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Fabrication of Fiber Reinforced Composite Material Like Bamboo Flex, Glass Fiber & Epoxy Resin

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Abstract – The Fabricated Sheet From Composite Material are Important for the aerospace, space, and automotive industry. In Construction, a lot of structures and high performance machines as develops incorporate composites into their design. There are Many companies in India who perform composite analysis and manufacturing. In this project, we are going to fabricate a composite material like Bamboo Flex and Glass Fiber in which Adhesive Material like Epoxy Resin will be used. The processes to fabricate a composite material like hand lay-up, automated lay-up, spray-up, filament winding, protrusion, resin transfer molding etc. but easy And Cost Effective Process is hand layup method . This process is to fabricate the composite material & After fabricated Sheet, We have to perform the Test Tensile test and Compressive test For Its Strength And Load Bearing Capacity.

1. INTRODUCTION

Composites Material are Important for aerospace, space, and automotive industry. In Construction, a lot of structures and high-performance machines are develops incorporate composites into their design. There are Many of companies in India who perform composite analysis and Have getting knowledge and experience in the design and fabrication of composite material increases the employability of an engineer. In this Experimental project, you are going to fabricate a composite material in which Adhesive Material will be used. This Experimental Project will help you gaining knowledge of composite material too.

Bamboo Flex, Glass fiber And Epoxy Resin are easily available materials and a great addition to the Strength And Durability of reinforcement of the composite material. Strengthening the reinforcement phase increases the strength of the composite significantly. The processes to fabricate a composite material like hand lay-up, automated lay-up, spray-up, filament winding, protrusion, resin transfer molding etc. but easy And Cost Effective Process is hand layup method. We will use this process to fabricate this composite material.

1.1 Objective of work: -

a) Lightweight and Strong:

Composites excel in applications where weight reduction is crucial, such as in aerospace and automotive industries, without sacrificing strength or structural integrity.

b) Tailored Properties:

By combining different materials (matrix and reinforcement), engineers can design composites with specific properties, like high strength, stiffness, or resistance to corrosion or fatigue.

c) Durability and Resistance:

Composites offer excellent resistance to corrosion, wear, and chemical attack, making them suitable for harsh environments.

d) Design Flexibility:

Composites can be shaped and molded into complex geometries, allowing for greater design freedom and customization.

e) Improved Performance:

Composites can enhance fuel efficiency in transportation by reducing vehicle weight, and they can also improve the performance of structures in various applications.

f) Versatile Applications:

Composites are used in a wide range of industries, including aerospace, automotive, construction, sports equipment, and more.

1.2 Purpose: -

- **High Strength-to-Weight Ratio:**

Composites can be significantly stronger and stiffer than traditional materials like metals or wood, while remaining lightweight. This is crucial in applications where weight is a critical factor, such as aerospace, automotive, and sports equipment.

- **Durability and Resistance:**

Composites are highly durable and resistant to corrosion, wear, and damage from harsh environments. This makes them ideal for applications in construction, infrastructure, and industrial settings.

- **Customizable Properties:**

The properties of composite materials can be tailored by varying the type and orientation of the constituent materials (matrix and reinforcement).

This allows for the creation of materials with specific performance characteristics for a wide range of applications.

- **Design Flexibility:**

Composites offer designers and engineers a high degree of freedom in creating complex shapes and structures that are difficult or impossible to achieve with traditional materials.

- **Reduced Maintenance:**

Due to their durability and resistance to corrosion, composite materials often require less maintenance than traditional materials, leading to cost savings in the long run.

- **Enhanced Fuel Efficiency:**

In transportation applications, the lightweight nature of composites can lead to improved fuel efficiency and reduced emission.

1.3 Scope of Study

The scope of studying fiber-reinforced composite material fabrication encompasses understanding various fibers, matrices, manufacturing techniques, and the resulting properties, with applications spanning diverse industries like aerospace, automotive, and construction.

➢ **Types of Fibers and Matrices:**

Fibers:

The study explores natural fibers (e.g., jute, flax, sisal) and synthetic fibers (e.g., glass, carbon, aramid).

Matrices:

It examines different polymer matrices (e.g., thermosets, thermoplastics) and their interactions with fibers.

Hybrid Composites:

The study also investigates the fabrication and properties of composites using combinations of different fibers and matrices.

➢ **Fabrication Techniques:**

Hand Lay-up:

A simple and cost-effective method for fabricating composite laminates.

Automated Lay-up:

Used for high-volume production of complex shapes.

Spray-up:

A process where resin and chopped fibers are sprayed onto a mold.

Filament Winding:

A method used to create cylindrical or tubular structures.

Pultrusion:

A continuous process for producing composite profiles.

Resin Transfer Molding (RTM):

A process where resin is injected into a closed mold containing pre-placed fibers.

Additive Manufacturing (AM):

Using techniques like 3D printing to fabricate complex composite structures.

2. METHODOLOGY

2.1Materials:

A. Bamboo :-

Bamboo, a rapidly renewable resource, is a strong and versatile material used in composite materials, particularly for its high strength-to-weight ratio and sustainability. It can be used as a reinforcement fiber in various applications, including construction, furniture, and everyday products.

Bamboo As Reinforcement fiber :-

- Natural Strength
- Low Density
- Sustainability
- Chemical Composition

B. Glass Fiber :-

Glass fibers, when combined with a resin matrix, form a composite material known as fiberglass, offering high strength-to-weight ratio, corrosion resistance, and thermal conductivity, making it versatile for various applications.

Fiberglass composites are created by embedding glass fibers within a resin matrix.Glass fibers provide strength and stiffness, while the resin matrix binds the fibers together and distributes stresses evenly.

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C. Epoxy Resin:-

Epoxy resin is a crucial thermosetting polymer used in composite materials, acting as a matrix that binds

reinforcing fibers like carbon or glass, resulting in high-strength, lightweight structures with excellent chemical and thermal resistance.

Definition:

Epoxy composites are a type of polymer material where an epoxy resin serves as the polymer matrix, reinforced with fibers or other fillers.

2.2Experiment Methodology

1. First Survey And Collect the Composite Material Like Bamboo Flex, Glass Fiber, And Epoxy Resin.
2. Then The Bamboo Flex have to wash it thoroughly so that no impurities will be there.
3. After completing the above process, you have to dry the Bamboo nearly a day to remove any moisture present in it. Then you have to perform alkali solution treatment to kill bacteria present in it.
4. Then you have to cut alkali treated Bamboo into small fibers using the cutter.
5. Make a square box with one side open, using wood or Cast iron with dimension 100*100*20mm. This box will be used as a

mold for fabricating your composite.

6. Then use polyethylene at the bottom of the mold to get the good surface finish.
7. Then start adding one layer of Epoxy Resin and upon which put fibers layer by layer. Keep repeating same Process, until you get desired thickness.
8. After this apply equal pressure throughout the mold so that both the material mixes together to form an effective composite material.
9. Then wait for few hours so that the mixture n the mold dries down and your composite is ready for tasting purpose.
10. Then make a few sample specimens for performing the various test. At least calculate the 3 standard specimen for each test.
11. Perform a tensile test using a UTM machine to find ultimate tensile strength, breaking strength, maximum elongation, and reduction in area. From these measurements, you can determine Young's modulus, Poisson's ratio, yield strength, and strain-hardening characteristics.
12. Then perform the compressive test in the same machine to find out ultimate compressive strength, breaking strength etc.
13. Compare both ultimate tensile test and compressive test of your composite with the strength of parent materials.

3. Result :-

Fabricating a composite material using bamboo flex, glass fiber, and epoxy resin results in a material with enhanced mechanical properties, including increased tensile strength, flexural strength, and impact resistance, compared to using epoxy alone.

Enhanced Mechanical Properties:

Tensile Strength: Bamboo fiber reinforcement in epoxy matrix significantly increases tensile strength. Studies show increases of up to 150% compared to the epoxy matrix alone.

Flexural Strength: The addition of bamboo fibers also improves the flexural characteristics of the material.

Impact Strength: Composites with bamboo particles and epoxy exhibit increased impact strength.

Bamboo Fiber Reinforcement:
Bamboo fibers act as reinforcing agents, improving the mechanical properties of the composite material. The increased adherence of bamboo fibers to the epoxy resin leads to improved performance.
Glass Fiber's Role:
Glass fibers provide low permeability and contribute to the water resistance of the composite structure. They Perform as a barrier to moisture, preventing water from diffusing through the composite.

4. Conclusion: -

In conclusion, composite materials offer a wide range of benefits, including enhanced strength, lightweight properties, and design flexibility, making them suitable for diverse applications across various industries, from aerospace and automotive to construction and biomedical fields.
The experimental analysis has shown that bamboo fiber reinforcement in the epoxy matrix has improved the mechanical properties of composite structure. The fabricated composites are of good quality with appropriate bonding between the fiber and resin. However in presence of voids is unavoidable in composite fabrication, particularly through hand-lay-up route. The presence of pores and voids in the composite structure significantly affect a number of mechanical properties and even the performance of the composites.
Higher void contents usually mean lower fatigue resistance and greater susceptibility to water penetration. Also the poor interfacial bonding generates partial spaces between the fiber and matrix material, hence resulting in a weak structure.