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MECHANICAL PROPERTIES OF MUSA FIBER & AL_2O_3 EPOXY COMPOSITES

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ABSTRACT

World is as of now concentrating on alternate material sources that are environment biodegradable in nature. Natural fiber reinforced polymer composite has a huge affinity to replace the composite made up of synthetic fiber. This is primarily because of the advantages like light weight, non-toxic, non-abrasive, easy availability, low cost, and biodegradable properties and constitutes the present extent of experimental work. Fiber reinforced polymer composites has numerous benefit like minimal effort of creation, simple to create and better quality contrast.The fiber strengthened polymer composite utilized within an assortment of provision as class of structure material. This work describe the mechanical behavior of Musa fiber & Aluminium oxide reinforced polymer composite with the extraordinary references to the impact of fiber loading and length of fiber on the properties of composites.

Keywords: Biodegradable, Reinforced, Musa fiber, Aluminium oxide, non-abrasive, composite.

1. INTRODUCTION

Composite material can be defined as the material which is composed of two or more distinct material on macro scale with different properties to form a new material with a property that is entirely different from the individual constituents. The primary phase of a composite material is called a matrix having a continuous character. In other words, matrix is a material which acts as a binder and holds the fibers in the desired position thereby transferring the external load to reinforcement. These matrices are considered to be less hard and more ductile. The composite material consists of a matrix along with a fiber with some filler material. The reinforced material can be either synthetic or natural fibers.

Based on the matrix used, composite material can be divided into three types i.e. Metal Matrix Composite (MMC), Polymer Matrix Composite (PMC) and Ceramic Matrix Composite (CMC). The selection of any of the above composite material depends upon the type of application. The most commonly used composites are polymer matrix composite. his is primarily because of their light weight and specific properties compared to ceramics and metals. Besides, the polymer matrix composites can be processed at low temperature and pressure.

In the present study, epoxy is as the matrix material. Generally, epoxy has a glassy appearance with classic advantages like good adhesion to other materials, good mechanical properties, good electrical insulating properties, good environmental and chemical resistances etc . The epoxy when treated with natural fiber to synthesize a fiber reinforced polymer composite, there is an interface formed between the matrix and the fiber. The adhesion between the fibers and the matrix around this interface decides the properties of the composites based on which its further application is decided..

Musa Fiber shows better mechanical properties as compared to fibers such as sisal, bamboo, vakka etc. Musa Fiber can be used in a different form to synthesize a composite product. These can be either in a form of a long strip. The selection of their fiber kind depends upon the property to be imparted in the composite. Longer Musa fiber are used in making structural composite that is used in automobile roofings, short musa fibers are used in making of medium density fibreboard & ply. The impact strength of pseudo-stem musa fiber improved by approximately 40% compare to the impact strength of neat epoxy. The impact strength value is higher which indications to higher toughness value of the material. They are also reported that when musa woven fiber was used with epoxy material then the flexural strength increased. There are many reports available on the mechanical and physical properties of natural fiber reinforced polymer composites, but, the effect of fiber length on mechanical behavior of Musa fiber reinforced polymer composites is scarcely been reported.. Aluminium oxide may be found in nature as corundum, rubies, sapphires, and emeralds. It's an alkaline earth compound that interacts with both acids and bases. It appears white and exists as a solid. It has no odour and is insoluble in water. This molecule is most commonly found in crystalline form, which is known as -aluminium oxide or corundum. Because of its hardness, it is usually utilized as an abrasive and in cutting tools.Aluminum oxide is an electrical insulator, it exhibits thermal conductivity in ceramic material. it has a relatively high melting point (2345^0K) and boiling point (3250^0K) and has a density of $3.987 g/cm^3$. It is most commonly utilized as a ceramic material. The current work has undertaken with the objectives to investigate the mechanical properties of Musa fiber and Aluminium oxide based epoxy composites

The main objectives of current research work which are outlined as Fabrication of short Musa fiber & Aluminium oxide based epoxy composites. To evaluate the mechanical properties such as tensile strength, flexural strength and hardness of fabricated composites & to study their influence of fiber loading and fiber length on mechanical properties of composites.

2. LITERATURE REVIEW

The mechanical behaviour of a natural fiber based polymer composite depends on numerous factors, for example, fiber length and quality, matrix, fiber-matrix adhesion bond quality and so forth. The strong interface bond between fiber and matrix is paramount to show signs of improvement mechanical properties of composites. **Shankar et a**l. [1] have studied and reported that the ultimate tensile strength value maximum at 15% and then decreases with increasing in fiber starting from 15% to 20%. They also reported that the flexural strength value decreasing from 5% to 10% (87.31 MPa) and after that the value increased from fiber. **Pothan et al**. **[2]** have investigated on the influence of fiber content and length on short banana fiber reinforced polyester composite material.

Laban et al. [3] has studied on the physical and mechanical behavior of banana fiber reinforced polymer composite and noticed that kraft mashed banana fiber material has better flexural strength. The tensile strength is detected maximum at 30 mm fiber length whereas the impact strength is noticed maximum at 40 mm length of fiber. Consolidation of 40% untreated banana fibers gives 20% rise in the tensile strength and 34% rise in impact strength. **Joseph et al. [4]** studied and compared the mechanical behavior of phenol formaldehyde composites which was reinforced with glass fiber and banana fiber. There are many researches who have evaluated the mechanical, chemical and physical behavior and banana fiber reinforced with epoxy composite. Many studied and compared of effect of treated and untreated banana fiber reinforced with thermoplastic and thermosetting polymer**[5-7]**

Manikandan1 et al [8] Conducted experimentation to study the influence of fly ash fillers on mechanical and tribological properties of woven jute fiber reinforced polymer hybrid composite. Composites were prepared using hand layup method with weight percentage of fly ash as filler material. Inclusion of Filler percentage increases hardness and wear resistance properties but decreases the tensile strength of composite material decreases. **Sandhyarani Biswas et al [9]** determined the physical and mechanical properties of bamboo fiber reinforced epoxy Composites. Composites were fabricated using short bamboo fiber at different weight percentages and observed that few properties increases significantly with respect to fiber loading, properties like void fraction increases with the increase in fiber loading. To reduce the void fraction, improve hardness and other mechanical properties and so silicon carbide filler is added in bamboo fiber reinforced epoxy composites resulting increases hardness, tensile strength and flexural strength.

The key criteria employed to optimize the mechanical strengths of epoxy-based composites were filler wt% & Fiber wt % during the hand lay-up process.

3. METHODOLOGY

It is divided into two parts first is details of processing of the specimen preparation & second is testing of mechanical properties of composites. The materials used are: Musa fiber,Aluminium oxide, Epoxy & Hardener.

3.1 Specimen Preparation Method

The Musa fiber is obtained from banana plant, which has been collected from local sources. The extracted Musa fiber were subsequently sun dried for ten hours then dried in oven for 27 hours at 110° C to remove free water present in the fiber. The epoxy resins and hardener Araldite (Resin AW106IN + Hardener HV953IN) purchased from Huntsman Corporation.

Figure 3.1 The epoxy resins and hardener Araldite

The musa fiber and aluminium oxide based epoxy composite is fabricated using hand lay-up process. The moulds have been prepared with dimensions of 180×180×40 mm^3 . The Musa fiber of 30mm length has been mixed with matrix mixture along with aluminium oxide with their respective values by simple mechanical stirring and mixture are slowly poured in different moulds, keeping the characterization standards and view on testing condition. The releasing agent has been use on mould sheet which give easy to composites removal from the mould after curing the composites. A sliding roller has been used to remove the trapped air from the uncured composite and mould has been closed at temperature 30° C duration 24 hour. The constant load of 50 kg is applied on the mould in which the mixture of the Musa Fiber, aluminium oxide, epoxy resin and hardener has been poured. After curing, the specimen has been taken out from the mould. The composite material has been cut in suitable dimensions with help of zig saw for mechanical tests as per the ASTM standards. The designation and detail composition of composites shown in table below.

Table 3.1: Designation and Composition of Composites

Composite	Al_2O_3 (Wt. %)	Fiber (Wt. %)	Epoxy (Wt. %)
C1	20	0	80
C2	15	5	80
C3	10	10	80
C4	5	15	80
C5	0	20	80

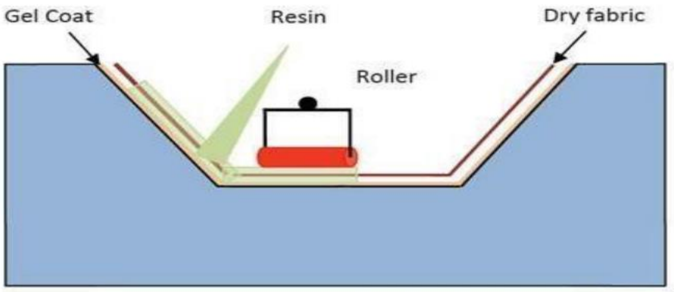

Figure 3.2 Hand Lay-up Technique

Figure 3. 3 Fabricated reinforced epoxy composites **Figure 3. 4** Specimens epoxy composites after cutting.

4. MODELING AND ANALYSIS

4.1 Testing of Mechanical Properties of Composites (Tensile Strength Test):

Fabricated composite was cut to get the desired dimension of specimen for mechanical testing. For the tensile test, the specimen size was 160 × 20 mm^2 and gauge length was 80 mm. Tensile strength was tested inTUE-C-600 Model. The specimen with desired dimension was fixed in the grips of the machine with 8 mm gauge length.

Figure 4.1 set up for tensile test

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4.2 Flexural Strength Test

Specimen dimension for flexural test was 100 mm × 20 mm × 80 mm and three point bend test method was used for finding the flexural strength using Universal Testing Machine Instron. The loading arrangement for flexural strength is shown in Figure.

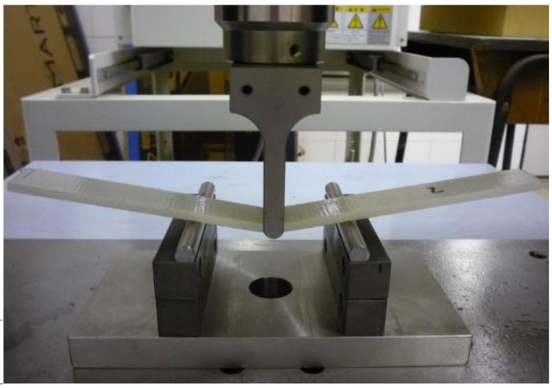

Figure 4.2 Three point bend test loading arrangement

4.3 Hardness Test

Fabricated composite was cut in dimension of 20 mm × 20 mm for hardness test. The hardness test was conducted in Vickers hardness test machine. The load was applied 0.32 kgf on the composite and the holding time was 12 second. Hardness is defined as the ability to oppose to indentation, which is obtained by measuring the stable depth of the indentation. In the Vickers hardness test a square base pyramid shaped diamond is used for testing.

Figure 4.4 Set up for hardness test

5. RESULTS AND DISCUSSION

5.1 Influence of Hardness on Composite

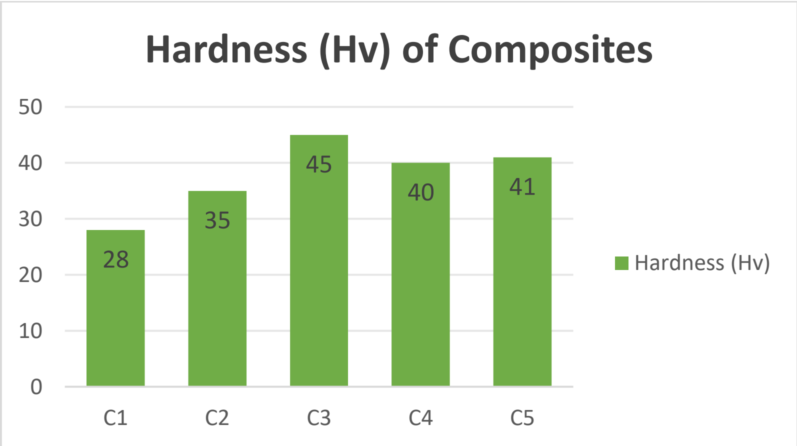

Figure 5.1 Variation Hardness(Hv) for Various Composites

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Figures show that neat polymer (C1) shows least amount of hardness i.e. 28 and as the fiber % is increased the hardness increase simultaneously, from composites C1 toC3. But C3 has Al_20_3 and Musa fiber as 10% wt. Increase in hardness with increase in fiber material & filler material simultaneously been observed in our research work. As the fiber Wt. % increases and filler content decrease I.e. from C4-C5 composites the hardness decreases.

5.1 Influence of Tensile Strength on Composites

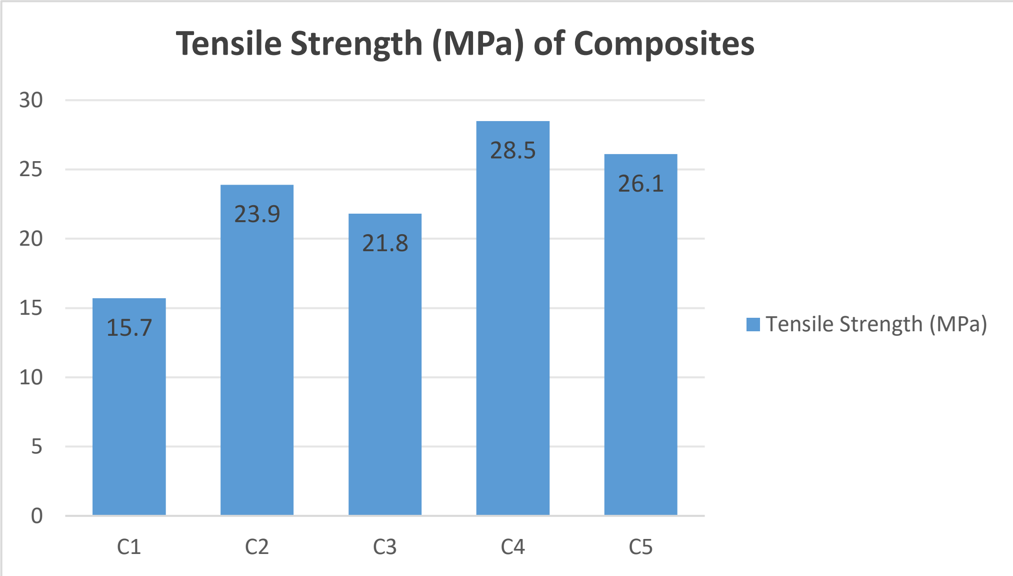

Figure 5.2 Variation tensile Strength (MPa) for Various Composites

The mechanical behavior like tensile strength of the Musa fiber & Aluminium Oxide based epoxy composites depends on fiber parameters like Wt.%. The influence of fiber content and loading on tensile properties of composites is shown in Figures 5.2. the tensile strength mainly depends on the Fiber content as in our case good tensile strength was observed when Fiber Wt. % is 15 and Al2O3 Wt. % is 5. It has been observed from the chart that the tensile strength of composites increases with increase in fiber Wt.% and after that starts decreasing. The C4 composites gives best tensile strength of 28.5 MPa.

5.1 Influence of Flexural Strength on Composites.

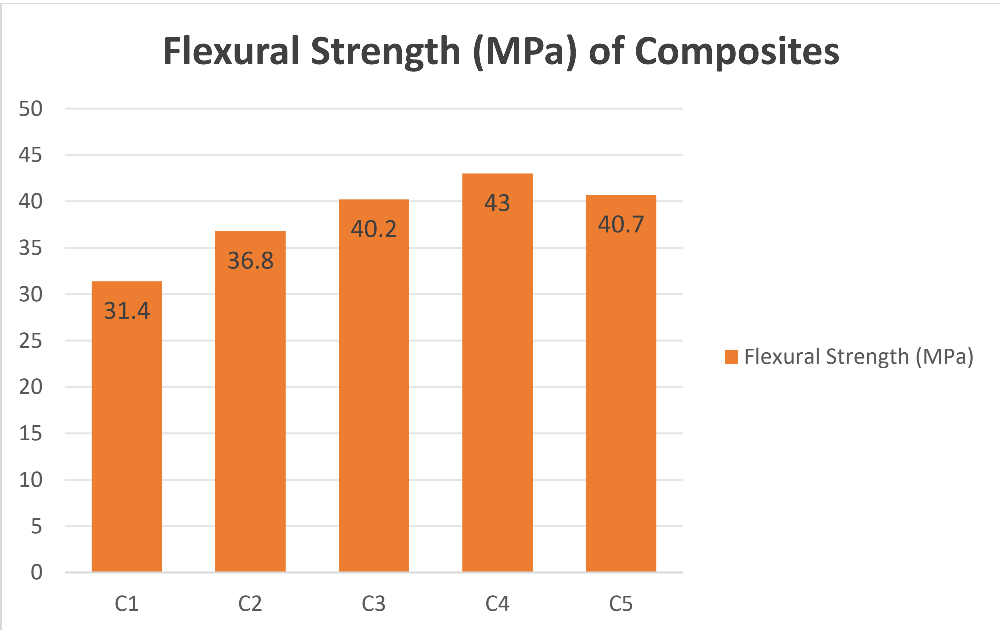

Figure 5.3 Variation Flexural Strength (MPa) for Various Composites

The influence of Musa fiber, Al2O3 epoxy composites and loading on flexural strength shown in Figure 5.3. Figure shows that when fiber Wt.% increases & simultaneously aluminium oxide decreases the flexural strength of the fabricated composites first increases up to C4 composites and then decreases. As the musa fiber wt% increases the flexural strength increases upto C4 composites. The maximum flexural strength is observed in C4 composites where musa fiber length is 30 mm with 15% (Wt. %), Aluminium oxide 5% (Wt. %).

6. CONCLUSION

The Fabrication of Musa Fiber & Aluminium oxide based Epoxy composite processed by hand lay-up method. By this project we came to know the mechanical strength of the Musa fiber & Aluminium Oxide when it is mixed with the Epoxy and Hardener with a ratio of 10:1 and that of percentage weight of fiber & Filler and matrix is 20% and 80% respectively. The best mechanical properties like tensile and Flexural strength is being observed in composite C4 and best hardness property was observed in C3 composites. The utilization of Musa as a fiber reinforcement and other filler in composites enlarges the entryway for further research in the given field. The research can be further extended to study the influence of Musa fiber on other properties of composites such physical, thermal and tribological properties.

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