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An Investigation of Mechanical Properties in Bamboo and Coir Fiber with Graphene for the Automobile Dash Board Panels.

Thiruvengaden R[1], Prithiviraj R[2], Yogendaran K A[3], Ramkumar G[4], Manikandan R[5]
Student[1234], Assistant professor[5], Department of Mechanical Engineering
Anjalai Ammal Mahalingam Engineering College, Thiruvarur, India

Abstract: *The aim of this research is focus on the study of mechanical properties in the natural composites like bamboo and coir fiber with polymer epoxy and graphene is used to enhance the needed properties. The composite material advancement is essential to the growth of the current, dynamic world. In order to reach the needed standard, numerous studies are being conducted in this area. There is a strong tendency for natural fibre reinforced polymer composites (NFPC) to replace composites based of synthetic fibers. The main reason for this is that they have benefits including being lightweight, non-toxic, non-abrasive, easily available, affordable, and biodegradable. Bamboo fiber and coir fiber cut into 2-4mm of length with epoxy resin having random orientations. Bamboo and coir fibers were treated with 6 wt. % NaOH solutions for 12 hrs. After, the NaOH treatment of the fibers, stirred homogeneously with the epoxy polymer resin and hardener. After the complete mixing with the resin it mould in the die which is already made. The curing time has been given as 24 hrs. in the control environment. After the curing period the specimen has been taken out and prepared for the mechanical testing like hardness and tensile. In the same approach with random orientation specimen were prepared with graphene also. At last the mechanical properties are evaluated for coir fiber (3 samples) bamboo fiber (3 samples) without grapheneand coir fiber (3 samples) bamboo fiber (3 samples) with graphene. The outcome of the paperis clearly shown that coir and bamboo fiber with graphene have significant mechanicalproperties.*

Keywords: Bamboo fiber, Coir fiber, Graphene, Tensile test, Hardness test

I. INTRODUCTION

Natural fibre composites have gained a lot of interest recently due to their sustainability and environmental friendliness. These composites combine natural fibers like bamboo, coir, hemp, and jute with a matrix material like epoxy resin, polyester, or polypropylene. Because of their low density, high strength-to-weight ratio, cheap cost, and biodegradability, these natural fibers are well suited for a variety of applications in many industries, including the automotive, construction, and packaging sectors. Two of the most popular natural fibers utilised in the creation of composites are coir and bamboo. It is the perfect material for structural applications because bamboo is a swiftly renewable resource with a high strength-to-weight ratio.

The addition of graphene, a two-dimensional material with exceptional mechanical, electrical, and thermal properties, has also improved the mechanical performance of epoxy polymer composites. The high surface area and strength of graphene can create composites with higher mechanical properties by enhancing the interfacial interaction between the natural fibers and the epoxy resin. The production of natural fibre composites employing bamboo, coir, and graphene in epoxy polymer composites involves a number of steps. Before the natural fibers are recovered, the raw material must first be cleaned to remove any impurities. Then, a coupling agent like silane is used to coat the fibers in order to increase their adherence to the matrix material. The graphene is then thoroughly mixed with the epoxy resin to produce a homogeneous dispersion of the graphene. The modified natural fibers are then added to the graphene-reinforced epoxy resin using a mechanical stirrer. The liquid is introduced into a mould, where it is given time to cure before being used to make the final composite material. The composite material must be heated to a specific temperature for a

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predetermined period of time during the curing process in order to allow the epoxy resin to crosslink and produce a rigid structure.

II. LITERTURE SURVEY

Investigation on Mechanical Properties of Bamboo and Coconut Fiber with Epoxy Hybrid Polymer Composite" Velpuri Venkat Raman, P. Sathish Kumar et.al[5],The present study focused to improve material characteristics and quality in terms of the NaOH concentration for treating the coconut and bamboo fiber to enhance the mechanical properties of natural fiber polymer-based hybrid composites. The NaOH-treated fibers were washed thoroughly using distilled water and allowed to dry for 24 hours. Composition of each specimen, bamboo (B) and coconut (C) fiber with epoxy composite, was prepared by hand layup process as per the American Society for Testing and Materials (ASTM) standard. The proportionality of the material was carefully fulfilled according to the previous literature reports. The weight fraction of the composite material content was set to be 30% and 70% of epoxy (E) resin and isolated fibers. Three distinct criteria were used to calculate mechanical parameters such as tensile strength, flexural strength, and material hardness. It was found that the combination of 70% E with 30% BC of hybridized composite had a maximum tensile strength of 62.42 MPa, whereas the flexural strength and hardness of the other combinations, such as 70% E with 30% C and 70% E with 30% B, were observed to be 58 MPa and 185 HRC (Hardness Rockwell C).

A study on mechanical properties of bamboo fiber reinforced polymer composite"P. Lokesh, T.S.A. Surya Kumari et.al[8], It has been explored that the mechanical properties of the composites such as tensile strength, flexural strength and impact strength highly influenced by the NaOH treated fibers used. Excess of fibers in composite materials deteriorate the mechanical properties of the composite because of lack of proper bonding between the matrix and fiber around their interface. This causes the disruption in transfer of load to the bonding fibers. Lower values of impact strength and flexural strength at higher composition of bamboo fibers may be because of this reason. The present study reveals that impact strength, tensile strength and flexural strength increases withincreasing the treated content of fiber in composite materials.

Thermal behavior of graphene oxide-coated piassava fiber and their epoxy composites" Fabio da Costa Garcia Filho, Fernanda Santos da Luz, et.al[10] ,The influence of graphene oxide (GO) functioning pias-sava fiber on its thermal characteristics was investigated by TGA/DTG and DSC analysis. In addition,for the first time, the thermal behavior of novel epoxy matrix GO-coated pias- sava fiber incorporated composites was studied by dynamic mechanical analyses (DMA) and have their results compared to epoxy matrix composites with neat piassava fiber. The TGA result showed that both the neat and GO- coated piassava fibers display similar thermal stability up to 200 ◦ C with distinct DTG maximum degradation rate. The main DTG degradation peaks for hemi cellulose and lignin, respectively, shifted from 288 and 359 ◦ C in the neat piassava towards 317 and 479 ◦ C in the GO-coated piassava. The DSC curves also corroborate the enhancement of thermal stability of the piassava fiber due to the GO-coating.

III. MATERIALS

Bamboo:

Bamboo, a natural fiber, possesses exceptional strength-to-weight characteristics, making it well-suited for structural use. The mechanical properties of bamboo, influenced by species, age, and growth location, vary but typically include a tensile strength of 120-200 MPa, flexural strength of 150-300 MPa, elastic modulus of 10-20 GPa, and density ranging from 0.6 to 1.2 g/cm3.

Coir fiber:

Coir fiber is a natural fiber known for its impressive mechanical properties, including high strength, stiffness, and impact resistance. Some typical mechanical properties of coir fiber include a tensile strength of 45-75 MPa, flexural strength of 40-70 MPa, elastic modulus of 4-6 GPa, and density ranging from 1.15 to 1.45 g/cm3

Epoxy Polymer Resin:

Epoxy polymer resin is a synthetic material widely used for its impressive mechanical properties, characterized by high strength, stiffness, and toughness. Typical mechanical properties of epoxy polymer resin include a tensile strength of 50-100 MPa, flexural strength of 80-200 MPa, elastic modulus of 2-6 GPa, and density ranging from 1.1 to 1.5 g/cm3

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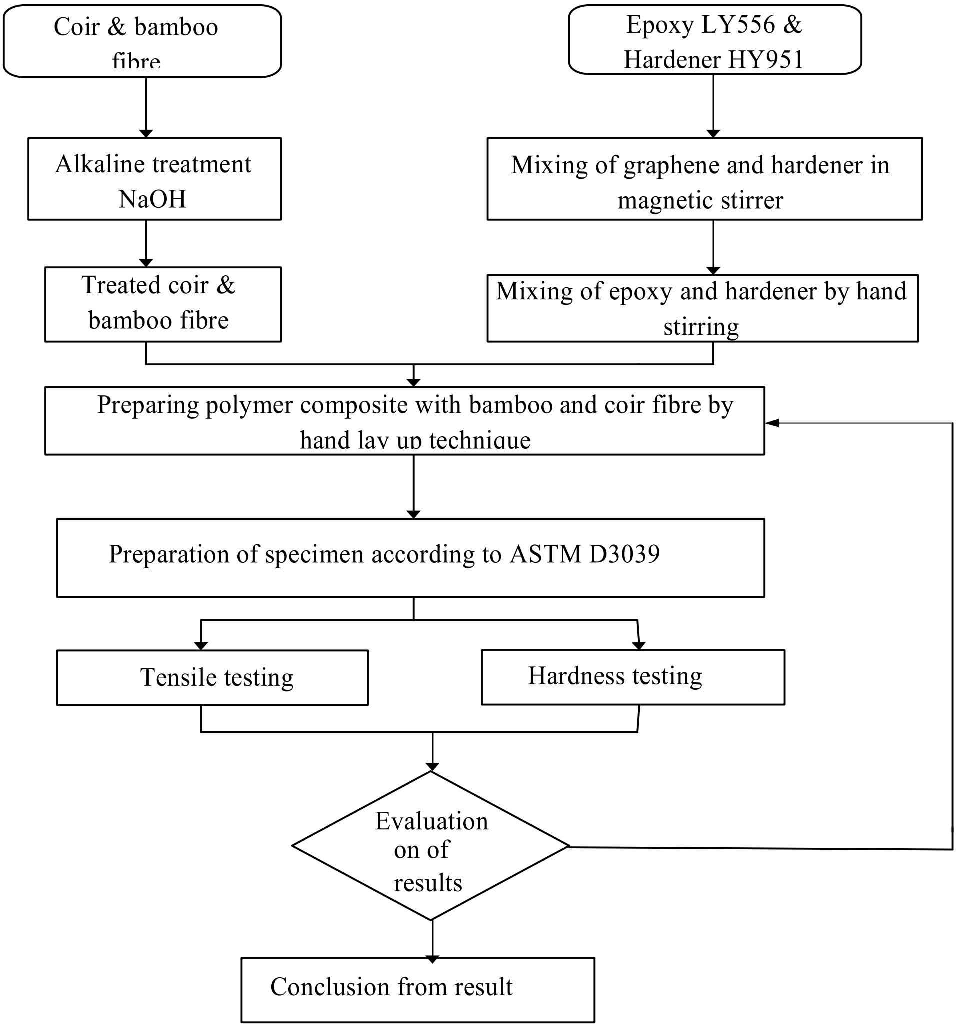
Hardener:

The choice of epoxy hardener in combination with epoxy polymer resin depends on the intended application and desired curing time. Typical properties of epoxy hardeners include a viscosity range of 100-500 mPa·s, density ranging from 1.1 to 1.2 g/cm3, and curing time varying between 1 and 24 hours

Graphene:

Graphene, a two-dimensional material, exhibits remarkable mechanical, electrical, and thermal properties. Typical properties of graphene include a tensile strength of 130 GPa, elastic modulus of 1 TPa, thermal conductivity ranging from 3000 to 5000 W/mK, and a surface area of 2630 m2/g.

IV. METHODOLOGY



Based on the literature review, Bamboo and Coir fibers were selected for their excellent mechanical properties and easy availability. The selected fibers underwent an alkaline treatment to improve their mechanical properties and remove any unwanted material present in the fibers. After the alkaline treatment, the fibers were chopped into small pieces for a more homogeneous mixture. The prepared fibers were then mixed homogeneously with epoxy resin and hardener. The resulting solution was poured into a wooden mold and left to cure. Once cured, the material was removed from the mold and sent to a grinding machine to achieve an excellent surface finish. The prepared specimen was cut according to ASTM standards of D2583 and D3034. After examining the results

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of the tensile and hardness tests, we concluded that the coir and bamboo fiber mixture showed more significant improvement than normal coir and bamboo fibers. Adding different percentages of graphene to the coir and bamboo specimen

V. RESULTS AND DISCUSSION

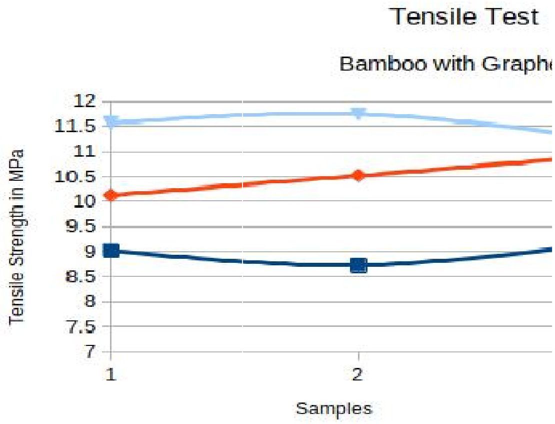
Tesnile test for bamboo with graphene

The results of the tensile test for bamboo with different proportions of grapheneare as follows:

Bamboo + 1% Graphene	Bamboo + 2% Graphene	Bamboo + 3%Graphene
9.02	10.12	11.56
8.73	10.52	11.75
9.18	10.93	11.23

Tab 3.1 Tensile strength for bamboo with different percentage of graphenecomposite.

The results indicate that the addition of graphene to bamboo composites can significantly improve their tensile strength. As the percentage of graphene increased, the tensile strength of the composites also increased. This is likely due to the high mechanical properties of graphene, including its high strength and stiffness.



Graph 3.1 Comparison graph for bamboo with different percentage of graphene composite

The results also suggest that there may be an optimal percentage of graphene that can be added to bamboo composites to maximize their tensile strength. In this case, the highest tensile strength was obtained in the composite with 3% graphene, with an average value of 11.51 MPa.

However, it is important to note that the addition of graphene can also affect other properties of the composite, such as its stiffness, toughness, and cost. Therefore, a comprehensive study is needed to determine the optimal percentage of graphene for specific applications.

Tensile test for coir with graphene

The results of the tensile test for coir with different proportions of graphene areas follows:

Coir + 1% Graphene	Coir + 2%Graphene	Coir + 3%Graphene
6.23	6.91	6.89
6.17	7.02	6.98
5.98	6.91	6.83

Tab 3.2 Tensile strength for coir with different percentage of graphenecomposite.

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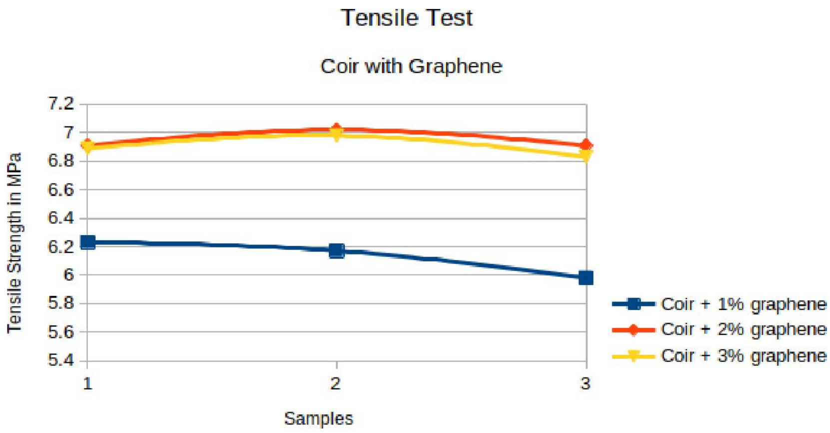
The results indicate that the addition of graphene to coir composites had a minimal effect on their tensile strength. The tensile strength of the composites did not increase significantly with the addition of graphene, and in some cases,it even decreased slightly.



Graph 3.2 Comparison graph for coir with different percentage of graphenecomposite.

This could be due to several factors, such as the poor dispersion of graphene in the coir matrix or the insufficient interaction between the graphene and the coir fibers. The low mechanical properties of coir fibers compared to bamboo fibers could also have contributed to the limited effect of graphene on the tensile strength of the composites.

Hardness test for bamboo with graphene

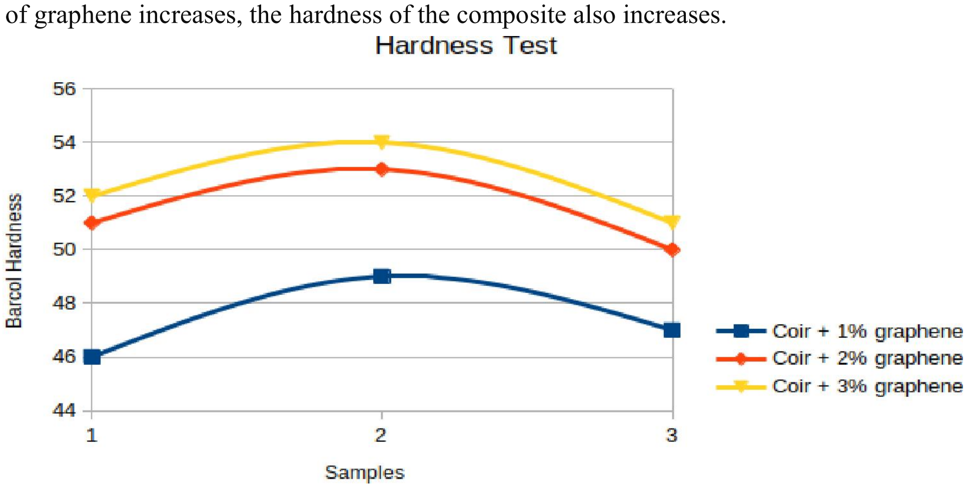
The results of the Barcol hardness test for coir reinforced with different proportions of graphene are as follows:

Coir + 1% Graphene	Coir + 2% Graphene	Coir + 3%Graphene
46	51	52
49	53	54
47	50	51

Tab 3.3 Hardness test for coir with different percentage of graphene composite.

Coir + 1% graphene: average of 47.3
Coir + 2% graphene: average of 51.3
Coir + 3% graphene: average of 52.3

The results show that the addition of graphene to coir fibers has a positive effecton the hardness of the composite. As the proportion of graphene increases, the hardness of the composite also increases.



Graph 3.3 Comparison graph for coir with different percentage of graphenecomposite

The improvement in hardness of the coir composite can be attributed to the excellent mechanical properties of graphene, which has high strength and stiffness. The graphene sheets dispersed in the coir matrix act as reinforcing agents, providing additional strength to the composite

Hardness test for bamboo with graphene

The results of the Barcol hardness test for bamboo reinforced with different proportions of graphene are as follows:

Bamboo +1% Graphene	Bamboo + 2% Graphene	Bamboo + 3%Graphene
43	47	51
46	49	53
45	50	52

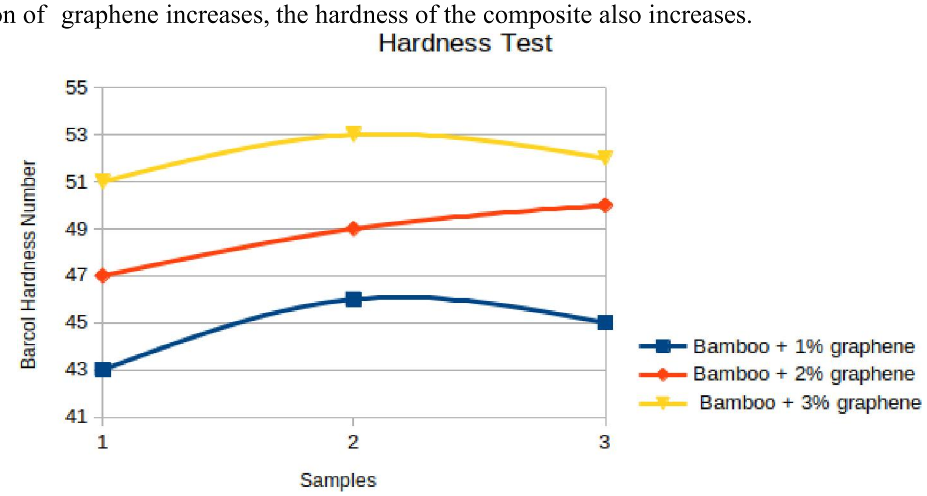
Tab 3.4 Hardness test results for bamboo with different percentage of graphenecomposite.

Bamboo + 1% graphene: average of 44.6

Bamboo + 2% graphene: average of 48.7

Bamboo + 3% graphene: average of 52

The results show that the addition of graphene to bamboo fibers has a positive effect on the hardness of the composite. As the proportion of graphene increases, the hardness of the composite also increases.



Graph 3.4 Comparison graph for coir with different percentage of graphenecomposite

The improvement in hardness of the bamboo composite can be attributed to the excellent mechanical properties of graphene, which has high strength and stiffness. The graphene sheets dispersed in the bamboo matrix act as reinforcing agents, providing additional strength to the composite

VI. CONCLUSION

We came to the conclusion that the coir and bamboo fiber blend demonstrated a more notable improvement than standard coir and bamboo fibers after analyzing the results of the tensile and hardness tests. The coir and bamboo specimens improved in tensile and hardness qualities when varying quantities of graphene were added.

Mechanical qualities significantly improved with the addition of 1% and 2% of graphene, and after 3%, there was barely any change in properties, indicating that it has reached saturation. Therefore, adding more grapheneis not desired

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