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Review on Composition of Natural and Synthetic Material

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A B S T R A C T

Materials science and engineering depend heavily on composite materials since they are believed to perform better than metals and alloys when compared to traditional materials. Two different materials that have different properties put together form a composite material. Compared to metals and alloys, composite materials are lighter, have a longer lifespan, and don't experience wear and tear. Due to their superior mechanical qualities and evolving application dynamics, composite materials are becoming increasingly popular. Conventional methods for making and characterizing composite materials are well-established technologies. Better options for enhancing the mechanical, chemical, and physical properties of composite materials have been found, nevertheless, when fillers are used in small amounts in addition to traditional reinforcing fibers and resins. As an alternative to conventional metals, hybrid composites comprised of natural fibers like banana fibers and synthetic fibers like carbon and e-glass fibers are stronger.

1. INTRODUCTION

In the modern material world, composites are a key technological advancement in the creation of stronger, more impact-resistant, and lightweight materials. The development of composites, which combine two or more materials as reinforcement and matrix, results in greater capacity through performance. Materials made of a combination of multiple distinct types of constituent materials with diverse properties are known as hybrid composite materials. These materials are made to minimize the shortcomings of each component while maximizing their strengths. The objective is to produce materials with improved qualities that are not possible with only one material component.

This review article describes how to create hybrid composites, which have several benefits over conventional materials such as improved mechanical and physical properties, by using natural and synthetic fibers such basalt, banana, carbon, and E-glass fibers. Below is a detailed discussion of each of the various fibers that were previously described.

1.1 Banana Fiber

One kind of lingo-cellulose fiber that is derived from banana stems is called banana fiber. A fiber bast with comparatively best machine-driven characteristics is fiber of banana. When it comes to particular strength, banana fiber is on par with traditional materials like fiberglass. The density of this material is lower than that of fiberglass. The stem is made up of a clustered arrangement of cylindrical leaf stalks. Banana fiber is a waste from the banana growing process and it is not used properly or is only partially used. Useful applications of these fibers will moderate demand, leading to lower prices.

High strength, low weight, strong hygroscopic quality, flame retardant quality, biodegradability, and enormous potential are all attributes of banana fiber. It is well known that garments and household items can be made from banana fiber. Banana fiber has great potential for making paper, especially in demand for handmade paper. Banana fiber produces products such as filter paper, paper bags, cards, lamp stands, pen boxes, decorative paper, ropes, carpets and other composite materials, etc.

Fig. 1. Banana Fiber.

1.2 Carbon Fiber

With a width ranging from 5 to 10 micrometers (0.00020 to 0.00039 in), these fibers are primarily composed of carbon atoms. One term for carbon fiber, a polymer, is graphite fiber. The material is strong and incredibly light. Carbon fiber is more robust than steel. Adding carbon fiber to other materials results in composites with better properties. Carbon fiber offers several advantages, including high temperature resistance, low thermal expansion, heavy stretchy strength, heavy strength-to-weight ratio, and robust resistance chemically. Carbon fibers are highly valued in the military, aerospace, and civil engineering sectors due to these characteristics.

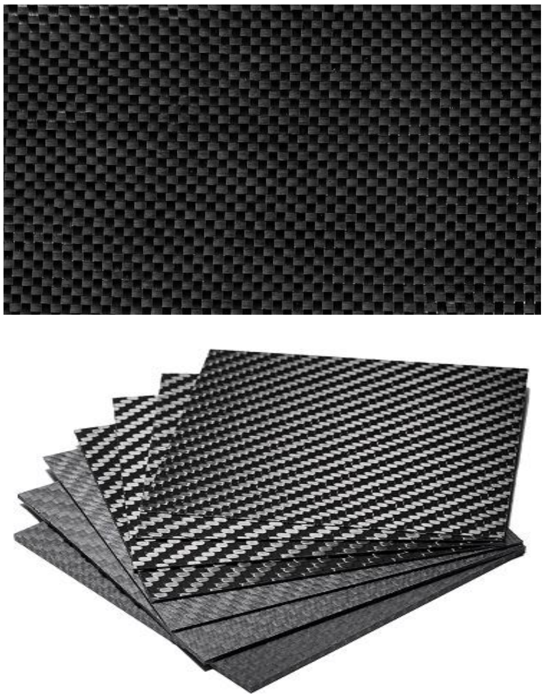

Fig. 2. Carbon Fiber.

1.3 Glass Fiber

An abundance of incredibly thin glass fibers combine to form the material known as fiberglass, or fiberglass. The usual method of producing it is extrusion, which involves stretching molten glass through tiny pores. The resulting fibers are then coated with various materials to improve their performance and durability. Based on its composition and intended usage, fiberglass can be divided into numerous categories. Common varieties include S glass for applications requiring greater strength, C glass for chemical resistance, and E glass for electrical applications. Fiberglass has excellent tensile strength, meaning they can withstand pulling. They are also resistant to heat, chemicals and harsh environmental conditions. In addition, they have low electrical conductivity, making them suitable as insulating materials.

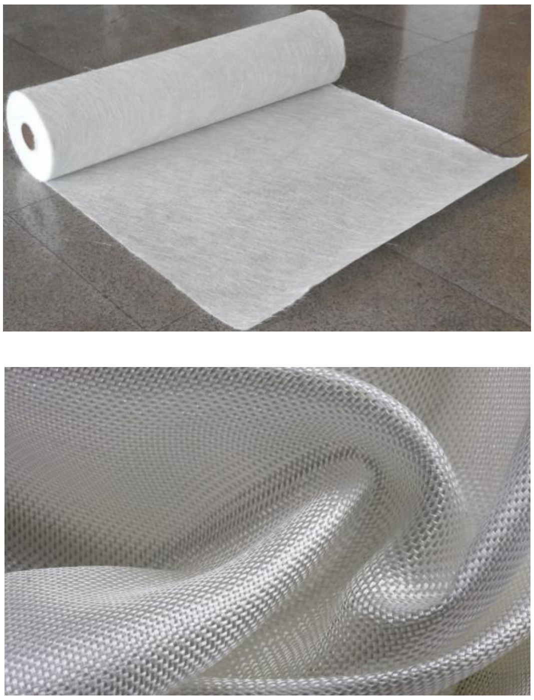

Fig. 3. Glass Fiber.

2. LITERATURE SURVEY

Kharatmol et al. [1]: In this paper, the authors consider composite materials as materials that have the ability to adapt to the built space for safe use in construction and other related applications. Because construction components are used on construction sites that require durability, rigidity, and lighter weight, etc. In this work, carbon fiber was used as an alternative source for other elements used in building construction. The authors used carbon-reinforced polymer composites with different material thicknesses, orientations, and lengths in an experimental investigation to determine the structural characteristics of RCC beams.

Venkateshwaran and Elayaperumal [2]: perspectives on polymer composites reinforced with banana fiber. An overview of published research on banana fiber reinforced polymer composites, including their mechanical properties and unique reference structure, is provided in this article. Banana fibers have short thickness, heavy stretchy strength, heavy tensile modulus, and short extension at disruption, making them an excellent material for composites with a wide range of applications in the automotive, equipment, and construction industries.

Jannah et al. [3]: investigated the effects of surface chemical modification on the characteristics of unsaturated polyester composites reinforced with banana weave reinforcement. Flexural characteristics are better in the treated composite system. Up to 15 vol% of fiber can significantly boost the impact strength; this trend is evident in the polyester composites reinforced with bananas and treated with acrylic acid. Comparing treated and untreated fiber composites, the former absorb less water.

Pujari et al. [4]: offers a viewpoint on the contrast between composites made of banana and jute fibers. This review delves into the potentials of mixtures made of banana and jute fibers, emphasizing their chemical composition and physio-mechanical characteristics. It is possible to use and apply low luxurious items in high-performance devices thanks to this synthesis process. The amalgamation of advantageous attributes from two distinct materials, along with reduced production expenses and adaptability, renders them advantageous in an array of engineering domains and high-performance applications, including sports and recreation, the marine sector, aerospace, and so forth.

Chandramohan K. Marimuthu [5]: research on fibers of natural; this article focuses on the development of biomaterials in the field of orthopedics and covers the global review report on natural fibers and their applications. attempts to create bio composites depends on bio-epoxy resins and fibers of natural like Agave sisalana, Musa septum, and Hibiscus sabdariffa, and use these materials to replace bone grafts while utilizing the benefits provided by renewable resources.

Srinivasan et al. [6]: Research to evaluate the mechanical and heat properties of composite in natural fibers from banana and flax. Test results show that the hybrid composite has much better properties than the single glass fiber reinforced composite under impact and bending loads. It turns out that the hybrid composite has better durability than the monofilament composite.

Badrinath and Senthilvelan [7]: research comparing the mechanical characteristics of sisal- and banana-reinforced polymer-based composites. It has been noted that the tensile strength of sisal fiber/epoxy is superior to that of banana fiber. Tensile strength improves along with an increase in fiber concentration.

Ahmad et al. [8]: In this paper, the authors investigated the use of new materials that would combine both weight reduction and safety issues. The authors have provided a clear illustrative presentation in the field of automotive applications. The authors also stated that carbon fiber reinforced material has the following properties such as 1. Weight reduction 2. Durability 3. Impact resistance.

Bhatnagar et al. [9]: According to the literature, composite materials are used in 4,444 different applications. Natural fibers are used as an optional active ingredient for manufactured fibers as well as to support polymeric materials, as discussed in the previous article. Conventional yarn has minimal cost, low tenacity and low thickness. In this work, banana fibers were compared with applications and their dependent properties, it was suggested that banana fibers improved the aggregate organization and properties.

Jagannatha, and Harish [10]: The utilization of hybrid composite materials is the main area of study for the writers of this paper. provides high-quality material in terms of matrix and fiber choice. The current study took into account the mechanical characteristics of epoxy composites supported by glass and carbon fiber. The procedure proposed in this work is the vacuum strategy. Vacuum packaging method is performed to produce half-and-half composites. The mechanical properties, for example, hardness, tensile strength, ductility of the proposed half-and-half composites, have been condensed according to ASTM guidelines. The machine-driven properties improved as the fiber content of scaffold increased in the mesh material.

Sandhanshiv and Patel [11]: In the present study, carbon fibers were fabricated in metal matrix composites (MMC), ceramic matrix composites (CMC) and polymer network composites (PMC). From the article, it appears that various exploratory works have been carried out on composite materials made up of carbon fibers. This paper examines the impact of carbon fiber on various properties such as mechanical, tribological and morphological properties of different materials.

Dhiman et al. [12]: In the present study, conventional metals were largely replaced by composite materials due to the importance of mechanical behavior. Among all the available materials, carbon fiber composites prove effective in terms of strength relative to weight. The choice of materials acts a significant part in the success of any industry, as does the concept of well-being. This audit presents a study of usage and future needs in various applications.

3. OBJECTIVE

- Enhanced Strength: Composite materials are designed to outperform their constituent parts in terms of strength. Composites are made of many materials that work together to bear greater loads and strains.
- Physicochemical Properties: Composites have certain qualities including heat resistance, toughness, and stiffness. You can alter these characteristics by choosing particular combinations of matrix reinforcement.
- One of the key objectives is to lose weight without sacrificing structural integrity. Because composites are substantially lighter than conventional materials like metals, they are perfect for uses where weight is an issue, including in automobile and aerospace components.
- Long-term dependability and durability: Composites are made to resist aging, wear, and weather conditions. Their robustness guarantees sustained functionality under a range of circumstances.
- Electrical Conductivity: Certain composites have better electrical characteristics, which makes them appropriate for use in the aerospace, electronics, and other industries.

4. HAND LAYUP METHOD

The most popular and expensive open-molding technique is hand lay-up. It works with both big and tiny goods and needs very little equipment. Using this method, fiber reinforcements are manually inserted into a mold, such as woven mats or chopped strand mats. Next, a brush or roller is used to apply resin, which is often a thermosetting polymer.

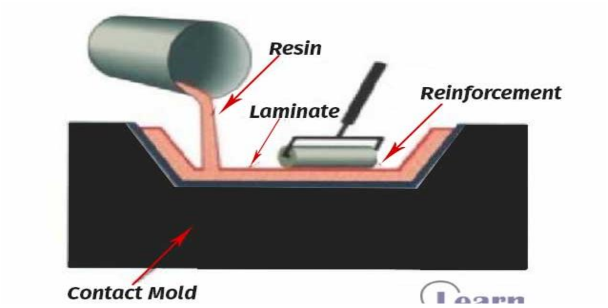

Fig. 4. Hand layup Method.

4.1 Fabrication required

Preparation:

- Mold Surface: In order to keep the polymer from sticking, a release gel (Vaseline) is sprayed over the mold surface.
- Reinforcement: The fiber material (Carbon Fiber, Banana fiber for trail-1, Banana fiber, Glass fiber for trail-2) (reinforcement) are cut to fit the mold size and located on the mold surface.

Polymer application:

- Liquid Polymer: An Epoxy resin (LY556) (usually in liquid form) is mixed with a prescribed hardener (HY951) (curing agent).
- Layering: The polymer that previously prepared is poured into the mat already placed in the mold.
- Brush Application: To evenly distribute the polymer throughout the Fiber, a brush is utilized.
- Repeat Layers: Additional layers of fiber material and polymer are stacked until the desired thickness is achieved.

Compression and Curing:

- Roller: Air bubbles and extra polymer in the mold are eliminated using a roller.
- Curing: The composite is cured either at room temperature or at a specific temperature.
- Demolding: The mold is opened and the composite item is taken out once it has cured.

Fig. 5. Composite Material after Demolding.

5. TEST CONDUCTED AND ITS RESULT

TRAIL-1

1. Tensile Test

Input Data:

- Specimen shape: Flat,
- Specimen width: 24.22 mm,
- Specimen thickness: 5.72 mm,
- Specimen cross section area: 138.538 mm^2,
- Pre load value: 0 N,
- Max. load: 100000.00 N,
- Max. elongation: 1000.00 mm.

Output Data:

- Load at peak: 21599.00 N,
- Elongation at peak: 4.978 mm,
- Tensile stength: 155.906 N/mm^2,
- Load at break: 18333.000 N.

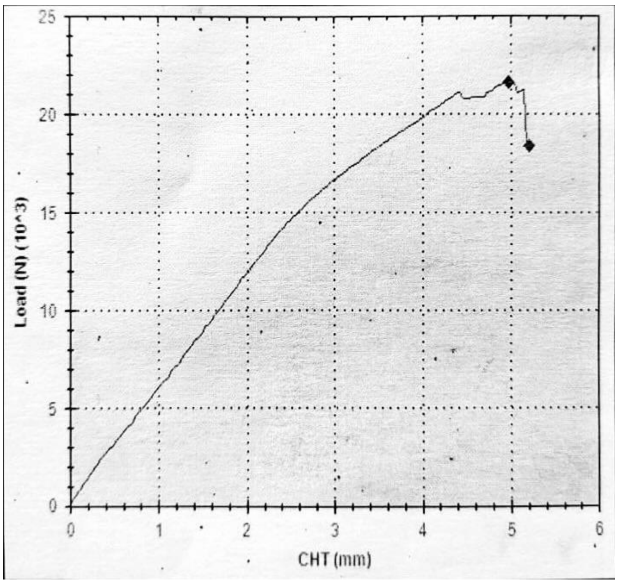

Fig. 6. Load v/s Cross Head Travel.

Fig. 7. Tensile Tested Specimen.

2. Hardness Test:
- Hardness (Shore D): 87.

3. Charpy Impact Test:
- Impact Energy: 4 J.

Fig. 8. Impact Tested Specimen.

TRAIL-2

1. Tensile Test

Input Data:
- Specimen shape: Flat,
- Specimen width: 21.7 mm,
- Specimen thickness: 4.68 mm,
- Specimen cross section area: 101.556 mm^2,
- Pre load value: 0 N,
- Max. load: 100000.00 N,
- Max. elongation: 1000.00 mm.

Output Data:
- Load at peak: 4735.00 N,
- Elongation at peak: 2.670 mm,
- Tensile stength: 46.625 N/mm^2,
- Load at break: 4735.000 N.

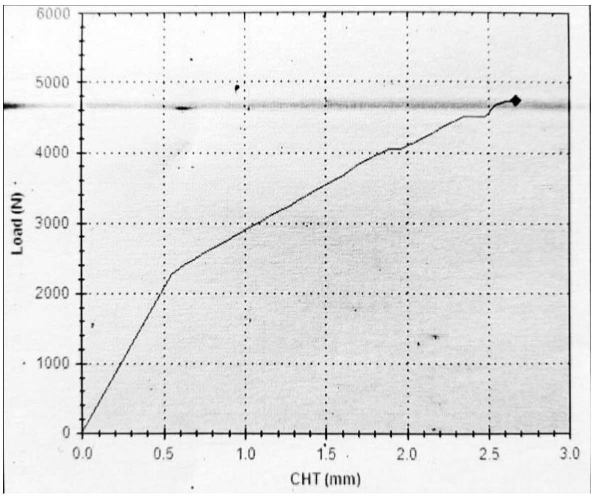

Fig. 9. Load v/s Cross Head Travel.

Fig. 10. Tensile Tested Specimen.

2. Hardness Test
- Hardness (Shore D): 79.

3. Charpy Impact Test
- Impact Energy: 2 J.

Fig. 11. Impact tested specimen.

6. APPLICATIONS

- Automotive: Back shelf, dashboard supports, interior door trim, and seat-back trim.
- Engineering: Applied to composite materials for a range of home products as reinforcement.
- Excellent Strength-to-Weight Ratio: Carbon fibers are renowned for having remarkable strength and low weight.
- Aviation: Owing to their strength and stiffness, they are frequently utilized in aviation applications.
- Sports equipment, such as tennis rackets, golf clubs, and bicycle frames, frequently uses carbon fiber-reinforced composites.
- Structural Components: Used in bridges, buildings, and other load-bearing structures.
- Wind Energy: Carbon fiber composites are employed in wind turbine blades.
- Marine: Ship hulls benefit from hybrid composites.
- Wind Power: Blades for wind turbines.
- Telecom: Hybrid aerials and underground cables.

7. CONCLUSION

This article explores the potential of composites made of banana fiber, carbon fiber, and glass fiber, emphasizing not only their mechanical and physical properties but also their chemical composition. The characteristics of banana fibers are superior to those of other natural fibers. Thanks to this composite technology, using and utilizing less expensive products in high-performing appliances is achievable. When two different materials combine their advantageous properties—such lower manufacturing costs, versatility, etc.—they become helpful in a range of engineering fields and high-performance applications, like sports and recreation, the shipping industry, aerospace, etc. With their lower cost, lighter weight, and greater environmental friendliness than glass fiber or other synthetic fiber composites, banana fibers have a bright future ahead of them. It is reasonable to draw the conclusion that composites are the most sought-after technology in the rapidly emerging modern trend in light of this.

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