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Fabrication and Evaluating Mechanical Properties of Bamboo Fiber Reinforced Composites

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Abstract

Over decades, composite materials have grown at a very steady rate, allowing them to progressively penetrate and conquer current markets. Modern composite materials in the materials world are reaching new heights by putting a firm foot in every single one of them. There is a market available that goes from a simple product that is utilised every day to an extremely sophisticated material. Attempts are made to comprehend the demands of the ever-expanding natural composite business by examining the current literature on diverse natural fiber-based composites. The conclusion is that by successfully fusing vegetable natural fibres with polymer matrices, the mechanical properties of the composite have improved in comparison to the matrix material. These filters are inexpensive, non-toxic, and simple to recycle.

Keywords: *Bamboo, Epoxy Resin, Glass Fibre*

1.0 Introduction

An automotive bumper is the structural front-most or rear-most element of the vehicle that is designed to withstand an impact without causing damage to the vehicle. The vehicle's safety systems. One of the most critical design aspects in automotive manufacturing is the selection of materials for car components. The material used has a considerable impact on a vehicle's overall attractiveness, which includes aesthetics, cost, performance, emission levels, and fuel efficiency.

Weight is a very essential aspect for vehicle makers when choosing materials for automotive components because it impacts many other attributes, hence active attempts are frequently taken to use lightweight materials for automobile components as much as feasible. However, cost is a significant issue that is also considered while selecting materials. In contrast, the majority of lightweight Aluminium, magnesium, and carbon fibres are more expensive than heavier materials like steel and cast iron for a variety of reasons, including scarcity and simplicity of manufacture.

To balance cost and weight criteria in design, compromise is frequently encountered. According to the US Department of Energy (2010), the steel content of automotive components was approximately 75% in 1977, but has decreased to 65% in 2010 due to an increase in polymers and composites used primarily for interior components. The US Department of Energy has set a goal of lowering new vehicle fuel usage by a factor of two by 2035. Although aluminium is the most commonly used automotive material for light weighting, polymers are much lighter but less durable. Because of their poorer mechanical qualities when compared to metals, they are rarely used for structural components. However, with the right amount of reinforcement, natural fiber-based

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composites may compete with the mechanical properties of steel and aluminium while being lightweight, with remarkable strength and durability. Natural fiber-based composites, unlike regular plastics, are useful for vehicle bumpers due to their reinforcements and so play a significant part in decreasing vehicle weight and fuel consumption by replacing various steel components. This project assesses the utilisation of several natural fiber-based composites as alternatives to conventional materials used in automotive bumpers depending on their composition and form, they have varying impact and static and dynamic mechanical properties. Block copolymer compatibilizers composed of polyethylene-polypropylene sequences appear to improve[1] compatibility between the rubber domains and the PP matrix, resulting in relatively good impact resistance.

Carbon-based nanomaterials have been created using simple catalytic pyrolysis. For the first time, synthesised TiO_2 nanoparticles were employed as a catalyst during the pyrolysis of plastic waste. The quality and performance of the carbon nanomaterials produced have been tested using several characterisation techniques. This novel approach can be used to manufacture diverse carbon nanocomposites by using metal oxides as a catalyst and various plastic waste systems as a carbon resource[2]

The external and internal components are critical to regaining eco-efficiency and renewability. Natural fibres have lately become more inexpensive as an alternative reinforcement for glass fibre reinforced thermoplastics in the automotive industry. In terms of cost, density, renewability, recyclability, abrasiveness, and biodegradability, natural fibres outperform typical reinforcement materials such as synthetic glass fibre[3].

Some polymer composites provide other benefits such as drag reduction, good electrical and thermal properties, and are therefore ideal for automotive applications. It thus holds considerable promise for replacing steel for bumper beams and many other structural components of a vehicle on the road to achieve greater fuel consumption reduction through light-weighting[4].

The thickness of the composite bumper is developed by applying a series of jute fiber layers and liquid resin layers. Poly Vinyl Acetate (PVA) which acts as a releasing agent, is applied to the mould. The bumper made from jute fibre composite possesses increased impact strength when compared with the bumper made from steel. Also the cost and weight of the jute fibre composite bumper are less when compared with the bumper made from steel.[4]

The impact behaviour when compared to steel and aluminium, both of which failed and demonstrated manufacturing issues due to strengthening ribs or weight increase due to the usage of denser materials[5] various impact standards and optimised the shape of the bumper Scam using software simulation for the specified material[6]

Many old designs are being improved by researchers employing fresh methodologies[5]. When there are conflicting performance and cost requirements, R&D units face an extra difficulty of coming up with a variety of alternative design options in less time and cost than existing designs. The finest solutions are obtained in a CAE environment by utilising some of the most recent CAD and FEM tools[7].

2.0 Problem Definition

The search for a material that can replace the existing car bumpers by lowering vehicle weight, fuel usage, production costs, and boosting the material's strength and capacity to be recycled by green manufacturing.

3. Materials and Methodology

3.1 Hand Lay Up Method

The common methods of manufacturing fiberglass

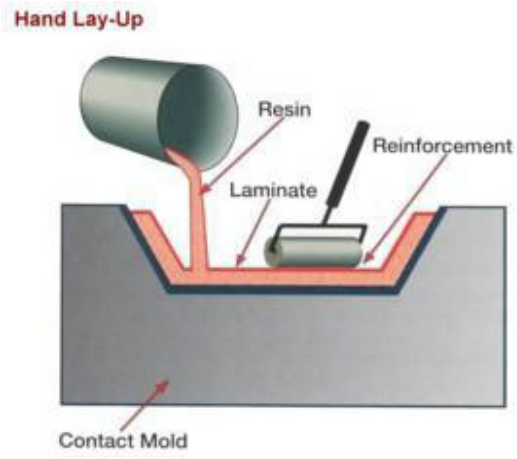

Figure 1. Hand layup technique.

composites. A releasing agent, usually in the form of wax or liquid, is applied to the mould of choice.

3.2 Material Selection

As we can see from the literature, bamboo fibre has superior mechanical qualities in comparison to other natural fibres.

As a result, using this plant fibre as reinforcement in composite materials for various structural components instead of the currently employed conventional materials will provide competitive benefits. The bamboo fiber/epoxy composite materials with a significant composition are used as the materials of an automotive bumper panel in this analysis.

3.3 Bamboo Fibres

Due to the abundance of bamboo plant resources in India, bamboo fibres are a viable option attracts for the prior reliance on this plant for various studies. Researchers are concentrating their efforts on highland bamboo species, which are excellent for a variety of purposes.

3.4 Epoxy and Hardener

The hardener utilised in this study is HY95, while the epoxy resin is LY556.LY556 Epoxy/HY951 Hardener (Cured at Room Temperature): HY951 is an aliphatic primary amine, Triethylene Tetramine, and LY556 is a functional epoxy resin matrix, Bisphenol-A Diglycidyl Ether. The weight-to-weight ratio is one to 10. Epoxy adhesives are an important part of the engineering adhesives category. These high-performance adhesives are used in the construction of aircraft, cars, bicycles, and snowboards, as well as other applications that require strong connections. Epoxy resin adhesives can be tailored to any application. Epoxy adhesives that cure at ambient temperature.

3.5 Glass Fibre

Sometimes known as fibreglass, is a synthetic substance composed of extremely tiny fibres. These fibres are often woven together to form a fabric-like material, which is subsequently utilised for a variety of purposes, including insulation, reinforcement in composite materials, and the building of different consumer and industrial items.

Glass fibre is well-known for its toughness, resilience, and resistance to heat and two chemicals. It is frequently utilised in situations where other materials, such as steel or aluminium, would be too heavy or expensive.

4.0 Results and Discussion

4.1 Impact Test

A drop load impact test is a type of test used to assess a material's or product's capacity to withstand impacts and shocks might happen during use or transit. A substantial weight or load is dropped upon the material or product and its response is measured.

Figure 2. Specimen at point of impact.

Table 1. Impact Energy

Indenter weight (Kilograms)	Velocity during Impact (m/s)	Impact Energy (Joules)(kgm^2/s^2)
3.6	1.9798	7.0560

Table 1 shows that the impact strength of the specimens is 7.0560, which is higher in comparison to other materials.

4.2 Comparative Impact Analysis of Various Composites

Figure 3 represents the comparative statement of three different materials, wherein bamboo materials seems to have better impact strength.

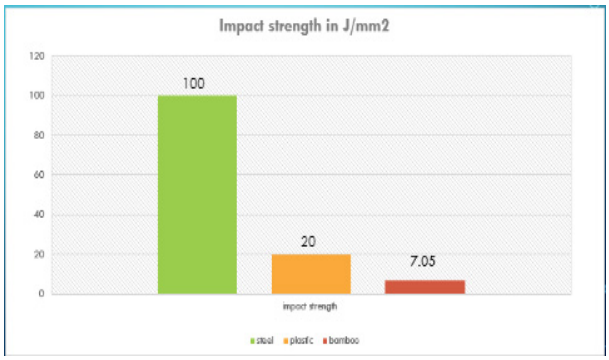

Figure 3. Comparative results.

5.0 Conclusion

The purpose of this research is to create and structurally assess specimens of natural bamboo core.

Face sheet made of areca fibre laminate. The material will be studied and tested for essential mechanical properties such as tensile and flexural strength, which are important for better vehicle safety as well as increased fuel efficiency. The results will be compared to materials already used in the automotive industry for safety grilles and bumpers, with the composite material expected to offer greater strength and mechanical qualities.

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