Mechanical Behavior of Areca Fiber Reinforced Epoxy Composite

[1]Vinayraj K G, [2]Dr.Ashock B C

[1] M-Tech Student, Department of Mechanical Engineering, Vidyavardhaka college of Engineering, Mysuru, Karnataka, India

[2]Associate Professor, Department of Mechanical Engineering, Vidyavardhaka college of Engineering, Mysuru, Karnataka, India

Abstract: **Over the last century, polymers have emerged as one of the most indispensible components used in everyday life, epoxy or poly-epoxide being one such example. Until recently, synthetic filler materials have been the preferred choice for reinforcement of epoxy to improve its toughness. However, natural filler and fiber materials are emerging as suitable alternatives to synthetic materials for reinforcing polymers such as epoxy due to their environment friendliness, high abundance, renewability, and cost effectiveness. The present experimental study aims at learning Mechanical behavior of areca fiber reinforced epoxy composites. Composites having 0, 5, 10 and 15% weight fraction of areca fiber were made using hand layup method. The fabricated composite samples were cut according to the ASTM standards for different experiments. Tensile, flexural, impact, hardness test and water absorption test were carried out at the samples. The maximum hardness, tensile, flexural, impact are getting for the material prepared with the 15 % reinforced areca fiber epoxy composite.**

Keywords: **Epoxy resin, Hardener, Areca fiber, NaoH.**

1. INTRODUCTION

The material which is composed of two or more different kind of constituents which are insoluble in each other and maintain their physical phases and they physically or chemically separated by a clear-cut interface or inter-phases called composites.

Generally, a composite material is composed of reinforcement (fibers, particles, flakes, and/or fillers) embedded in a matrix (polymers, metals, or ceramics). The matrix holds the reinforcement to form the desired shape while the reinforcement improves the overall mechanical properties of the matrix. When designed properly, the new combined material exhibits better strength than would each individual material.

As defined by Jartiz, [1] Composites are multifunctional material systems that provide characteristics not obtainable from any discrete material. They are cohesive structures made by physically combining two or more compatible materials, different in composition and characteristics and sometimes in form.

Kelly [2] very clearly stresses that the composites should not be regarded simple as a combination of two materials. In the broader significance; the combination has its own distinctive properties. In terms of strength or resistance to heat or some other desirable quality, it is better than either of the components alone or radically different from either of them.

Berghezan [3] defines as “The composites are compound materials which differ from alloys by the fact that the individual components retain their characteristics but are so incorporated into the composite as to take advantage only of their attributes and not of their shortcomings”, in order to obtain an improved material.

Van Suchetclan [4] explains composite materials as heterogeneous materials consisting of two or more solid phases, which are in intimate contact with each other on a microscopic scale. They can be also considered as homogeneous materials on a microscopic scale in the sense that any portion of it will have the same physical property.

Composites consist of one or more discontinuous phases embedded in a continuous phase. The discontinuous phase is usually harder and stronger than the continuous phase and is called the 'reinforcement' or 'reinforcing material', whereas the continuous phase is termed as the ' matrix'. Properties of composites are strongly dependent on the properties of their constituent materials, their distribution and the interaction among them.

The composite properties may be the volume fraction sum of the properties of the constituents or the constituents may interact in a synergistic way resulting in improved or better properties. Apart from the nature of the constituent materials, the geometry of the reinforcement (shape, size and size distribution) influences the properties of the composite to a great extent.The concentration distribution and orientation of the reinforcement also affect the properties. The shape of the discontinuous phase (which may by spherical, cylindrical, or rectangular cross-sanctioned prisms or platelets), the size and size distribution (which controls the texture of the material) and volume fraction determine the interfacial area, which plays an important role in determining the extent of the interaction between the reinforcement and the matrix.

Concentration, usually measured as volume or weight fraction, determines the contribution of a single constituent to the overall properties of the composites. It is not only the single most important parameter influencing the properties of the composites, but also an easily controllable manufacturing variable used to alter its properties.

The following are some of the reasons why composites are selected for certain applications[5]:

- Low density
- High Specific Strength
- High Specific Modulus
- High Thermal Conductivity
- Good Fatigue Modulus
- Control of Thermal Expansion
- High Abrasion and Wear Resistance

Composites are needed because modern applications require materials with strange combination of properties like low stiffness, high strength, abrasion and impact resistance.

The Arecanut fiber-reinforced composite has the advantage of being light, strong, cheap, safe and more environment-friendly reinforced materials has opened up questions regarding how much material is to be tested for strength and durability.

2. FABRICATION OF COMPOSITE MATERIALS

For preparation of composites to conduct mechanical and tribological test, the following materials has been used; arecanut fiber, NaoH solution, Epoxy, Hardener. Among all the natural fiber-reinforcing materials, areca appears to be a promising material because it is inexpensive, availability is abundant. Selected areca fruit husks were used to prepare the composites. Dried areca husk was soaked in deionised water for about five days. The soaking process loosens the fibers and can be extracted out easily.

The areca fibers were treated in a solution of 10% NaoH where the total volume of solution. The fibers were kept in this alkaline solution for 36 hours at a temperature of 30° C; it was then thoroughly washed in running water then neutralized with a 2% acetic acid solution. Lastly, it was again washed in running water to remove the last traces of acid sticking to it, so that the pH of the fibers is approximately 7 (neutral). Then, they were dried at room temperature for 48 hrs to get alkali treated fibers.

In this investigation LAPOX L-12 epoxy resin was used. LAPOX L-12 is a liquid, unmodified epoxy resin of medium viscosity which can be used with various hardeners for making reinforced composites and laminates.

In this investigation hardener K-6 is used. K-6 is a low viscosity room temperature curing aliphatic amine curing agent. It is commonly employed for civil engineering systems where low viscosity and fast setting at ambient temperature is desired.

3. FABRICATION & PREPARATION OF COMPOSITE SLABS

The arecanut were collected from farm and were cleaned and are dried. The waste materials are removed and short fibers (1-2mm length) are obtained. Usual hand lay-up technique was used for preparation of the samples. A plastic mold of dimension (200x125x5) mm was used for casting the composite sheet. A mold release spray was applied at the inner surface of the mold for quick and easy release of the composite sheet. For different weight fraction of fibers, a calculated amount of epoxy resin and hardener (ratio of 10:1 by weight) was thoroughly mixed in a glass jar and placed in a vacuum chamber to remove air bubbles that got introduced. Then calculated amount of areca fiber is added to the mixture of epoxy resin and hardener and mixed properly. Then the composite mixture is poured in to the mold. Care has been taken to avoid formation of air bubbles. Pressure was then applied from the top and the mold 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 can be maintained. This procedure was adopted for preparation of 5, 10, 15 weight fractions of fiber reinforced epoxy composite slabs. After 72 hrs the samples were taken out from the mold and then cut in to required sizes as per ASTM standards for Mechanical test.

4. RESULTS AND DISCUSSION

TENSILE STRNGTH RESULTS:

Table.4.1: Tensile Strength As per ASTM D638 Standard

Weight fraction	Tensile stress (MPa)	Force at Break (N)	Elong at Max %
Epoxy +0% fibers	16.95	1100.48	0.55
Epoxy +5% fibers	22.58	1841.29	0.74
Epoxy +10% fibers	26.21	1958.71	0.80
Epoxy +15% fibers	37.89	2219.78	1.16

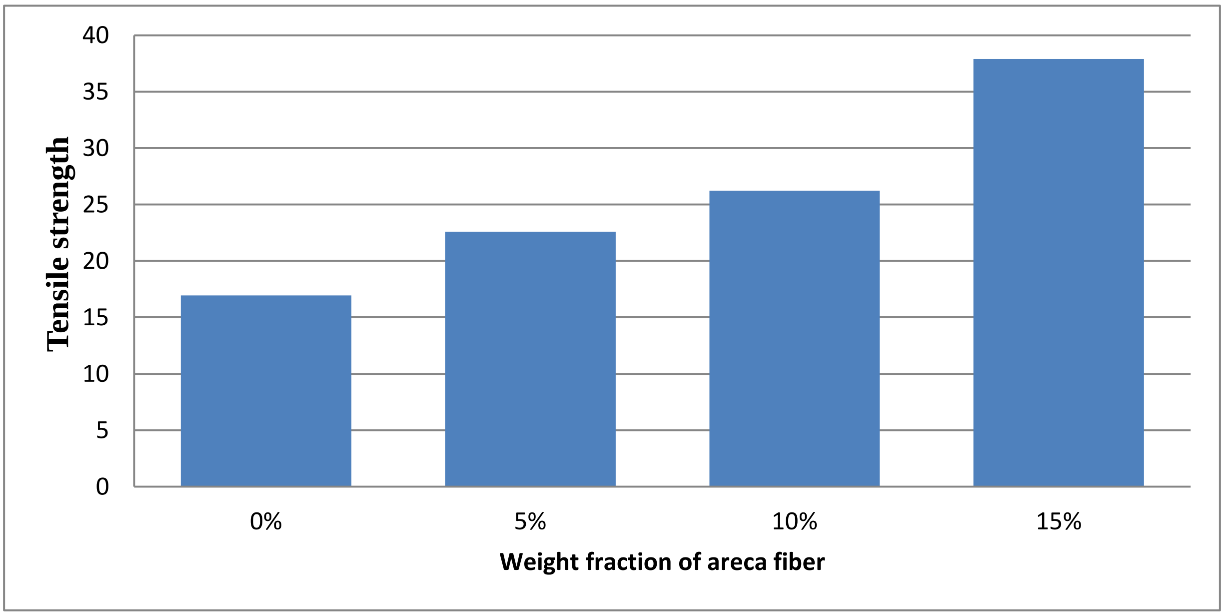

Figure.4.1: Variation of Tensile strength with different fiber contents

Fiber content and fiber strength are influencing parameters for the strength related properties of the composite. Hence the strength variation with different weight fractions of fiber loading showed differently. This variation in tensile of the composites with 0%, 5%, 10%, 15% of fiber content are shown in figure 4.1. The figure clearly indicate the gradual increase in tensile strength for 5% and 15% fiber content.

FLEXTURAL TEST RESULTS:

Table.4.2: Flextural Strength As per ASTM D790 Standard

Weight fraction	Flextural strenghth(MPa)
Epoxy +0% fibers	17.68
Epoxy +5% fibers	52.4
Epoxy +10% fibers	54.12
Epoxy +15% fibers	86.62

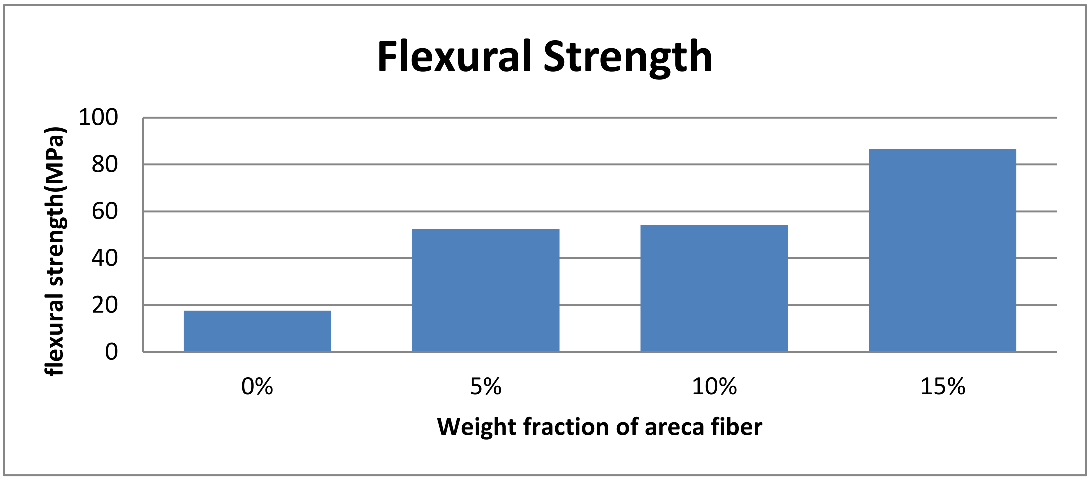

Fig.4.2: Variation of flexural strength with different fiber contents

The three point bend test was carried out in UTM machine in accordance with ASTM D790 to measure the flexural strength of the composites. The flexural strength values are tabulated in Table 4.2. From the table, it is observed that the composite having 15% fiber content has the highest values of flexural strength.

IMPACT TEST RESULT:

Table.4.3: Impact Test data

Weight fraction	**Impact strength**
Epoxy +0% fibers	8.01
Epoxy +5% fibers	8.30
Epoxy +10% fibers	12.76
Epoxy +15% fibers	14.46

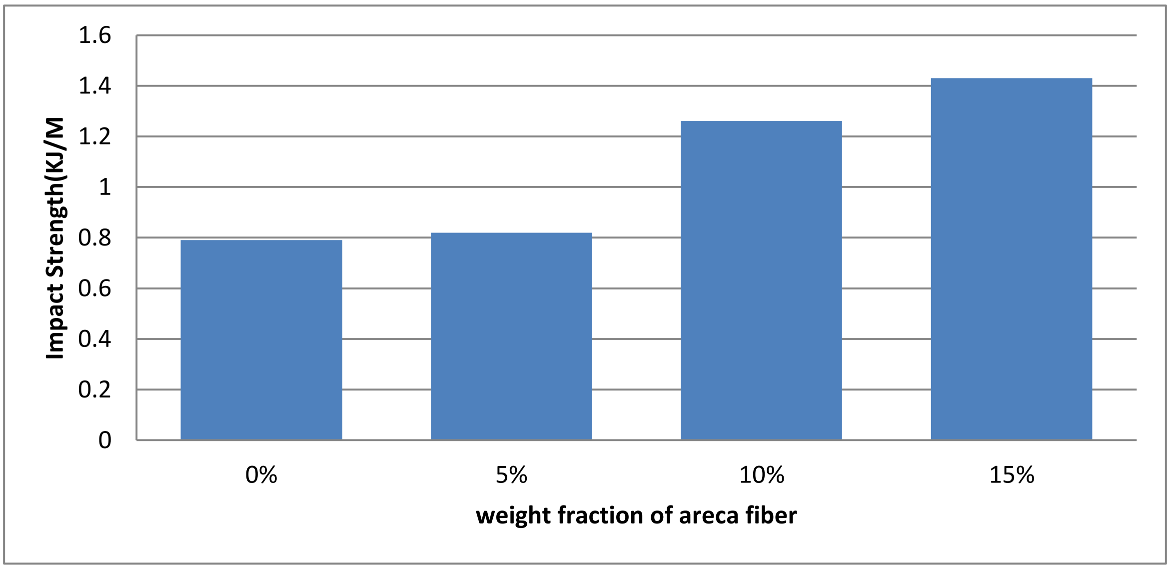

Fig.4.3: Variation of impact strength with different fiber contents

The impact strength increases with increasing weight fraction of fibers, reaching a maximum value at 15%. The maximum impact strength of the composites varies between 0.79KJ/m to 1.43 KJ/m.

ROCKWELL HARDNESS TEST:

Table.4.4: Hardness number

Weight fraction	RHN
Epoxy +0% fibers	75
Epoxy +5% fibers	85
Epoxy +10% fibers	90
Epoxy +15% fibers	95

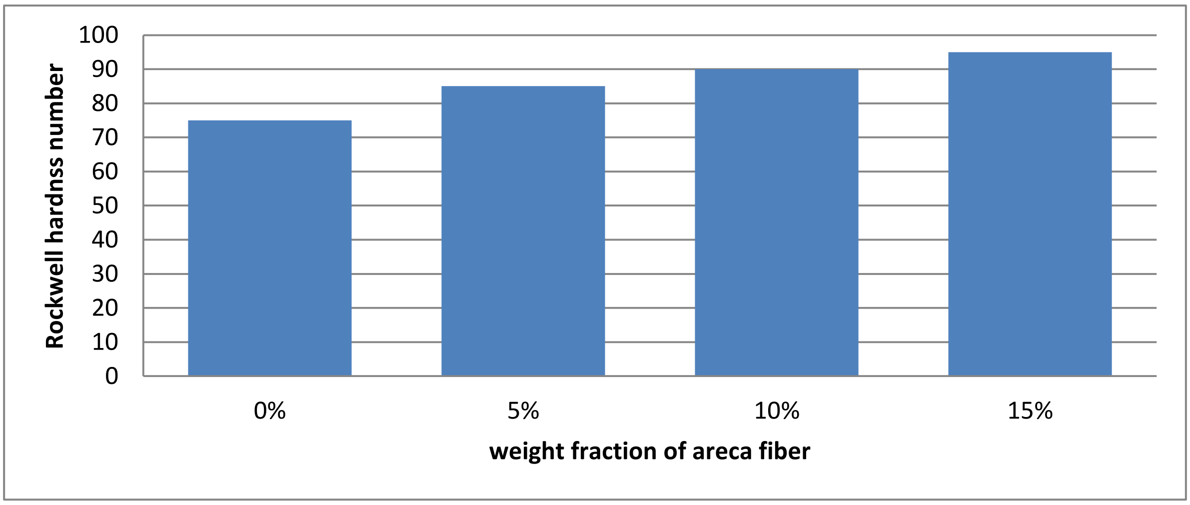

Fig.4.4: Variation of hardness number with different fiber contents

Rockwell hardness number is measured by Leitz Micro –hardness tester. The results are tabulated in the table 4.4. Figure 4.4 drawn between the hardness values of composite and the weight percentage of composite. It is observed that as the reinforcement increases the hardness increases the maximum value is obtained for composite prepared with the 15% composite.

5. CONCLUSION

The present work deals with the preparation of characterization of waste areca 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 Areca fiber.
2. The tensile strength of the composite is found to be maximum for the 15 % weight percentage of the areca fiber.
3. The flexural strength of the composite is found to be maximum for 15% weight percent of areca fiber.
4. The impact strength of the composite is found to be maximum with 15% weight fraction of areca fiber.
5. The hardness value of the composite increases with increasing of the fiber content.

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