Ra. Aravind, 2023, 11:6
ISSN (Online): 2348-4098
ISSN (Print): 2395-4752

International Journal of Science, Engineering and Technology

An Open Access Journal

Assessing the Mechanical Properties of Banna Glass Fiber Reinforced Epoxy Hybrid Composites

Ra. Aravind[1], V. Nagamanikam[2], J. Jasim Ahamrd[3], C. Kirubakaran[4]

Assistant Professor, Mechanical Engineering, Kongunadu college of engineering and technology, Trichy, India[1]
Mechanical Engineering, Kongunadu college of engineering and technology, Trichy, India[2,3,4]

Abstract- The increasing demand for environmentally friendly materials and the desire to reduce the cost of traditional fiber lead to the development of natural fiber composites. Natural fibers presented in the composite have some important advantages such as low density, appropriate stiffness, mechanical properties and renewability. In the present work deal with fabrication and investigation of mechanical properties of banana fiber, glass fiber and reinforced with epoxy resin as natural hybrid composite, they are recyclable and biodegradable. The Composites of different combinations with varied fiber content were prepared using hand lay-up technique using epoxy resin and hardener as reinforcing materials. Banana fiber with 30, 25 and 20% were hybridized with 10, 15 and 20% of E-glass fiber to form composites and compared with normal Banana fiber and epoxy resin composites. The results thus obtained signified mechanical properties got improved in Banana -glass hybrid composite with increased glass fiber content from 10%-20%, thus acting as a positive reinforcement in providing extra strength and smooth surface finish to the composite and at the same time the Banana fiber imparted elasticity to the composite.

Keywords- Spiral baffles, Helical coil spring, Double pipe heat exchanger, Overall heat transfer coefficient, Pressure drop.

I. INTRODUCTION

The term composite can be defined as a material composed of two or more different materials, with the properties of the resultant material being superior to the properties of the individual materials being superior to the properties of individual material that make up the composite. Glass Fiber Reinforced Polymers is a fiber reinforced polymer made of a plastic matrix reinforced by fine fibers of glass. Fiber glass is a lightweight, strong, and robust material used in different industries due to their excellent properties. Although strength properties are somewhat lower than carbon fiber and it is less stiff, the material is typically far less brittle, and the raw materials are much less expensive. Its bulk strength and weight properties are very favorable when compared to metals, and it can be easily formed using molding processes. Now a day's natural fiber such as Banana and jute fiber composite materials are replacing the glass and carbon fibers owing to their easy availability and cost. The use of natural fibers is improved remarkably due to the fact that the field of application is improved day by day especially in automotive industries. Several researches have been taken place in this direction. Most of the studies on natural fibers are concerned with single reinforcement. The addition of natural fiber to the glass fiber can make the composite hybrid which is comparatively cheaper and easy to use.

In the present study the mechanical properties of Banana–glass fiber reinforced composite materials

is studied. The Banana composite materials are manufactured by hand lay-up process. The properties such as tensile, hardness, impact and water absorption test are studied and presented in detail.

The attraction in utilizing natural fiber, for example, distinctive wood fiber and plant fiber as support in plastics has expanded drastically throughout last few years. Concerning the ecological viewpoints if natural fibers might be utilized rather than glass fibers as fortification in some structural provisions it might be extremely intriguing. Natural fibers have numerous points of interest contrasted with glass fiber, for instance they have low thickness, and they are biodegradable and recyclable. Also, they are renewable crude materials and have generally great Strength and stiffness.

II. LITERATURE REVIEW

M.Ramesh, et.al., (2023),[1] In the fast-developing world, the concern for the environmental pollution and the prevention of non-renewable and nonbiodegradable resources has attracted researchers seeking to develop new eco- friendly materials and products based on sustainability principles. The fibers from the natural sources provide indisputable advantages over synthetic reinforcement materials such as low cost, low density, non-toxicity, comparable strength, and minimum waste disposal problems. In the present experiment, banana fiber reinforced epoxy composites are prepared and the mechanical properties of these composites are evaluated. The composite samples with different fiber volume fractions were prepared by using the hand lay-up process and apply pressure at room temperature. The samples were subjected to the mechanical testing such as tensile, flexural and impact loading. Scanning electron microscope analysis is carried out to evaluate fiber matrix interfaces and analyze the structure of the fractured surfaces.

P. Sathish, et.al., (2023),[2] Fiber composites are having lot of advantages and applications which are bio degradable, economical and non-toxic. Hence, they are replacing conventional materials in aerospace, automotive, agriculture and construction industries. Natural fibers such as Abaca, sisal, jute, acacia, ramie, hemp, flax, bamboo and banana are preferred in general in industries for making composites using epoxy and polystyrene resin. Normally, hand layup method is preferred for making composites because of its simple procedure and low cost.

T. Hariprasad, et.al., (2022),[3] The use of natural fibers as reinforcement in polymers has gained importance in recent years due to their eco-friendly nature. Thus, an investigation has been undertaken on banana-coir, which is a natural fiber abundantly available in India. Natural fibers are not only strong and lightweight, but also relatively very cheap. Composite plates were prepared with resin 392 g, coir 54 g, and banana 69 g. The purpose of this work is to establish the tensile, flexural, and impact properties of banana-coir reinforced composite materials with a thermos set for treated and untreated fibers. The resin used was epoxy (EP306). The tensile and impact tests showed that treated banana- coir epoxy hybrid composites have higher tensile strength and impact strength than untreated composites. However, untreated fiber composites have greater flexural strength than the treated fiber composites. The finite element analysis software Ansys has been employed successfully to evaluate the properties. The stresses at the interface of the banana-coir and matrix, induced by the different loading conditions, were applied to predict the tensile, impact, and flexural properties by using the models. The model output was compared with the experimental results and found to be close. This analysis is useful for realizing the advantages of hybrid fiber reinforced composites in structural applications and for identifying where the stresses are critical and damage the interface under varying loading conditions.

G.Navaneethakrishnan, et.al., (2022),[4] The increasing demand for environment friendly materials and the desire to reduce the cost of traditional fiber lead to the development of natural fiber composites. Natural fibers presented in the composite have some important advantages such as low density, appropriate stiffness, mechanical properties and renewability. Also, they are

recyclable and biodegradable Glass fiber and Banana fiber reinforced silica nanoparticles filled epoxy bio-nanocomposite have been prepared for the evaluation of tensile strength and impact strength. Banana fibers obtained from the stem of banana plant have been characterized for their diameter variability and their mechanical properties, with a stress on fracture morphology.

Raghavendra, et.al., (2021),[5] Natural fibers reinforced bio-degradable composites are good alternative for convention materials. Natural fibers are cheaper in cost, environmentally friendly and biodegradable. In the present work composites are made using short Banana fibers and natural rubber. Composites are prepared using vulcanizing technique at 1500c. And composites obtained were determined for mechanical properties like tensile strength, tear strength were studied. The effect of different lengths of fiber content with natural rubber were determined also matrix fiber interface were studied.

Shashank, et.al., (2021),[6] The present work deal with fabrication and investigation of fracture toughness of banana reinforced with glass fiber as natural hybrid composite. Composites of different combinations with varied fiber content were prepared using hand lay-up technique using L-12 epoxy resin and K-6 hardener as reinforcing materials. Banana fiber with 15, 20, 25 and 30% were hybridized with 20, 15, 10 and 5% of glass fiber to form composites and compared with non-hybrid 35% glass and banana fiber composites. The fracture toughness was investigated according single edge notch bending technique, with image confirmation. The non-hybridized 35% banana fiber showed highest value and 35% glass fiber showed the least. Whereas, the hybrid composite with fiber volume of 20% banana and 15% glass showed higher value when compared with other hybrid fractions.

R.S.Srinivasa Rao, et.al., (2020),[7] Work has been carried out to investigate 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 was fixed as 0.4Wf. It has been observed that the flexural properties increase with the increase in the weight fraction of fibers to certain extent.

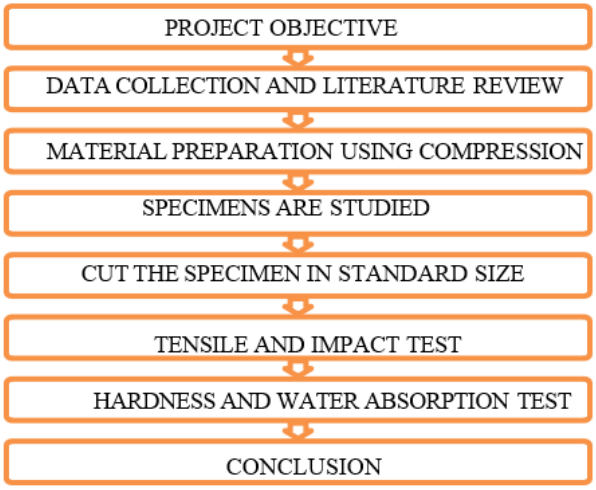
Ravi Ranjan, et.al., (2020),[8] Advanced technology emergence in the field of petrochemical-based polymers has brought many benefits to mankind. It is validating that the ecosystem is considerably disturbed and damaged as a result of the nondegradable plastic materials used for disposable items. This project relates the use of hybrid bio-composites, which is eco-friendly and easily degradable. Previous literature related to hybrid bio-composites proves its eco-friendly and excellent degradable properties. In this project, banana and sisal fibers were selected to execute the hybrid bio-composite preparation with poly lactic as its matrix.

III. PROBLEM DESCRIPTION

In this project a series of fracture problems in polymer composite materials are identified, their methods of solution are briefly discussed, and some sample results are presented. The main problem of interest is the determination of the hardness and tensile state in the neighborhood of localized imperfections such as cracks and inclusions which may exist in the composite. Particular emphasis is placed on the evaluation of quantities such as the hardness and tensile intensity factors, which may be used directly or indirectly in connection with an appropriate fracture criterion for the prediction of fracture initiation and propagation load levels. The topics discussed in the project include hardness and tensile in layered composites and inclusion problems in bonded materials. This polymer composition type (30% banana+ 10% glass+ 60% epoxy resin) increases the hardness and tensile of the material. This research identifies a number of fracture issues in polymer composite materials,

briefly discusses possible solutions, and presents some example outcomes.

Determining the hardness and tensile state of the composite material near potential localized flaws like fractures and inclusions is the primary area of interest. In order to anticipate fracture initiation and propagation load levels, special attention is paid to the evaluation of parameters like the hardness and tensile intensity factors, which can be employed either directly or indirectly in conjunction with a suitable fracture criterion. Hardness and tensile in layered composites as well as inclusion issues in bonded materials are among the subjects covered in the research. Third, in order to precisely assess the mechanical characteristics of these hybrid composites, such as their tensile strength, flexural strength, impact resistance, and fatigue behavior, trustworthy testing of banana fiber glass and epoxy resin procedures must be developed.



The mechanical testing of banana-glass fiber reinforced epoxy resin hybrid composites addresses several critical challenges in material science and engineering. First, the optimization of hybrid composites involves understanding the interplay between two distinct reinforcement materials, banana fibers, and glass fibers, each with unique mechanical properties. Second, ensuring proper dispersion and alignment of these fibers within the epoxy matrix is essential for achieving desired mechanical performance. Third, the development of reliable testing methodologies is necessary to accurately evaluate the mechanical properties, including tensile strength, flexural strength, impact resistance, and fatigue behavior, of these hybrid composites.

IV. EXPERIMENTAL METHODOLOGY

Alkali treatment of natural fibers, also called mercerization, is the common method to produce high-quality fibers. Mercerization leads to fibrillation, which causes the breakdown of the composite fiber bundle into smaller fibers. Mercerization reduces fiber diameter, thereby increasing the aspect ratio, which leads to the development of a rough surface topography that results in better fiber- matrix interface adhesion and an increase in mechanical properties. Moreover, mercerization increases the number of possible reactive sites and allows better fiber wetting. Mercerization has an effect on the chemical composition of the flax fibers and degree of polymerization. The degree of polymerization is the number of repeat units in an average polymer chain at time t in a polymerization reaction. The length is in monomer units.

Figure 1 Banana Fiber with NaOH Solution

Additionally, the potential applications of these materials in various industries such as automotive, aerospace, and construction underscore the importance of thorough mechanical testing to validate their suitability for real- world use. The degree of polymerization is a measure of molecular weight and molecular orientation of the cellulose crystallites due to cementing substances, such as

lignin and hemicelluloses, which are removed during the mercerization process. As a result, mercerization had a long-lasting effect.

Banana fibers were immersed in 5%NaOH solution for two hours at room temperature, as shown in Figure 4.2. Following the alkali treatment, the fibers were washed thoroughly by immersion in water tanks, followed by running water. The material was then filtered and dried at 80 °C for 24 hours.

V. PROPERTIES OF HARDNER

In the present work, the hardener (EH758) has been used. The properties of the hardener. Chemical Composition: Typically, Hardener 758 is made up of a mixture of amines and other curing chemicals. Depending on the manufacturer and intended use, the precise composition may change. Chemical Resistance: The cured epoxy resin system containing Hardener 758 exhibits good resistance to a wide range of chemicals, including acids, bases, solvents, and oils, depending on the specific formulation.

Mechanical Strength: After curing, epoxy resin systems with Hardener 758 typically exhibit high mechanical strength, including tensile strength, flexural strength, and impact resistance, making them suitable for structural applications. Thermal Stability: The cured epoxy resin system demonstrates good thermal stability, with the ability to withstand moderate temperatures without significant degradation or loss of mechanical properties.

VI. METHOD OF FABRICATION

A plate of dimensions 290 × 290 × 3 mm was fabricated by this process. First, the epoxy-banana-glass composite was fabricated. The matrix material was poured slowly into the mold to avoid trapping air. The mixture was left for 2 minutes until it became a little tacky. After that, the banana fiber ply was laid unidirectionally on the matrix layer, which was covered by another layer of matrix poured slowly onto the surface of the fiber ply. A small pressure was applied by using a roller to distribute the matrix material and to avoid the formation of voids. Then, chopped coir fibers (30–50 mm) were laid on the matrix layer. The banana-glass layer plate was fabricated similarly. The setup was cured under the loaded condition of 25 Kg for about 24 hours.

Figure 2 Compression moulding machine

VII. TENSILE TEST

A tensile test, also known as a tension test, is probably the most fundamental type of mechanical test performed on any material. Tensile tests are simple, relatively inexpensive, and fully standardized. As the material is being pulled, we can establish its strength together with how much it will elongate.

The point of failure of the material is of significant interest and it is typically called its —Ultimate Tensile Strength. For some materials (e.g., metals and plastics), the departure from the linear elastic region cannot be identified easily. Therefore, an offset method is allowed to determine the yield

strength of the tested material. An offset is specified as a percentage of strain (for metals, it is usually 0.2% from E8, and sometimes for plastics a value of 2% is used).

VIII. CONCLUSION

The application of banana fiber in composite materials offers a viable path for environmentally responsible substitutes in a range of sectors. It is clear from this work that banana fibers have excellent mechanical qualities, like high strength and stiffness, which qualify them as useful reinforcements for composite structures. Their biodegradability, affordability, and abundance further increase their attractiveness as a competitive substitute for conventional reinforcing materials like carbon fibers or glass. Still requiring research and development are issues like moisture absorption and compatibility with specific matrices.

REFERENCES

1. M.Ramesh, (2023) 'Processing and Mechanical Property Evaluation of Banana Fiber Reinforced Polymer Composites'
2. P.Sathish, ISSN 2350-0328 (2023) 'Banana Fiber Reinforced Composites'
3. T.Hariprasad, ISSN (2022) 'Study of mechanical properties of banana-coir hybrid composite using experimental and fem techniques' 2289-4659; e-ISSN: 2231-8380; Volume 4, pp. 518-531
4. G.Navaneethakrishnan (2022) 'Fiber Hybrid Reinforced Silica Nano Particles with Epoxy Bio Nanocomposites' Issn 0974-2115
5. S.Raghavendra, (2021) 'Mechanical Properties of Short Banana Fiber Reinforced Natural Rubber Composites' Issn: 2319-8753
6. Shashank, (2021) 'Evaluation of Fracture Toughness behavior of Glass banana Fiber Reinforced Epoxy Hybrid Composites' 2394-3696volume 3, Issue3
7. S.Srinivasa Rao, (2020) 'Fabrication and Testing of Natural Fiber Reinforced Hybrid Composites Banana/ Pineapple' pp-2239-2243 ISSN: 2249
8. Ravi Ranjan, (2020) 'Mechanical Characterization of Banana/Sisal Fiber Reinforced Pla Hybrid Composites for Structural Application'
9. Ashwani Kumar (2019) 'Development of Glass/Banana Fibers Reinforced Epoxy Composite' ISSN: 2248-9622, Vol. 3, Issue 6
10. R.Sakthivela (2019) 'Experimental Investigation and Analysis a Mechanical Properties of Hybrid Polymer Composite Plates' ISSN:2231-5381
11. Jagannatha (2017) 'Mechanical properties of carbon/glass fiber reinforced epoxy hybrid polymer composites' Issan 2278 – 0149
12. S.Pichireddy (2018) 'Tensile and flexural strength of glass fiber epoxy composites'
13. T. Madhusudhan, (2016) 'A Review on Mechanical Properties of Natural Fiber Reinforced HybridComposites' e-ISSN: 2395 - 0056 Volume: 03 Issue: 04 p-ISSN:2395-0072
14. K. Devendra1, (2016) 'Strength Characterization Of E-Glass Fiber Reinforced Epoxy Composites with Filler Materials', 353-35
15. K.P.Ashik,(2015)'A Review On Mechanical Properties of Natural Fiber Reinforced Hybrid Polymer Composites' 2015.35044
16. M. R. Sanjay, (2015) 'Studies on Mechanical Properties of Jute/E-Glass Fiber ReinforcedHybridComposites'.2016.41002
17. K.Alagarraja, (2014) ' Fabrication And Testing of Fiber Reinforced Polymer Composites Material' Issn: 2278-1684, P-Issn : 2320–334x Pp 27-34
18. Amit Kumar Tanwer (2014) 'Mechanical Properties Testing of Uni-Directional and Bi-Directional Glass FiberReinforced Epoxy Based Composites' Vol.2, No.1
19. Maneesh Tewari (2018) 'Evaluation of Mechanical Properties of Bagasse-Glass Fibe Reinforce Compoite'ISSN: 2028-2508