"DEVELOPMENT OF NATURAL FIBER COMPOSITE FOR STRUCTURAL APPLICATION"

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Abstract

this study is to investigate the mechanical, hygral, and interfacial strength of continuous bamboo fiber reinforced epoxy composites. The untreated and alkali-treated continuous bamboo fibers were prepared from cutting the nature bamboo Culm. The basic characteristics of the bamboo fibers, such as density, equivalent diameter, and tensile properties were experimentally measured. The bamboo fiber reinforced epoxy (BF/EP) composites were fabricated by the resin transfer molding (RTM) process with the resulting fiber volume fraction about 42%. The strength of bamboo fiber was found to decrease with the alkaline treatment. However, alkali-treated bamboo fiber reinforced epoxy composites acquired better tensile strength than those with untreated bamboo fibers. The untreated bamboo fiber was believed to have weak interface with the epoxy resin, which was verified by the subsequent interface strength tests. The size effect of bamboo fibers on the tensile properties of the BF/EP composites was also studied. The results showed that the tensile strength and Young's modulus of the composite increase with the decrease of the bamboo fiber diameter. For the hydrothermal aging test, BF/EP composites are highly sensitive to moisture absorption, and the moisture has a detrimental effect on the mechanical properties of the BF/EP composite

Keywords – Epoxy, Composite, Fiber,Bamboo etc.

INTRODUCTION

Fiber Reinforced Polymer (FRP) is the most widely used composite. According to literature, glass fiber reinforced composites began mass production in the industry in the 1940s. Later, the advent of carbon fiber reinforced composites played an important role in defense and aerospace industry. In recent years, environmental awareness has emerged, and fossil fuels have gradually become depleted at the same time. The commonly used synthetic fibers such as carbon fiber and glass fiber are not easily decomposed in the natural environment and subjected to the problem of environmental pollution. As a result, the development of green composites and biodegradable materials has attracted much attention. In the 2010s, about 315,000 tons of natural fibers were made into composites, which accounted for 13% of the total reinforcing materials which include glass fiber, carbon fiber and natural fiber. It is estimated that by 2020s it will increase to about 830,000 tons. In the field of natural fiber reinforcement, a large number of plant fiber reinforced polymer composites have been used in the past years. Commonly used plant fibers include bananas, sisal, cotton, bamboo, and wood. These plant fibers have the advantages of low density, good thermal insulation and mechanical properties, low cost, durability, sustainability and biodegradability.

Bamboo is a suitable choice for the development of natural fiber composites. It grows rapidly, up to several centimeters per day, and has excellent mechanical properties. There were numerous bamboo fiber extraction methods such as retting, steam explosion, alkali treatment, and degumming, etc. All the extraction methods will directly affect the quality and strength of the fibers.

Bamboo is a natural honeycomb fiber-reinforced composite material. Vascular Bundles are surrounded by parenchyma cells. The vascular bundle consists of vessels, a phloem, and a large number of fibers. Parenchyma cells are a lignified wall composed of lignin, cellulose and hemicelluloses. In the entire bamboo stalk, fiber and parenchyma occupy 40% and 50% respectively. The cell structure of fiber in the vascular bundle has a small hole in the middle, which is surrounded by a multi-layer structure consisting of a secondary wall and a primary wall from the inside to the outside. These cell walls consist of cellulose, hemicelluloses, polysaccharides and pentose sugars. There is also an intermediate layer outside the primary wall between fibers. There is also an intermediate layer outside the primary wall between vascular bundles.

The main component of this layer is lignin with the content of more than 90%. The cell wall structure and mechanical properties of bamboo fibers were studied using scanning electron microscopy (SEM), Atomic force microscopy (AFM), and nano indentation by Zou et al. The investigation showed that the bamboo fiber cell wall is composed of cobblestone-like nano-sized polygonal cellulose particles, approximately 21-198 nm in size. For the bamboo fiber with a nano-grain structure, the measured hardness is 0.44±0.09 GPa and the elastic modulus is 10.4±1.8 GPa. The cellulose, lignin and hemicelluloses account for about 95% of the plant cell wall. Although lignin has the function of binding fibers together, it is a complex compound that causes poor interfacial adhesion with polymer resin. However, lignin can be dissolved in sodium hydroxide solution during the fiber extraction process. The experimental results showed that proper surface treatment could effectively remove lignin and hemicelluloses, resulting in a better interface than those obtained without the alkaline treatment.

In use, composites are often exposed to moisture. When the composite absorbs moisture, the water and the polymer interact (hydrolyze) or affect the adhesion between the matrix and the fiber, leads to a hydrothermal aging of the composite which has a detrimental effect on the mechanical properties of the composite. Unlike glass fibers, the prominent tendency of natural fibers to absorb moisture is the biggest factor limiting biocomposites. Therefore, it is important to study the phenomenon of bamboo fiber reinforced composites for hydrothermal aging.

This study is to investigate the mechanical, hygral, and interfacial strength of continuous bamboo fiber reinforced epoxy composites. The untreated and alkali-treated continuous bamboo fibers were prepared by cutting the nature bamboo culm. Bamboo fiber reinforced epoxy (BF/EP) composites were fabricated by using the resin transfer molding (RTM) process. The size effect of bamboo fibers on the tensile properties of the BF/EP composites and hydrothermal aging test were also studied.

I. RESULT

Sr. No	Sample ID	Tensile Strength (MPa)	Izod Impact Strength (J/m)	Flexural Strength (MPa)
1	2 Layer	17.11	489.5	47.27
2	3 Layer	18.22	444.4	23.69

Note:

- Tensile Strength: ASTM D 638-14 standard.
- Izod Impact Strength: ASTM D 256-10 standard.
- Flexural Strength: ASTM D 790-2003 standard.

II. CONCLUSION

The tensile strength, impact strength and flexural strength of two layers and three layers specimen are measure experimentally. These properties are comparable with the existing fiber. Therefore, we can easily replace the existing synthetic fibers by natural fibers in lower structural application. Because natural fibers are fully sustainable, renewable and biodegradable.

The synthetic fiber pollute the environment as they cannot degradable they creates more environmental concern therefore natural fiber are better reinforcement for polymer composite.

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