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RESEARCH ARTICLE

FABRICATION AND INVESTIGATION OF MECHANICAL PROPERITIES IN NYMPHAEA FIBRE REINFORCED EPOXY COMPOSITE

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ABSTRACT

In the present investigation the new Nymphaea (water lily) are successfully incorporated in epoxy and the composite are prepared. Nymphaea epoxy composites with varying weight fractions (10%, 20%, 30%) are fabricated. the mechanical properties such as density, hardness, flexural strength, tensile. and moisture absorption of all composites are tested. The effects of fibre content on the mechanical properties of composites were investigated. The results show that by the incorporation of Nymphaea fibre into epoxy improves the mechanical properties. When compare in to the pure epoxy the water absorption tests were carried out in saline and sub zero environment and the results of the absorption test also presented in the project.

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INTRODUCTION

Composite materials due to their low density, excellent stiffness and good thermal and mechanical properties are particularly superior to many traditional materials such as metals. Recent developments on various applications of polymer composite are well documented in many literatures. Different types of polymer show different Mechanical and tribological behavior. However neat polymers is very rarely used as bearing materials and wear resistance material because unmodified polymer could not satisfy the demands arising from the situations wherein a combination of good mechanical and tribological properties is required (Mallick, 1993). Visualizing the importance of polymer composite reinforced with cellulosic fibers like sisal, coconut (coir), bamboo, banana in their natural form as well as several waste cellulosic products. Such as shell flour, wood flour and pulp have been used as reinforcing agents of different thermosetting and thermoplastic composites. However as per the information of the investigator there is no information available on the mechanical behavior of fruit waste. There is little work done by Abdul Khalil *et al.* (2008) to characterize the epoxy composite filled with the bio-based fillers like bamboo stems, coconut shells and oil palm fiber bunches. Their results showed that there was improvement in thermal stability of the carbon black filled composite compared to the neat epoxy. Christian J. Espionze Santos (2009) performed details characteristics studies on coconut fibers. He observed that increase in weight percent of fiber reinforcement increase the flexural strength of the composite. Keeping all these in view in the present work an attempt has been made to study the mechanical and flexural behavior of Nymphaea reinforced epoxy composite.

According to type of matrix material they are classified as:

1. Metal Matrix Composites (MMC)
2. Ceramic Matrix Composite (CMC)
3. Polymer Matrix Composite (PMC)

Objectives of the Present Work

The objectives of the present work are:

- To prepare the Nymphaea particulates of desired particle size.
- To fabricate the particulate with different weight percentage in the epoxy matrix.

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- To study the density of different samples.
- To check the micro-hardness of different samples.
- To perform the tensile and flexural tests on the composite samples.

MATERIALS AND METHODS

Raw materials used in this experimental work are listed below

1. Natural fiber (Nymphaea)
2. Epoxy Resin
3. Hardener

Nymphaea

- Scientific name of water lily is Nymphaea
- Hardness
- Less weight
- Economically low

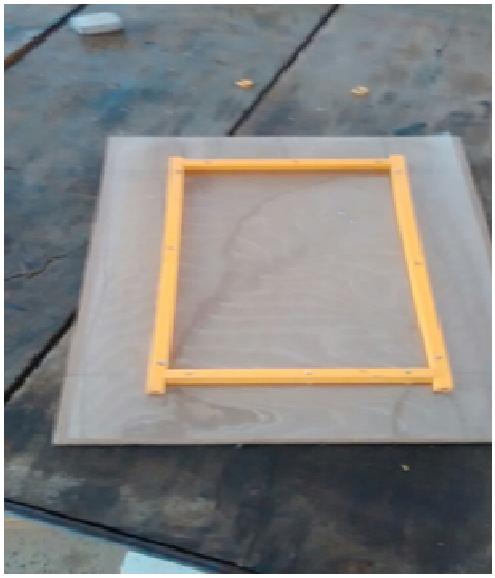
Fig. 3.1 WATER LILLY

Epoxy Resin

The type of epoxy resin used in the present investigation is araldite LY556 which is chemically belongs to epoxide family. Its common name is BisPhinol-A-Diglycidyl-Ether. It is supplied by CIBA GUGYE India Limited

Hardener

The hardener with IUPAC name NNO-bis (2aminoethylethane-1,2diamin) has been used with epoxy designated as HY951. This has a viscosity of 10-20 MPa at 25ºC.



a)

b)

c)

Figure (a) Mould used for making the composite, (b) Tensile test specimen, (c) Flexural test specimen

Composite preparation

A Per-pex sheet mould (dimension 130X100X6mm) figure-3.2 was used for casting the composite sheet. A mould release spray was applied at the inner surface of the mould for quick and easy release of the composite sheet. A calculated amount of epoxy resin and hardener (ratio of 10:1 by weight) was taken and mixed with Nymphaea particulate with gentle stirring to minimize air entrapment. After keeping the mould on a glass sheet (coated with wax) the mixture is then poured into it. Care was taken to avoid formation of air bubbles. Pressure was then applied from the top and the mould was allowed to cure at room temperature for 72 hrs. During application of pressure some amount of epoxy and hardener squeezes out. Care has been taken to consider this loss during manufacturing so that a constant thickness of sample could be manufactured. This procedure was adopted for preparation of 5, 10, 20 and 30% weight fractions of Nymphaea. After 72 hrs the samples were taken out of the mould, cut into different sizes and kept in air tight container for further experimentation.

RESULTS AND DISCUSSION

Table : Density of different Samples

Fiber content (%)	Measured Density (gm/cm^3)	Theoretical Density (gm/cm^3)	Volume fraction of voids (%)
0	1.082	1.100	1.636
5	1.0991	1.118918	1.7712
10	1.113	1.138498	2.239613
20	1.143	1.179788	3.118215
30	1.1398	1.224186	6.893266

Weight fraction of Nymphaea

Figure: The variation of density with different fiber content

Hardness Test

Vickers hardness number is measured by Leitz Micro – hardness tester. The results are tabulated in the table. It is observed that as the reinforcement increases the hardness increases the maximum value is obtained for composite prepared with the 20% composite.

Table: Hardness of diffeent samples

Weight fraction of Particulates (%)	Vicker Hardness value
Neat epoxy	**17.894**
5	**18.28**
10	**19.68**
20	**20.72**
30	**18.95**

Tensile Test

The results of tensile test using UTM are tabulated in Table and it is observed that the tensile strength is maximum for the composite prepared with 20% fiber However, for 30% fiber composite the tensile strength decreases because of the void content.

Table Tensile Stress and Tensile Modulus of composites

Weight percent of fiber	Tensile Stress (MPa)	Tensile Modulus (MPa)
Neat epoxy	18.031	648.23
5%	19.25	742.46
10%	22.69	1313.63
20%	25.85	1271.69
30%	21.34	938.96

Flexural Test

The three point bend test was carried out in UTM 201 machine in accordance with ASTM D2344-84 to measure the flexural strength of the composites. The flexural strength, flexural modulus and ILSS values are tabulated in Table. From the table, it is observed that the composite having 20% fiber content has the highest values of flexural strength, flexural modulus and ILSS. Finally from all the tables it is observed that the flexural and ILSS values are getting maximum for the composite prepared with 20 % fiber.

Table Flexural properties of the composites

Weight fraction of Particulates (%)	Flexural Strength(MPa)	Flexural modulus(GPa)	ILSS (MPa)
Neat epoxy	45.519	5.046	1.137
5%	48.23	5.146	1.425
10%	56.98	9.631	1.653
20%	62.35	10.970	1.808
30%	57.89	8.334	1.765

Conclusion

The present work deals with the preparation of characterization of waste Nymphaea fiber reinforced epoxy composite. The mechanical behavior of the composite lead to the following conclusions

1. With the successful fabrication of a new class of epoxy based composites reinforced with Nymphaea fiber.
2. The flexural strength of the composite is found to be maximum with 20% weight percent of Nymphaea fiber.
3. The tensile strength of the composite is found to be maximum for the 20 % weight percentage of the Nymphaea fiber.
4. The hardness value of the composite increases with increasing of the fiber content.

Recommendation for further research

- In this study fiber weight fraction of 30% has been used. This can be further increased to higher weight fraction of fiber using other manufacturing methods.
- The current study is limited to mechanical study only. It can be extended to tribological tests.
- The same work could be extended to different treated fiber composite.

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