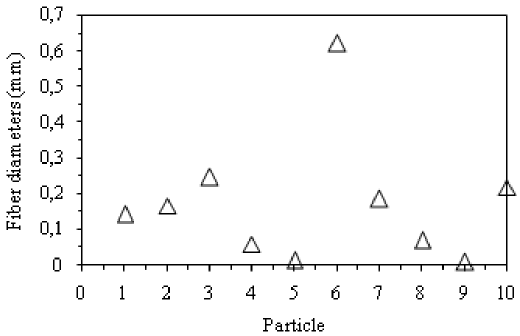

Figure 5. The distribution of fiber-shaped *Acacia* leaf particles (diameter) on concrete.

Figure 6. The results of the analysis of *Acacia* leaf fiber particles in the form of powder using *ImageJ* software.

The study also carried out tensile strength test of *Acacia* leaf fibers was also carried out. The measurement results of the tensile test of *Acacia* leaf fibres obtained a value of 6.38 kg/cm². The diameter of the fibers measured on the UTM tool is 0.07 cm. The tool analysis shows the type of fibers of *Acacia* leaves are natural elastic fibers.

CONCLUSION

The results of taking pictures of concrete compositions with a microscope and analysis using *ImageJ* software obtained a size distribution of sand particles (fine aggregate) with the largest particle size being 1.149 mm², the smallest being 0.012 mm², and the average particle size being 0.2 mm². As for gravel (coarse aggregate), the largest particle size is 227.54 mm², the smallest is 4.89 mm², and the average particle size is 92.694 mm². The size distribution of powder-shaped *Acacia* leaf particles with the largest particle size is 0.503 mm², the smallest is 0.022 mm², and the average of the particle sizes is 0.162 mm². As for fiber-shaped *Acacia* leaf particles, the largest fiber diameter size is 0.623 mm wide, the smallest is 0.01 mm, the average particle size is 0.174 mm, and the tensile strength test value is 6.38 kg/cm². *Acacia* leaf fibre can be used as a mixture of environmentally friendly composite materials. Environmental damage due to burned planet is massive, which worsens the air quality around the community. Using *Acacia* leaf fibre can reduce environmental damage by utilizing plant waste into advanced materials and has economic value.

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