Experimental Modal Analysis of Composite Beam

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Abstract

This paper presents an experimental investigation on modal analysis for natural fibre composite beams. The composite beams were developed using natural fibres such as sisal, banana, and bamboo fibres mixed with epoxy resin as a matrix material. Natural fibres are biodegradable and have low cost and are eco-friendly. The composite beams were developed using a hand-lay-up method for various angles such as 0°-90° and 45°-45°. Chemical treatments were used for improving interfacial shear strength between fibres and matrices. Impact testing and modal analysis were conducted on natural fibre composite beams. The natural fibre composite beams were found to have good properties for vibrations. The results indicated that natural fibre composite beams have good properties for mechanical strength and damping properties. The natural fibre composite beams can be used for applications where there is a need for light weight and high sensitivity for vibrations.

Index Terms: Sisal Fiber, Banana Fiber, Natural Fiber Composites.

1. INTRODUCTION

Composite materials are created by combining two or more materials with different properties to obtain the required properties. Composite materials consisting of natural fibers such as sisal, banana, and bamboo are widely used because they are light in weight, biodegradable, and cost-effective. The natural fibers consist of cellulose, hemicellulose, and lignin. These components provide the required mechanical properties. The use of natural fibers has been extended to engineering applications. Modal analysis is an essential tool in the determination of the vibration properties of the system. The natural frequency and mode shapes can be obtained. The experimental modal analysis has been carried out in this paper on the composite beam.

Sisal and banana fiber has been used as reinforcement material to increase the effectiveness of natural fibers. The composite was fabricated using the hand lay-up method. The testing was carried out for tensile, flexural, and water absorption. - Badrinath et al. [1]

Baharin et al. [2] said that from the banana stem and leaf, the laminated boards were produced. Tensile strength and impact strength and elastic modulus increase with the increase in the number of layers. The properties obtained in the fiber direction were more compared to the perpendicular direction.

Elenchezhian et al. [3] Paper aims at learning the mechanical properties of fiber composite materials. Gives review on the mechanical properties of Abaca, Jute, Sisal fibers, etc.

Jordan et al.[5]The aims study of two different chemicals for improving the bonding between the fibers and matrix like LDPE. Untreated banana fibers show an increase in the properties of the composite.

The aims of Ramesh et al. [7] this paper aims that natural sources provide indisputable advantages over synthetic material as low cost, non toxicand, minimum waste disposal problems. Samples with different fiber were fabricated by using hand layup method.

[8] This paper proposed that availability of natural fibers atlow cost and ease of manufacturing and having greatattentionof researchers towards possibilities of reinforcement. Chemically

treated natural fibers show better properties in impact, fatigue strength.

1. METHODOLOGY

A. Selection of Best Natural Fiber

There are many natural fibers available in the world which are named as natural fiber composites. Out of these fibers, some are having good properties in terms of reinforcement as well as mechanical properties. For preparation of our laminate, selected natural fibers such as Sisal and Banana natural fibers are selected. These fibers are easily available in our surrounding areas at very low cost.

B. Bleaching/Chemical Treatment

For removing lignin present on the surface of natural fibers as well as for improving strength of natural fibersit is very essentials to perform bleaching treatment on natural fibers. For chemical treatment on natural fibers,selected alkali solutions containing sodium hydroxide along with peroxide treatment. In this case, natural.

fibers are treated with 5% weight sodium hydroxide solution for a period of one day and then distilled water is used for washing. This process is again repeated for peroxide treatment, and finally fibers were dried in sun light.

Fig.1 Chemical Treatment

C. Extraction of Bleached Fibers

After chemical treatment next step was the extraction of treated natural fibers for separation purpose. This extraction is done by using hand. Separated all banana as well as sisal fibers in single fibers as shown in fig. 2.

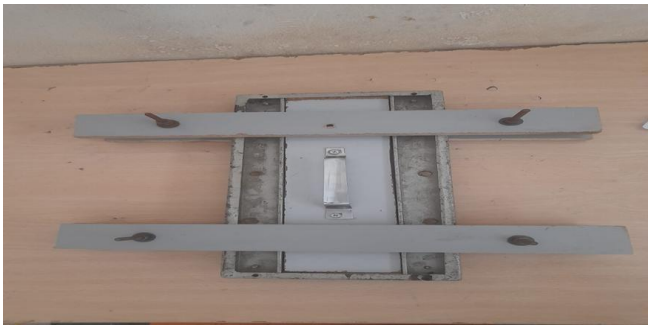


Fig.2 Extraction of fibers

D. Preparation of Metal Mold

The metal mold consists of a rigid metallic base with supporting side plates and clamping arrangement. Due to its high strength and dimensional stability, the mold ensures that the composite layers remain properly positioned during the fabrication process.

Fig.3 Metal Mold

E. Fabrication of Plate

After the preparation the Metal mold next step was preparation of the laminate by using epoxy resin having grade as LY556 and HY917 as Araldite and hardener respectively. Fibers were attached to mold by using of clamps of mold. Some weight is put over the plate so that it will be in uniform thickness, and After 8 hrs plate was ready.

Fig.4 Sisal plate

Fig.5 Bamboo Plate

F. Testing of Plate

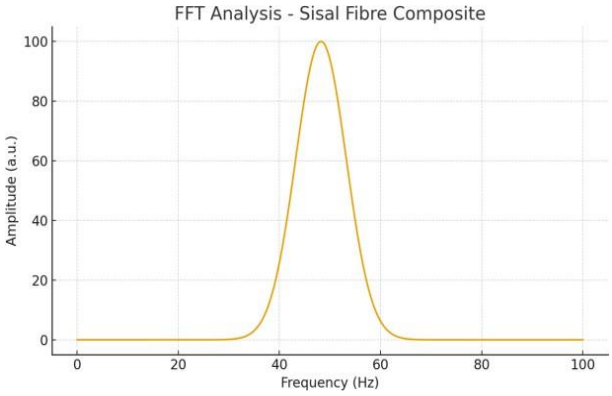
The Fast Fourier Transform (FFT) analyzer was used to measure the vibration response of the fabricated composite beam. An impact hammer test setup was used where the beam was excited at one end, and the vibration response was recorded using an accelerometer. The FFT analyzer converted the time-domain signal into frequency-domain representation to identify natural frequencies.

Fig.6 FFT Tesing

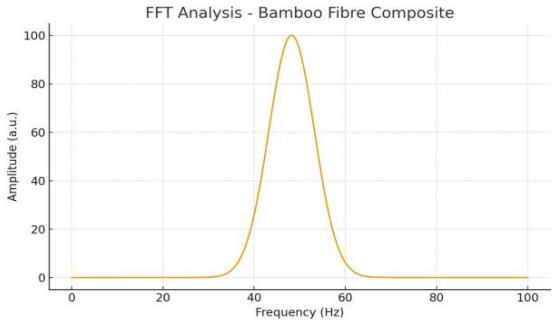
Fig.7 Vibration Lab

2. RESULTS AND DISCUSSION

A. Sisal Plate Vibration Testing Result



B. Bamboo Plate Test Result



C. Banana Plate Test Result

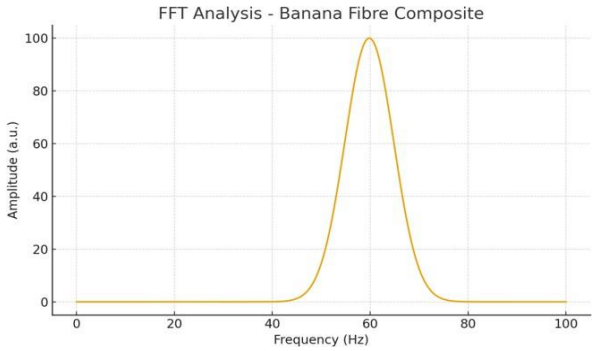


Table no. 1 Tabulated Results of Tests.

Fiber	Frequency
Sisal	48.22
Banana	59.81
Bamboo	48.22
Knef	54.93

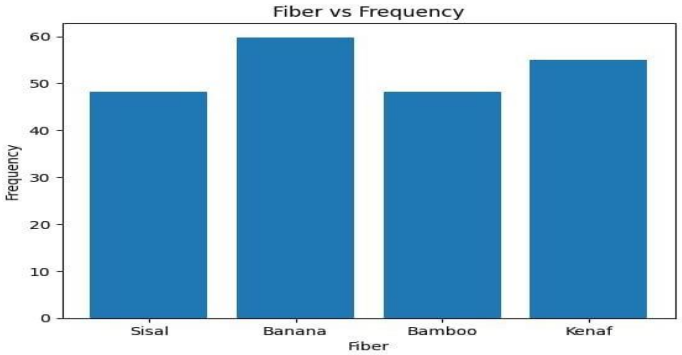


Fig.8 Result in Graph

3. CONCLUSION

The project successfully demonstrated the fabrication and modal analysis of a natural fibre reinforced composite beam. The use of bamboo, banana, and sisal fibres with epoxy resin provided a lightweight, eco-friendly composite material with good vibration resistance. The

FFT analysis produced comparable results, confirming the reliability of both experimental methods. Future work can focus on optimizing fibre orientation and resin ratio to further improve performance.

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