Comparative Analysis of Bamboo Fiber Reinforced with E-Glass Fiber Mono Leaf spring and Conventional Mono Leaf Spring

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***Abstract*— In heavier cars, steel or conventional leaf springs are commonly utilised, but with the introduction of new composite materials, such as natural fiber composites, light hybrid materials with good strength can be developed. The goal of our study is to compare and contrast bamboo fiber reinforced with e-glass fiber leaf springs with standard leaf springs. We treated the bamboo fiber with sodium hydroxide (NAOH) for 24 hours before drying it in the sun to achieve the goal. In an epoxy matrix, the dried fiber was reinforced with e-glass fibers. The resulting composite is then ground to the precise dimensions of a single mono leaf spring. After that, we tested the results.**

***Index Terms:* Bamboo fiber, epoxy, e-glass, leaf spring, sodium hydroxide.**

I.INTRODUCTION

The first leaf spring was created in 1804 by Obadiah Elliot and was utilized as a suspension device in horse carts. With the advent of contemporary vehicles in the twentieth century, they became quite prevalent, and they can now be found in practically all heavy-duty vehicles in the twenty-first century. The leaf springs were traditionally made of steel, which made them heavier and had an impact on vehicle performance. Nowadays, with the introduction of composite materials that are both light and robust, it is possible to experiment with replacing the traditional leaf spring.

When compared to typical leaf springs, glass fiber reinforced polymer was not able to handle significant impact loads when used alone [5]. Kaur v., Chattopadhyaya D.P [6] found that treating bamboo fiber with NAOH solution increases its tensile strength, and reinforcing it with glass fiber in an epoxy matrix results in an excellent composite material. Natural fiber reinforced composite materials frequently exhibit poor fiber-matrix adhesion, necessitating treatment with an alkali solution. Sudhakar behera et al[7] found that increasing the percentage concentration of NAOH improved mechanical properties such as tensile strength while also increasing composite hardness. According to vikas khatkar et al[1,] textile composites with unidirectional fiber exhibited higher tensile strength than chopped fiber and bidirectional fiber composites. They also had equivalent flexural rigidity and impact strength. In a simulation research on mono leaf springs constructed of conventional steel and hybrid polymer composite, Nishant Varma et al [2] found that incorporating a flax layer in between carbon fiber enhanced the Factor Of Safety. Mechanical characteristics are reduced as strain energy and the fraction of flax layers increase beyond a particular degree. K.Vijaya Kumar et al. [3] show experimentally and in anysys that increasing the proportion of glass fiber content in bamboo and e-glass fiber in epoxy matrix composites increases tensile strength.

The increasing use of light-weight e-mobiles necessitates light-weight parts, which can be achieved by using GFRP composite [glass fiber reinforced polymers], as Fabian Becker et al [4] investigated. Fakkir et al investigated a variety of leaf spring materials, including s-glass fiber, e-glass, alumina, and kevlar29. The tensile strength of GFRP built of s-glass was found to be the greatest among the materials utilising anysys software.

II.MATERIALS USED

Bamboo fibers and e-glass fibers are needed for this project, while epoxy resin is used as the matrix media. Ly556 epoxy resin and HY 951 hardener are utilized, as well as mould release wax. Table 1 lists the characteristics of several fibers and materials.

Treated bamboo fiber is noted for its great tensile strength, and it is employed in a variety of structural applications. After drying in the sun for 12 hours, NAOH treated bamboo fiber is utilized to assist remove cellulose, hemicelluloses, and lignin, as illustrated in fig.1.

Table1.

Bamboo fiber	Average tensile strength- 262MPa Young's modulus -9.8GPa Compressive strength-19.96 MPa
Epoxy LY556	Chemical composition- Bisphenol – A-based epoxy resin Visual aspect - clear Viscosity at 25deg,Celsius-10000-12000mPa-s Specific gravity-1.15 to 1.20 gm/cm^3
Hardener HY951	Viscosity at 25deg.celsius-10-20mPa-s Specific gravity -0.98 gm/cm^3
E-glass	made from oxides of silicon, magnesium, calcium, boron Density-2.54gm/cm^3 tensile strength-3400MPa Modulus of elasticity-72GPa
Steel used in conventional leaf spring (55Si2Mn90)	Young's Modulus 200 GPa Poison's ratio 0.3 UTS 1692 MPa YTS 1500 MPa Density 7850 kg/m^3

III.METHODOLOGY

1. Sodium hydroxide solution treatment of bamboo fibres - Untreated bamboo fibers contain cellulose and hemicelluloses (structural component of cell wall). Lignin (which gives plants their stiffness) interferes with the properties of composites, so they must be treated with sodium hydroxide solution. Different concentrations of NAOH have different effects on the tensile strength of fibres, so we will use a 0.5 percent sodium hydroxide solution and soak the fibres for 12 hours. [6].

2. After the treated fibers have been cured in the sun for 12 hours, bamboo fibers and glass fibers are inserted in a die and epoxy resin in a 10:1 epoxy to hardener ratio is utilised. The composite materials in die are supposed to be kept as it is for 24 hrs then removed.

The composite components are then ground to attain nearly identical dimensions to a standard leaf spring.

3.The manual layup process is utilised to make composite material.

4.The composite material is subsequently put through a series of tests, including tensile testing and spring deflection testing.

IV.EXPERIMENTAL ANALYSIS

Following tests were performed in order to carry out experimental analysis of composite leaf spring

1 Max load test on spring testing machine.

2 Tensile test on UTM.

1. Max load test in spring testing machine.

A load is applied at midpoint of leaf spring when in simply supported position till maximum deflection is achieved. The results of above test are discussed in table 2. And is graphically represented in fig 3.

Table.2

MATERIAL TYPE	LOAD FOR MAX. DEFLECTION (in kg)
Steel	100
Bamboo fiber +e-glass fiber	20

Fig.1. Bamboo e-glass fiber composite leaf spring undergoing a Max. deflection test on a leaf spring testing machine.

2. Tensile test

Here a specimen is applied with tensile stress and its tensile force for failure is noted.

The specimen used here has dimensions of ASTM D3039. The bamboo fiber used here has an approximate wt% of 30% and epoxy 40% and glass fiber 30%.

The results of the tensile tests results are discussed in table 3.and also in fig.4.

Table.3.

MATERIAL TYPE	MAX. TENSILE STRENGTH(in MPa)
Steel	1692
Bamboo fiber(30% by wt) +e-glass fiber	72.9

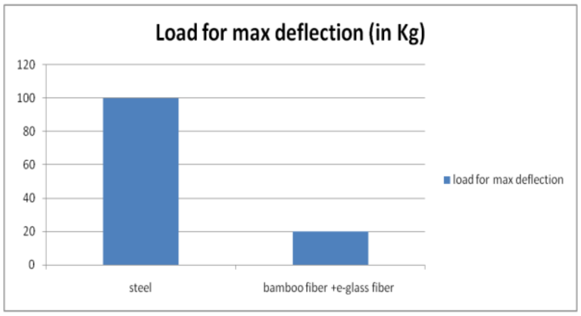

Fig.2. graphical representation of experimental results of leaf spring testing machine for different specimen

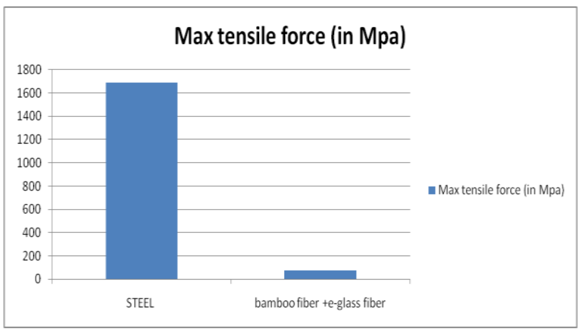

Fig.3. graphical representation of results of tensile testing machine for different specimen

V.RESULTS

- First test was carried out on leaf spring testing machine. to determine the max.load required for max.deflection. the order of load required is Conventional leaf spring > bamboo fiber with e-glass fiber .
- second test was tensile test which determines the max tensile load can take before fracture here max tensile strength for a conventional leaf spring was about 1692 MPa , while that of bamboo fiber composites is relatively very low that is 72.9.

VI.CONCLUSION

- A comparative analysis of bamboo fiber reinforced with glass fiber composite is performed it can be seen that in tensile test conventional steel leaf spring clearly dominates similar was the case for maximum deflection test using leaf spring testing machine.
- On the other hand when comparing in tensile tests the conventional leaf spring is far superior to resist tensile load as compared to e-glass fibner reinforced leaf spring.
- The strength of bamboo fiber reinforced glass fiber composite also varies with the change in percentage of bamboo fiber ,and also the strength of bamboo fibers themselves vary based on NAOH treatment they get , here we have used the 0.5% NAOH treated bamboo fiber. . the composite material under our research won't be able to replace conventional leaf spring in Heavy vehicles but it might be useful in light weight e-rickshaw.

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