

# Mechanical Behavior of Natural Fiber Reinforced Composite Materials

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**ABSTRACT:** The aim of this experimental study is to investigate the mechanical behavior of natural banana fiber reinforced polymer composite. The composite material is prepared using hand-layup technique and the mechanical properties are analyzed as per the ASTM standards. The effect of fiber loading influencing the mechanical properties like tensile strength, flexural strength, Impact strength and hardness of composites is studied. The moisture absorption ability of the material is also determined.

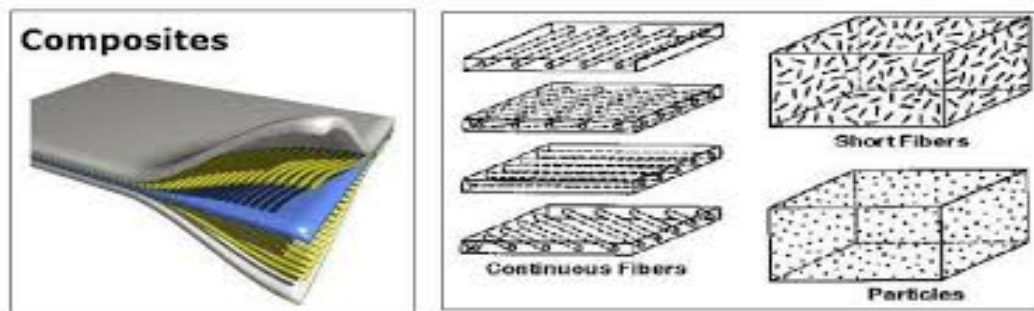
The mechanical behavior of the developed composite material shows that it can be used for various applications mainly for household furniture. The work proves that the waste banana fibers can be transformed into a valuable product.

**KEYWORDS:** ASTM, hardness, composite materials, fibers

## I. INTRODUCTION

### 1.1.COMPOSITE MATERIAL

Now a day composite materials have become a predominant one due to their superior properties. The volume and number of applications of composite materials have grown steadily that let to conquer new markets. The applications of composite materials in various fields. A typical composite material composes of two or more materials on a macroscopic scale. The advantage of both the materials is the strength to the composite material; the combination often eliminates the weakness of the individual materials. The composite material offers a list of benefits over other materials. The main advantage of the composite material that it is stronger and stiffer than metal



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## II. LITERATURE SURVEY

The study on natural fiber based composite materials is increasing day by day. Mainly due to their advantages like light-weight, low cost. In particular banana fiber based polymer composite attracted the interest of many researchers, due to that several works were done in this composites.

**Sujeet Kumar [1]** studied the mechanical behavior of banana fiber reinforced composite material based on epoxy resin. The specimen is prepared by means of hand lay-up process. It has been observed that fiber loading and length has major effect on the mechanical properties of composite like as hardness, impact, tensile and flexural strength. The composite with 10mm fiber length and 15% fiber content. Show a better mechanical properties compare to the other composition involved in the study.

**Alavudeen et al [2]**, studied the effect of weaving patterns and random orientation on the mechanical properties of banana, kenaf and banana/kenaf fiber-reinforced hybrid polyester composites. Composites were prepared using hand lay-up method with two different weaving patterns, namely, plain and twill type. Of the two weaving patterns, the plain type showed improved tensile properties compared to the twill type in all the fabricated composites. Furthermore, the maximum increase in mechanical strength was observed in the plain woven hybrid composites rather than in randomly oriented composites. This indicates minimum stress development at the interface of composites due to the distribution of load transfer along the fiber direction. Moreover, alkali (NaOH) and sodium lauryl sulfate (SLS) treatments appear to provide an additional improvement in mechanical strength through enhanced interfacial bonding. Morphological studies of fractured mechanical testing samples were performed by scanning electron microscopy (SEM) to understand the de-bonding of fiber/matrix adhesion.

**A. Baharin et al [3]**, produced laminated boards by laminating banana stem fiber boards with banana leaf tapes. Various laminated boards were created by changing the number of layers of leaf tapes. The tensile strength, elongation at break, flexural modulus and impact strength of the laminated boards increased with increasing number of layers of the leaf tapes. The elastic modulus of the laminated boards, however, showed the opposite trend. The orientation of fiber in the leaf tapes has little effect on impact strength but other properties studied show that the properties measured along the fiber orientation were higher than that in the perpendicular direction.

**Nithyanandakalia et al [4]**, presented the development of epoxy based composites with the incorporation of fly ash, an industrial waste, as reinforcement. In coal based thermal power plants fly ash is produced during power generation. Five different volume fractions (viz., 0, 5, 10, 15 and 20% fly ash) were used in the present study to synthesize the epoxy-fly ash composites. Effect of fly ash content on the mechanical properties of these composites under different mechanical test conditions was studied in a comprehensive way. The results suggested that the tensile and compressive strength of these composites increases with increasing fly ash content while the flexural strength and the impact strength decreases with increase in fly ash content. Detailed microscopic observations were carried out for all fractured surfaces.

**Madhukiran.J et al [5]**, carried out the investigation of the flexural properties of composites made by reinforcing banana and pineapple as the new natural fibers into epoxy resin matrix. The natural fibers were extracted by retting and manual process. The composites are fabricated using banana and pineapple fiber reinforcements. Hybrid composites were prepared using banana/pineapple fibers of 0/40, 15/25, 20/20, 25/15, and 40/0 weight fraction ratios, while overall fiber weight fraction (Wf) was fixed as 0.4. It has been observed that the flexural properties increase with the increase in the weight fraction of fibers to certain extent. The hybridization of the reinforcement in the composite shows greater flexural strength when compared to individual type of natural fibers reinforced composites. All the composites shows increase in flexural strength in longitudinal direction. Similar trends have been observed for flexural modulus, inter laminar shear strength and break load values.

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### III. EXPERIMENTAL SET UP AND PROCEDURE

#### PREPARATION OF MOLD AND MIXTURE

The raw materials used in this experimental work are

- Natural fibers
- Epoxy resin – LY556 and
- Hardener–HY951.

The mould box of size 350mm x 250 mm x 3mm is used for the preparation of the required composite. The resin and hardener are mixed first. By using hand lay-up technique, the composite plates were prepared, and the same technique is done for various weight fraction. The mould setup and preparation of specimen is shown in Fig. 3.3 and 3.4.



Fig.3.3.Mould setup



Fig. 3.4 Preparation of specimen

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## IV. RESULTS AND DISCUSSIONS

### 4.1. TENSILE TEST

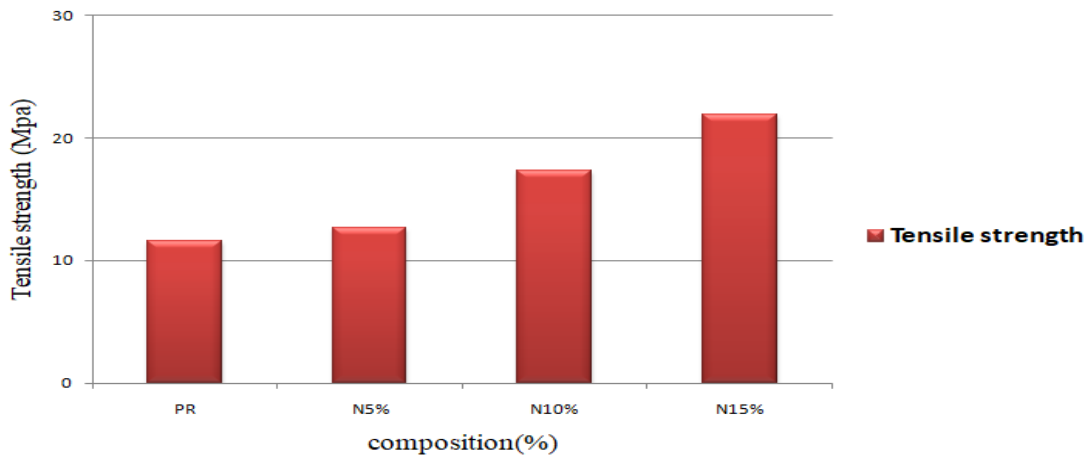


Fig.4.1. Tensile strength for different composition of banana fiber epoxy composite study samples

From the above result it clearly show that the tensile strength increases with the fiber content and the highest value is obtained at N15. It has been observed that the tensile strength of composites increases with increase in fiber loading that was indicated in many studies[6].

### 4.2. FLEXURAL TEST

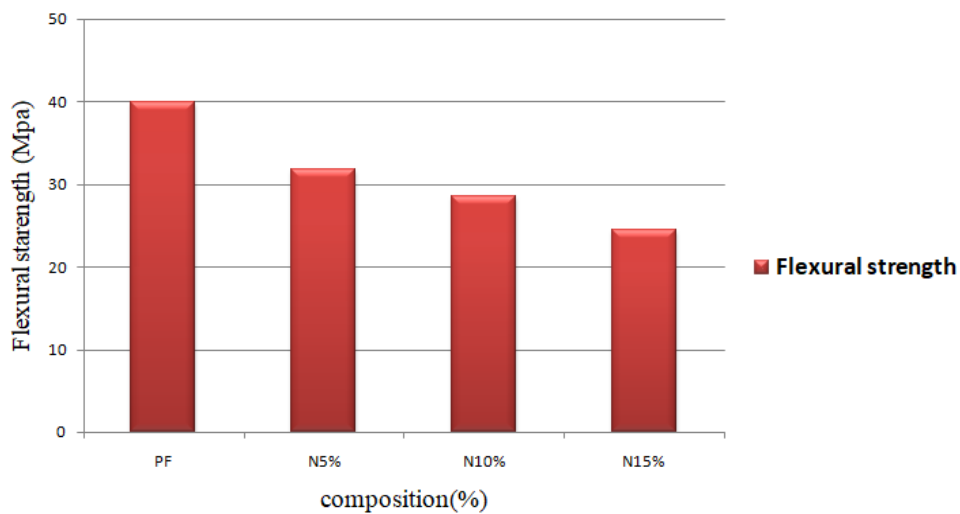


Fig. 4.2.Flexural strength for different composition of banana fiber epoxy composites study samples

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It shows that when fiber loading increases the flexural strength of the fabricated composites decreases. The decrease in flexural strength is due to a poor interface bonding among the banana fiber and epoxy. As the vol. % of banana fiber increases, the vol.% of epoxy decreases which makes an ineffective stress transfer from the matrix to the fibers, thus not allowing a full exploitation of the reinforcement[6].

### 4.3. IMPACT TEST

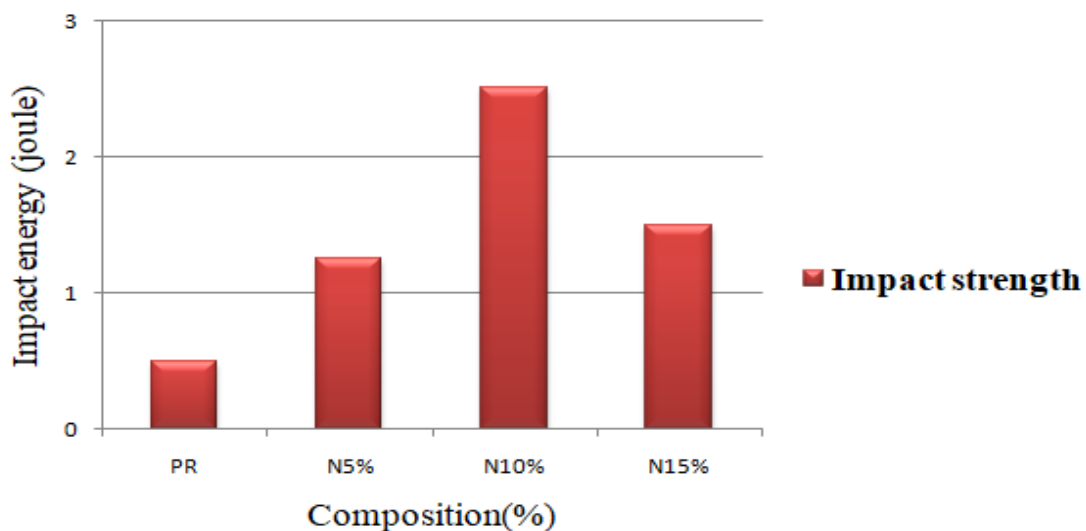


Fig. 4.3. Impact strength for different composition of banana fiber epoxy composites study sample

In case of impact strength, a higher value is given by 10% of fiber reinforcement. It has been observed that the impact strength of composites increases with increase in fiber loading to an extent of 10% fiber reinforcement. Impact properties are depends upon the cellulose content in the fibers

### V. CONCLUSION

A composite based on natural fiber and polymer was fabricated by hand layup technique and its mechanical characteristic were tested according to ASTM standard. From the experimental study the following conclusions have been drawn.

- ✓ The tensile strength of the composite increase with the fiber loading and the maximum fiber composition used in the study (15%) show the maximum tensile strength. The tensile strength show an increasing responses with the increase in fiber content in the composite.
- ✓ The flexural strength behaves contrary to the tensile strength, in which the flexural strength decrease with the increase in fiber content. The maximum flexural strength is given by the pure resin.

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- ✓ The impact strength increases up to 10% of fiber loading. But if the fiber content exceeds 10% of fiber loading, the fibers get contacted with themselves and due to this contact of fibers, the impact strength decreases.

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