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PERFORMANCE ANALYSIS OF NATURAL HYBRID COMPOSITE FIBRE STRENGTH

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In this work, a hybrid layered natural composite made of banana and Bristol coir is constructed using a hand layup process, and the mechanical characteristics are investigated using numerical analysis, Finite Element Analysis, and experimental investigation. The mechanical properties of the proposed hybrid natural composite were numerically evaluated using an excel sheet, and the tensile and flexural strength results were derived by FEM analysis utilising. Tensile and flammability tests are carried out, and the experimental findings are reported. When the numerical analysis findings are compared to the experimental test results, it is found that the divergence between the result is very close percentage for all produced laminates.

1. INTRODUCTION

Understanding how natural composites are generated and how they attain their exceptional features allows researchers, scientists, and engineers to create new materials that imitate or improve on these properties. This has a wide range of uses, including building, transportation, biomedical engineering, and renewable energy. Polymer matrix composites consist of a polymer resin as the matrix material and a variety of reinforcements. because of its low density, strong thermal and electrical insulators, ease of fabrication, and inexpensive cost, this type of composite is used in a wide range of composite applications [1]. The composite material is defined as the macroscopic combination of two or more components necessary to generate a third useful substance (shown in fig 1). The term macroscopic refers to a component that can be identified with the naked eye.

Fig.1 Composite Material

2. BACKGROUND WORK

The use of banana and Bristol coconut fibre attracts the researchers in the field of composite material design because it is easily available in the nature and its treated fiber may be used to fabricate as reinforcing agent in polymer-based composites due to its structure, physical, and mechanical properties. Alexander et al.[1] have presented because of its better strength-to-weight ratio as compared to metals, glass fibre composites are commonly employed in engineering applications.Tribological properties of these composites vary with operational conditions and fiber distribution. Bobbili et al.[2] have synthesized a sustainable bio-composite material using polypropylene (PP) reinforced with banana fibers (BF) and permeated with nano manganese oxide (MnO2). Different samples were synthesized with varying percentages of PP, BF, and MnO2. Binoj et al.[3] have discussed the global consumption of thermoplastic materials derived from fossil sources and the associated environmental impacts due to energy consumption during their production and processing. They proposed using natural materials such as banana fibre (BF) as a sustainable option to progressively replace these thermoplastic polymers.

The insights from this work can guide composite manufacturers, designers, and users in selecting appropriate composite materials for thermal and acoustic applications, such as interior components, brake ducts, engine component covers, heat shields, and more. Chun et al.[5] have presented a study in which thermoplastic composite and glass fibre packing foam sheets were effectively manufactured using the Dunlop technique. Activated carbon (AC) was utilised as a filler to improve mechanical characteristics and absorb ethylene gas generated by packed bananas. Das et al.[6] have proposed an unique method for producing natural fiber-reinforced polymer composites with mechanical qualities equivalent to glass fibre composites without the use of any chemicals. Fiber reinforcement was taken from the pseudostem of the Nendran banana plant, and a needle punching technique was used to create a non-woven fabric composite. Dhanalakshmi et al.[7] have demonstrated the use of natural fibers in polymer composites. These cost-effective fibers have low density and high specific attributes. Natural fiber composites exhibited attributes similar to those of regular fiber composites, including excellent mechanical properties, high specific strength, low abrasion, eco-friendliness, and environmental sustainability. Huang et al.[10] have researched the best way to hybridise banana-coir fibre particles in a polymer matrix for possible use in automotive component design and manufacture. They used a Central Composite Design with control factors such as particle size, volume fraction, and stirring time, while evaluating tensile strength and flexural strength as response variables. Wang et al.[11] have emphasized the significance of studying the behavior of pesticide residues in fruits to ensure the effective application of pesticides and minimize the risk of pesticide exposure to humans. This research aims to investigate the effect of selected chemical treatment on Banana fiber. This work also investigated the potential of using chemically modified Banana fibers (BPF) as reinforcement for polyester composites manufacture.

3. METHODOLOGY

The main idea behind the creation of a Banana and Bristol coir composite is to combine the beneficial features of these two natural fibres to produce a material with superior mechanical properties while also utilising sustainable and renewable resources. Banana fibres are known for their high strength, low weight, and good biodegradability, as well as their chemical and thermal stability, whereas Bristol coir fibres have exceptional moisture resistance, durability, and sound absorption properties. Finite number by dividing the solution region into small parts called elements and by expressing the unknown field variables in terms of assumed approximating functions (Interpolating functions/Shape functions) within each element. The approximating functions are defined in terms of field variables of specified points called nodes or nodal points. three samples are fabricated i.e., BCB, CBC and BBC using three different square plate. It is very important and necessary to develop proper hybrid composite plate fabrication method. There are lots of fabrication methods to develop composite plate. It is essential for the reader to know how these materials are made. In present research work, hand lay-up method has been used to fabricate composite plates. Specimen's preparation kit are fabricated by hand layup technique and cured under room temperature.

4. UMERICAL ANALYSIS

The Excel Software is used to find the Mechanical Properties of the proposed natural hybrid composite. The mechanical properties data may be used to draw the stress-strain relationship of the proposed natural hybrid composite as shown in the Fig. 4.1 which illustrates that the stress-strain relationship of the proposed natural fiber-reinforced composite which depends on several factors such as the fiber volume fraction, fiber orientation, and the properties of the matrix material used. Natural hybrid fiber-reinforced composites have lower stiffness and strength than synthetic fiber-reinforced composites. They do, however, offer greater damping qualities, which can be useful in some applications.

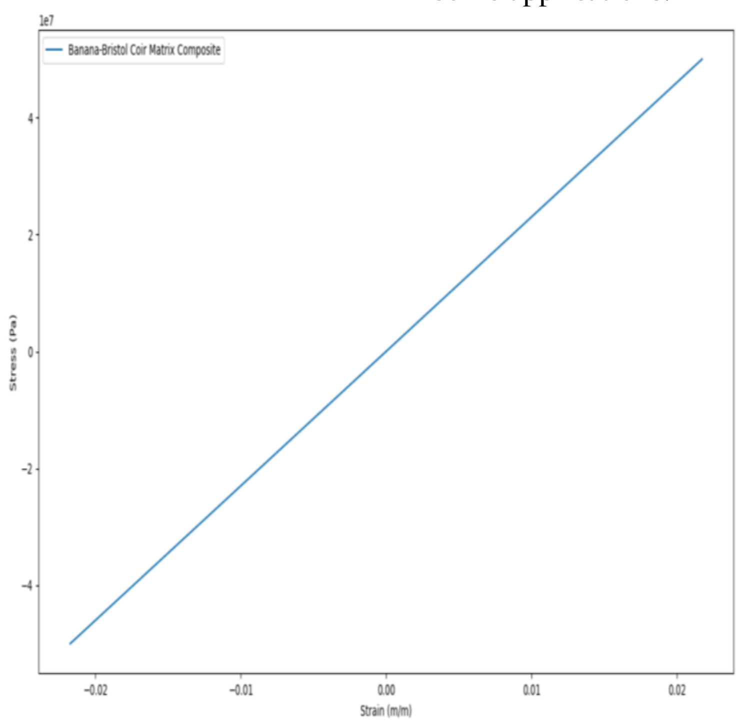

Fig. 2 Stress-Strain relation of the proposed composite

5. FEM ANALYSIS

ANSYS is a widely used software package for finite element analysis (FEA). In present work, ANSYS Design Modeler has been used to create geometry of composite as shown in Fig. 4.2. This is a built-in geometry modeling tool within ANSYS Workbench, which is the graphical user interface for ANSYS. Design Modeler provides a robust set of tools for creating and modifying geometry directly within the ANSYS environment. Mesh generation is an important phase in finite element analysis (FEA) that includes breaking down a model's geometry into smaller finite elements in order to discretize the domain for analysis. The accuracy and efficiency of the FEA solution, as well as the quality of the results obtained, are determined by mesh generation shown in fig 3.

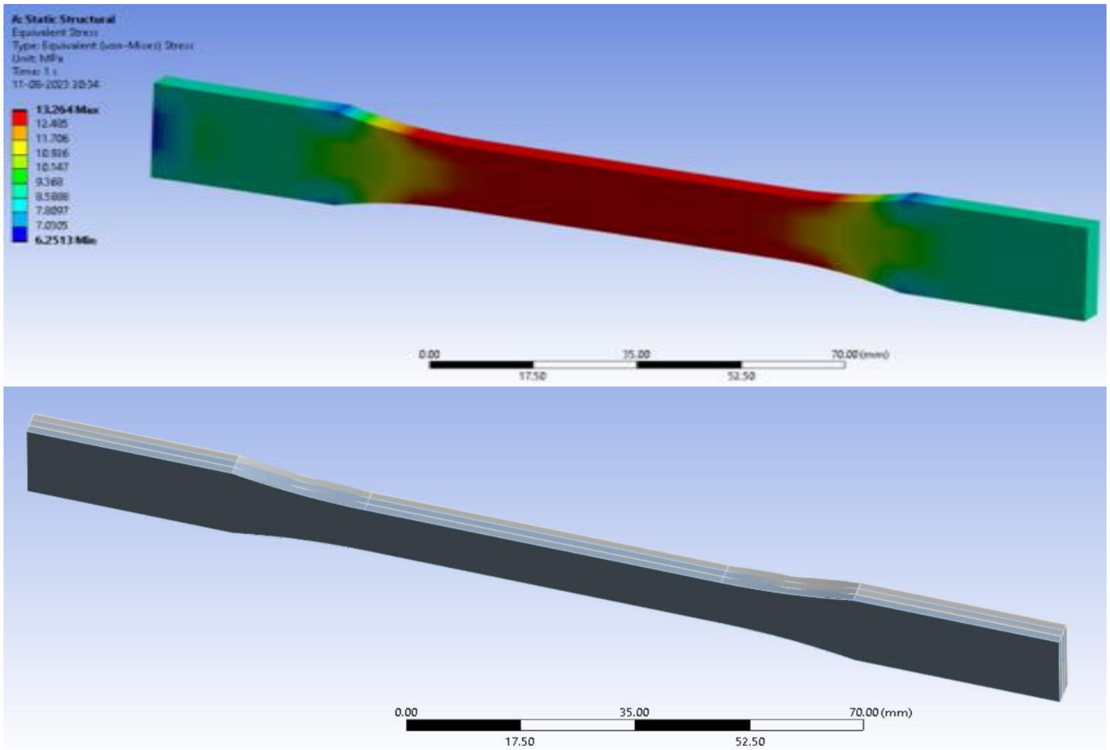

Fig 3 FEM analysis

6. EXPERIMENTAL ANALYSIS

The tensile strength of the proposed composite samples BCB, CBC, and BBC is depicted in Fig. 4. The analysis reveals that the designed BCB exhibits the highest tensile strength, while the designed CBC demonstrates the lowest tensile strength. The maximum von Mises stress distribution for the intended BCB is 23.54 MPa, while the lowest von Mises stress distribution is 11.623 MPa, based on the simulated findings for the tensile strength. Furthermore, the maximum von Mises stress distribution for the planned CBC is 13.364 MPa, and the minimum von Mises stress distribution is 6.2613 MPa. Furthermore, for the strength of the designed BBC, it has been found that the maximum von Mises stress distribution is 16.354 MPa, with the minimum von Mises stress distribution being 7.6233 MPa.

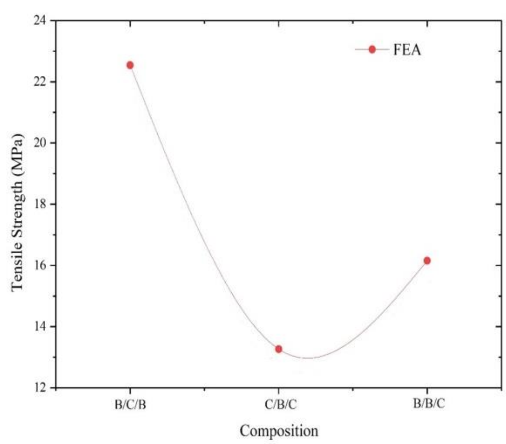

Fig 4 Tensile stress Graph

A Burning test is a type of laboratory procedure used to evaluate the ignitability and fire behaviour of materials. This test is crucial for assessing the potential fire hazard posed by various materials, especially those used in construction, textiles, furnishings, and other products. This works the horizontally burning test value obtained as shown in Fig 5. Parameters such as burn rate, dripping, and flame spread are measured.

Fig 5 Burning test of natural fibre

7. Conclusions

The proposed natural composite were obtained using excel sheet, revealing a proportional relationship between stress and strain. In the second part, numerical results for the proposed natural fibers were acquired using ANSYS software. The numerical analysis, a hand layup method was employed to fabricate the proposed natural layered fiber-reinforced composites utilizing banana and coir fibers. The laminates were prepared using a hand layup technique, and tensile and flexural tests were performed in accordance with ASTM standards. A comparative study of the mechanical performance between banana and coir fiber-reinforced epoxy composite laminates was conducted, with numerical results validated through experimental tests. To overcome the limitations of ANSYS, additional tests including tensile, flexural, water absorption, and flammability tests were carried out to obtain experimental results. Apart from hand lay-up method another fabrication method using machine may be used to fabricate the natural layered composite and various tests may be performed to check the mechanical strength.

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