Communications on Applied Nonlinear Analysis
ISSN: 1074-133X
Vol 31 No. 1s (2024)

Experimental Analysis of Mechanical Tests on a Plate Composed of Banana Fibre

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Article History:

Received: *03-02-2024*

Revised: *05-04-2024*

Accepted: *22-04-2024*

Abstract:
Due to their attractive characteristics, natural and synthetic fibre - reinforced hybrid composite materials are playing a prominent role in science. Innovators are now being drawn to the poor world to create new sustainable and environment products and materials focused on environmental objectives. Natural fibre has a number of advantageous qualities, including low density, non-toxicity, and minimal comparability in strengths, minimal waste disposal issues, and inexpensive cost. This study presents the experimental analysis of mechanical tests performed on a plate composed of banana fiber. The mechanical properties, including tensile strength, flexural strength, and compression strength, were evaluated to assess the performance and potential applications of the banana fibre plate. The experimental tests were conducted following standard testing procedures specified by ASTM. The results obtained provide valuable insights into the mechanical behavior of the banana fibre plate and contribute to the understanding of its suitability for various engineering applications.

Keywords: Banana fibre, mechanical tests, tensile strength, flexural strength, compression strength.

1. INTRODUCTION

A lingo-cellulosic fibre called banana fibre is derived from the pseudo - stem of the banana tree. Banana fibre is a strong fibre with decent mechanical characteristics. The specific strength characteristics of banana fibre are good and on par with those of more traditional materials like fiberglass. This substance is less dense than glass fibers. The pseudo-stem is made up of a coiled, grouped collection of leaf stalk bases. Banana fibre is a byproduct of banana farming that either isn't fully or improperly used. If these fibers were put to good use, the demand would stabilize and prices would drop as a result. Natural fibers have excellent fire protection, light in weight, low flexibility, good moisture absorption, huge potential, and biocompatible. Natural fiber has been used for clothing and furniture. Banana fibre offers significant potential for creating paper, especially for the growing market for recycled paper. Products including filter paper, paper bags, cards, lamp stands, pen stands, decorative papers, rope, mats, and composite materials are all made from banana fibre. Germany and India are both testing the use of banana fibers in banknotes. The floor safety shields used in opulent vehicles like Benz are made of polypropylene reinforced with banana fibre. The majority of products made with banana fibre are crafts and domestic accents. Due to their intrinsic qualities, natural fibre reinforced hybrids now outperform artificial fibre reinforced polymer composites in terms of mechanical properties. The mechanical characteristics of both natural and artificial fibre reinforced polymer composites with various fibre volumes, including fracture toughness, modulus of elasticity, and impact strength, were assessed. The outcome showed that mechanical qualities had significantly improved, and the procedure of hybridization had decreased the dangers associated with environmental concerns. Banana fibre, a byproduct of banana farming that is commonly accessible in tropical nations like Malaysia and South India, was used to create the composite materials. When compared to artificial fibers, this fibre holds a superior mechanical strength and offers several advantages. In order to determine the bending moment under the conditions of peak output, they constructed 3 samples with various shapes, assessed the maximum stress value and elastic modulus along opposite paths, and discovered the peak deflection. Researchers tested the tensile and flexural characteristics of bio composites, and the findings were analyzed. They discovered from the study that adding natural fibers like sisal to glass fibre increases the tensile and flexural strength, and that these combinations are essential in the technical fields and innovation. They recommended using these composite materials for applications requiring moderate strength.

Venkateshwara et al. investigated the mechanical characteristics of epoxy synthetic structures reinforcement with sisal as well as banana fiber, including their tensile strength, flexural strength, impact resistance, and moisture absorptive. They have shown that hybridizing sisal material up to 50% by weight with banana fibers bound epoxy resins results in a considerable increase in structural rigidity and a decrease in the rate of moisture absorption. When compared to flax and GFRP combinations, banana and GFRP composites have good tensile properties with minimal deflection. In addition, as comparison to flax and glass fibre reinforced polymer matrix composites, banana and flax fabric composites have higher impact and flexion strengths. When in comparison to synthetic fibre reinforced composites, natural fibre reinforced composite materials are an environmentally benign, sustainable, compostable, and lighter material. The potential uses for these composites are expanding quickly across a wide range of engineering specialties, particularly when cost of materials and erosive environment improvement are concerns. Under ambient pressure, natural fibre composites containing sodium hydroxide can have their mechanical and physical properties enhanced without significantly altering their mechanical behavior. Researchers have examined the impact and fatigue behavior of non-woven hemp fibre composites bonded with polyester and discovered a major improvement in such qualities. Natural fibres offer significant benefits such low density, superior mechanical qualities, high degradability, and recyclability. They are also disposable and reusable. The utilization of natural fabrics as reinforcing has been the subject of extensive investigation. The pseudo-stem of the banana tree yields banana fibre, a ligno-cellulosic fibre with high reliable qualities. The "pseudo-stem" is a cylinder-shaped grouping of leaf stalk bases. Currently, banana fibre is a byproduct of banana farming that is only partly or improperly utilised. It is uncommon to remove fibre from the pseudo stem, and a significant portion of the stem isn't used to make fibres. When compared to other natural fibres, banana fibres are pricier. Banana fibre sales are sporadic, and there is no reliable method of routine fibre extraction. If these fibres were put to good use, the supply would stabilise and prices have fallen as a result.

Zaman and colleagues point out that Bangladesh is one of the top banana-producing countries worldwide, which means there's a lot of leftover banana plant waste. However, they suggest that this waste can be turned into something useful like banana fibre. This fibre can benefit both rural areas and industries economically. They discuss how banana fibres have cool properties when it comes to handling stress and mechanical stuff. They're saying that compared to other natural fibres, banana fibers are pretty awesome. Thus, manufacturing composites—essentially combining banana fibers with other materials—allows us to create items that are both affordable and robust. These goods could find applications in a wide range of fields, including transportation, aircraft, sporting equipment, and everyday things like mats, decorations for your house, and even paper. Ultimately, they advise us to continue investigating this concept. Perhaps new applications for banana fiber can be discovered, and its production costs might be reduced even further.

Badanayak et.al. are discussing making a special kind of strong material by treating fibres from sisal, bamboo, and Jamaican bananas with chemicals. They suggest these materials could be useful in making things like aeroplanes and cars. They say banana fibers are especially good for this. The Paper explains how they treat these fibres to make them even better and also discusses some techniques used to study the fibres and figure out how good they are for making stuff. They say we should keep researching to find more ways to use these fibres and make machines better and cheaper. The author also suggests looking into pineapple leaf fibres to see how they could make things even better.

Iqbal et.al. talk reveals that how more people are looking at using natural plant fibers for different purposes. These fibers are said to be better than synthetic fibers because they are natural, biodegradable, renewable, lightweight and have durable properties. The focus is on banana fibers, which is important because bananas are everywhere. They suggest about the different parts of the banana like the fruit, skin and leaves that can be used for all sorts of things. The branch-like part of the banana, the pseudo-stem, has very good fibers that can be used for a wide variety of purposes. The author also said that the waste left over from the production of these products can be used for other purposes, which can help the country's economy. They say their research provides vital information for farmers, business owners, policymakers, scientists and governments to make smarter decisions and help the country grow.Several studies have been conducted to explore the diverse applications and properties of banana fiber in composite materials. These studies delve into various aspects such as dyeability, mechanical properties, and potential enhancements brought by banana fibers in different composite matrices. Investigations cover a wide range of composite materials, including polypropylene, recycled high-density polyethylene, epoxy, and sawdust-based bio-composites. Furthermore, hybrid composites combining banana fibers with other natural fibers like sisal are explored to enhance mechanical properties. Additionally, enzymatic treatments using cellulase and pectinase enzymes on banana pseudostem fibers aim to improve their properties for textile applications. These studies contribute valuable insights into the development of sustainable materials by utilizing banana fibers, potentially offering lightweight, eco-friendly solutions for diverse industrial applications.

2. PREPARATION OF BANANA FIBRE PLATE

To make a component, we start by getting a wooden box in the right shape. Then, we use a brush to put resin on the box.Next, we add the desired color on top of the resin. After that, we apply more resin on top of the color. On top of that, we place glass fiber. Then, we add more resin to make sure the glass fiber sticks well and forms one piece. Next, we put banana fiber on top, making sure it sticks with the resin. We add another layer of resin over the banana fiber, then place more glass fiber on top. Finally, we add another layer of color using resin on top of the glass fiber.

3. TEST RESULTS

3.1 Flexural Test

Flexural specimens are created in accordance with ASTM D790, and Universal Test Machine is used for the analysis. The test is conducted by inserting the test sample into the UTM and exerting stress on it until it broke and fractures.

Table 1: Flexural Test Result

Sr No	Sample Identification	Flexural Strength (MPa)
1	Horizontal	124.94
2	Vertical	92.7
3	Inclined (45^{o})	138.09

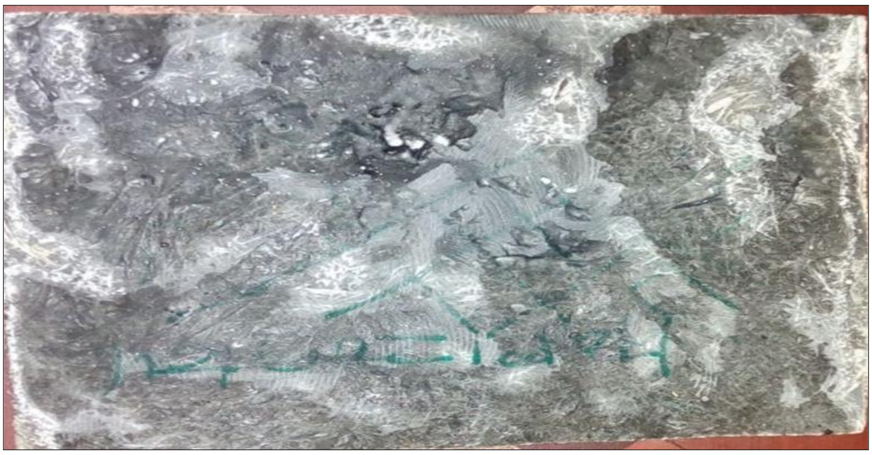

Fig.1: Banana Fibre Plate for Flexibility Test.

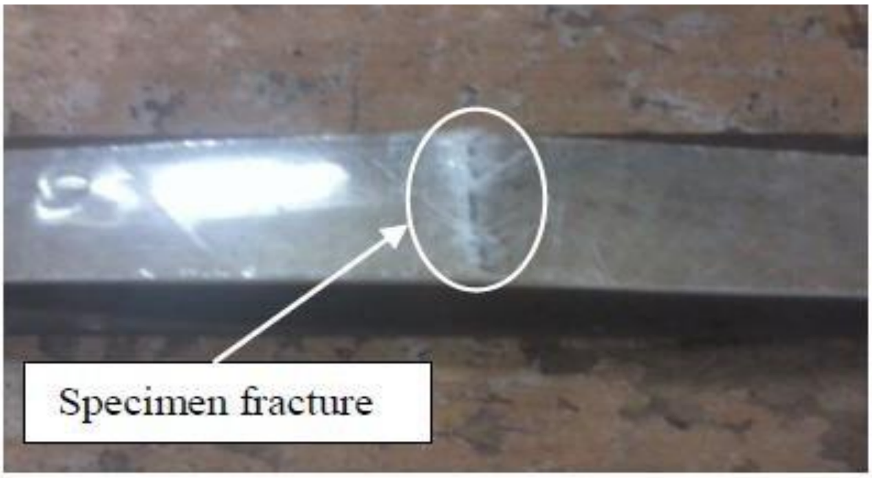

Fig.:2 Fractures after Flexibility Test

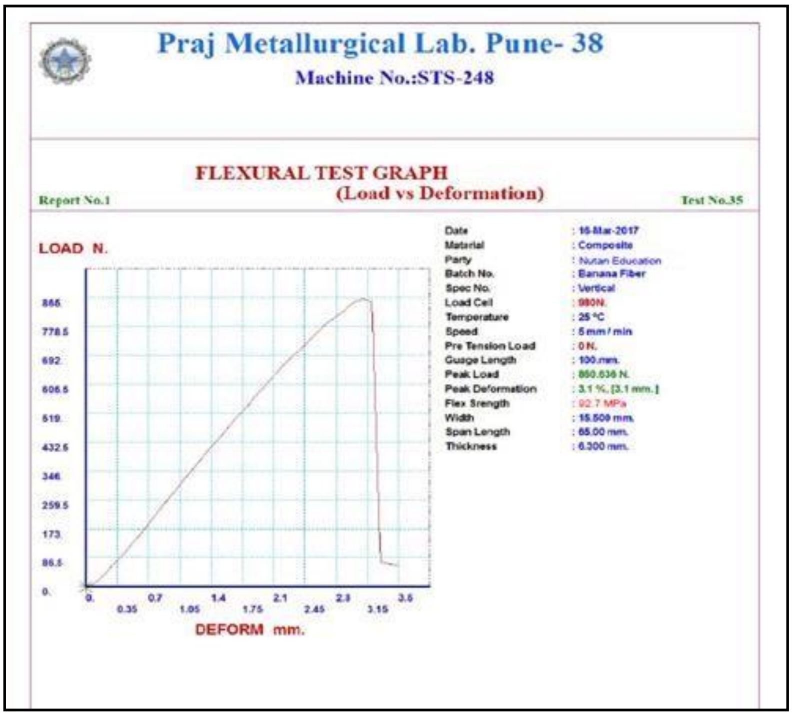

Fig. 3 Graph of Vertical Orientation of Banana Fibre Plate.

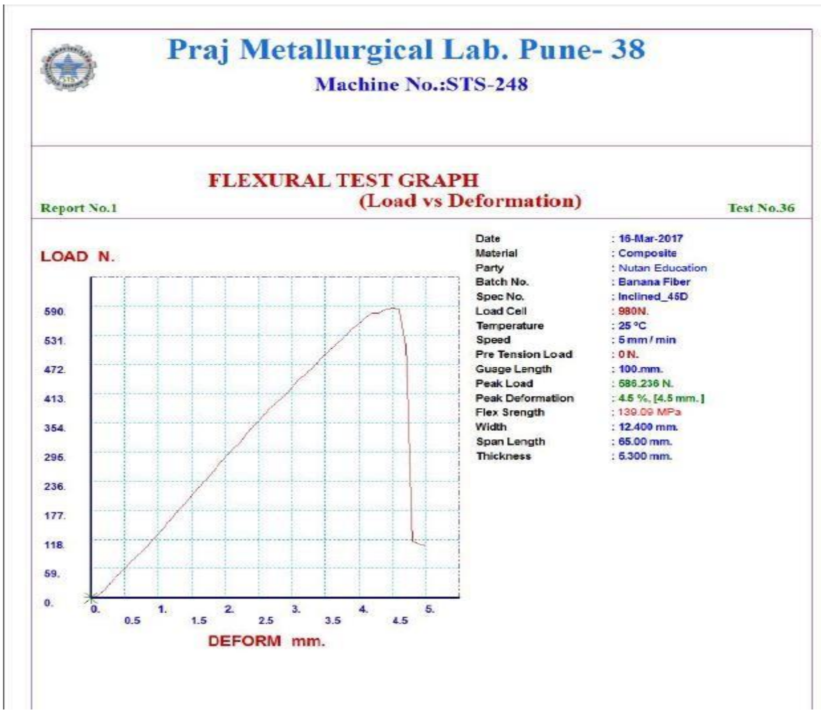

Fig.:4 Graph of Inclined (450) Orientation of Banana Fibre Plate.

3.2 Tensile Test

Using a manual cutting tool, the sample was formed to the appropriate dimensions, and sand paper was used to polish the edges. It is manufactured in accordance with ASTM D638. On the Universal testing machine, the tensile test is conducted. The sample is put on the Universal testing machine, and force is applied until the material breaks.

Table 2: Tensile Test Result

Sr. No.	Sample Identification	Tensile Strength(MPa)
1.	Dumble Shaped Plate	224.31

Fig.5 Specimen for Tensile and Compression test

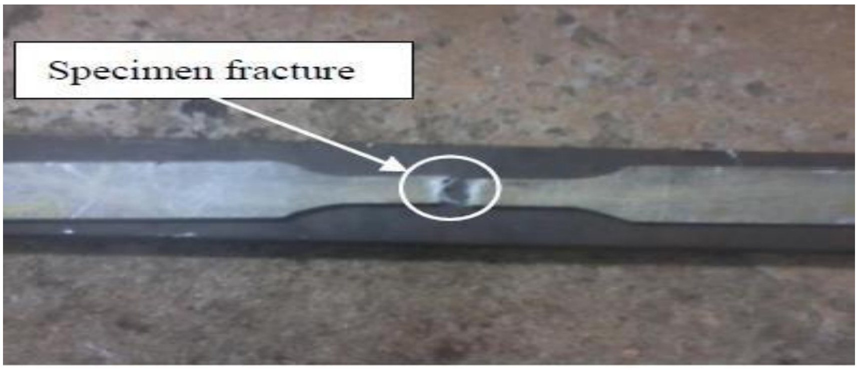

Fig.6 Specimen after Tensile Test.

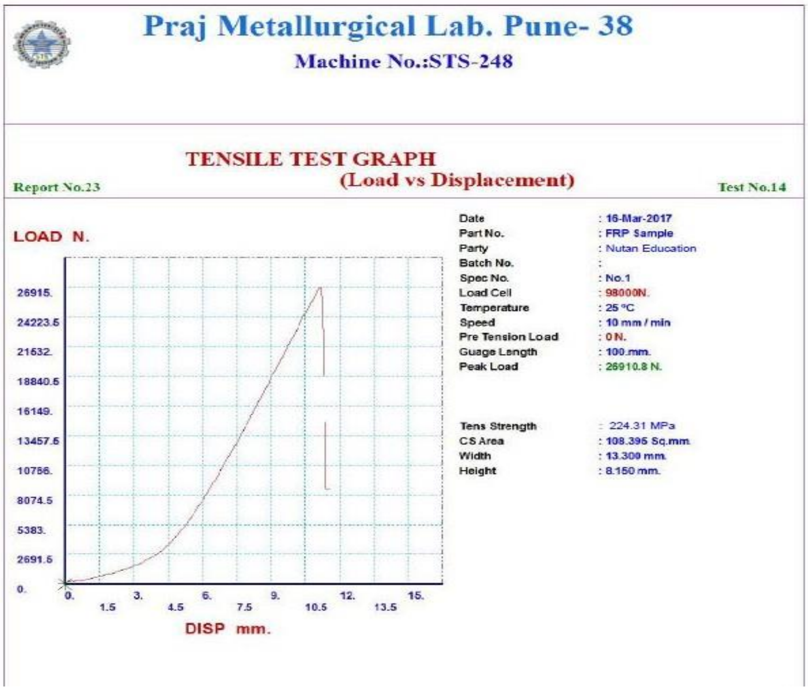

Fig.7 Graph of Tensile Test.

3.3 Compression Test

Using a rectangular plate and sand paper, the manufactured sample is molded to the necessary specifications. It was made in compliance with ASTM D638. The universal tester is used to conduct the compressive strength test.

Table 2: Compression Test Result

Sr. No.	Sample Identification	Compressive Strength (MPa)
1.	Square Plate	226.03

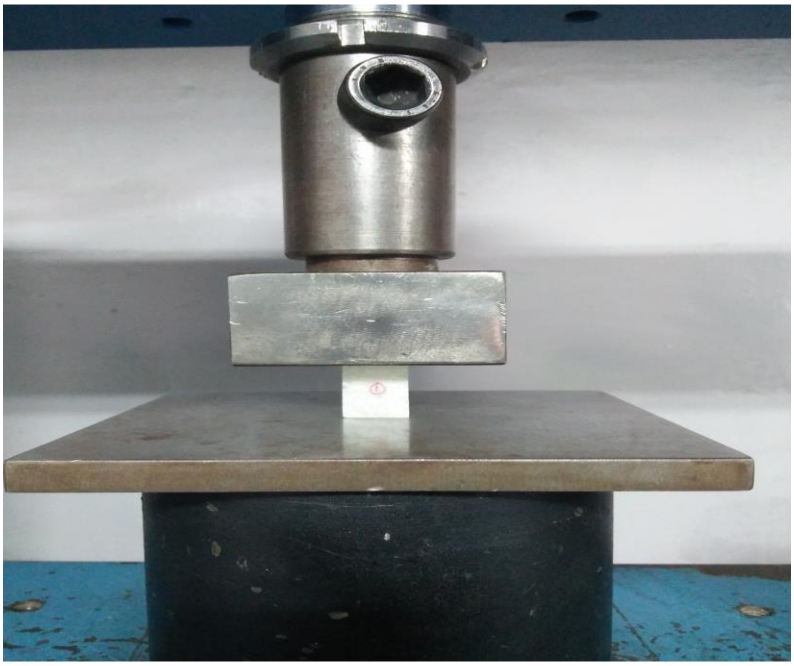

Fig. 8 Compression Test Setup.

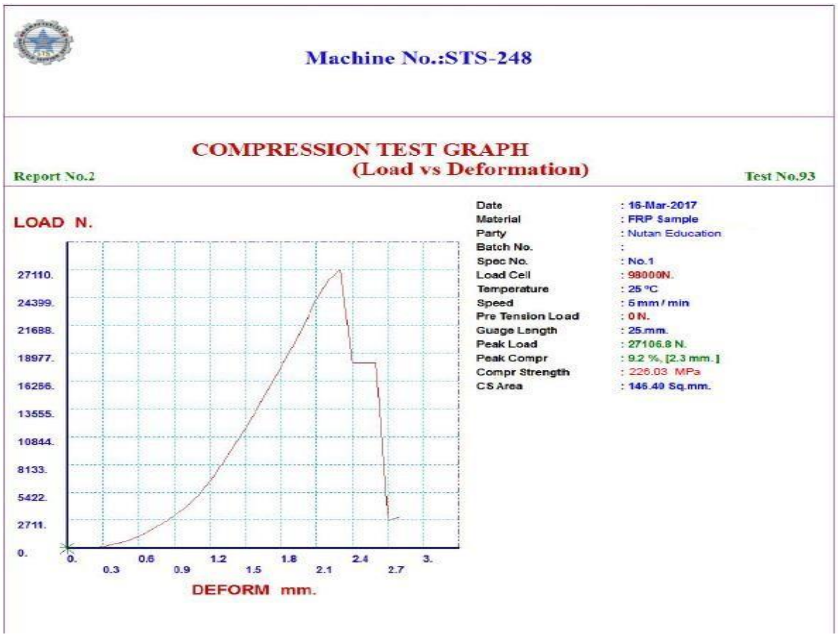

Fig.9 Graph of Compression Test.

4. CONCLUSION

The empirical work has resulted in the following findings. Dumbbell Shaped Plate has a maximum tensile strength of

224.31 MPa. The maximum flexural strength is 124.94, 92.70, and 138.09 MPa in various positions such as horizontal,vertical, and inclined (45°), respectively, and this value is also maintained by the same composite sample combination.

226.03 MPa is the maximum compression strength when using square plates. The SEM examination clearly shows the type of fibre fracture brought on by mechanical loading, the development of cracks in the matrix layer, and matrix failure.

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