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Tensile and Flexural Strength of OKRA Fiber Reinforced Polymer Composites

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ABSTRACT

Increased environmental awareness and consciousness, has developed an increasing interest in natural fibers and its applications in various fields. Natural fiber reinforced composites plays a key role in engineering applications like automobile parts, car doors, furnitures etc. The present work aims to determine the tensile and flexural strength of the okra fiber reinforced composite in araldite LY556 resin. The fiber percentage is varied from 0 to 25% in steps of 5. The tensile test is conducted on specimens made according to ASTM D-638-1 and the flexural strength according to ASTM D-790. The tensile strength increased with the increase in % okra fiber upto 20% and thereafter it decreased. The flexural strength increased with increase in % okra fiber upto 10% and thereafter decreased.

Keywords---- Fiber, Polymer, Tensometer

I. INTRODUCTION

Fiber reinforced polymer (FRP) materials are composites consisting of fibers embedded in polymer matrices. These materials are suitable for a large number of diverse applications ranging from aerospace to sporting equipment. The FRP composites primarily consist of synthetic fibers like glass, carbon, armid, kelvar etc. Although the synthetic fiber reinforced composites has excellent strength and hardness they are high cost and non biodegradable. Because of these reasons, over the past few years the synthetic fibers have been replaced with natural fibers [1-3]. The growing interest in using the natural fibers is due to their availability, satisfactory specific strength and modulus (4), light weight, low cost and biodegradability (5). Also the price of the polymer reinforced natural fiber composite is two to three times lower than the polymers reinforced composite with glass fibers.

Natural fiber reinforced composites contain plant derived fiber with plastic binder. The nautral fibers like wood, sisal, hemp, coconut, kenaf, flax, jute, abaca, banana leaf, bamboo are extensively used. (6). The properties of the natural fibers depend on the nature of the plant, locality in which it grows, age of the plant and extraction method used. The properties of the composite also depend on the direction of fibers. The bidirectional bamboo fiber reinforced composite has higher punch shear strength and lower tensile strength than that of the unidirectional fiber composite (7). The mechanical strength of the natural fiber reinforced polymer composite (NFRPC) is compared with the glass fiber reinforced polymer composite. It is observed that for achieving equivalent mechanical strength of the material, the volume fraction of the natural fiber should be much higher than that of the glass fiber (8). It is reported that when a 30% of glass fiber is substituted with 65% of hemp fibers, the net energy saving of 50000MJ (3 tons of emission) can be achieved. (9). The mechanical properties of sisal-glass fiber reinforced epoxy composites were studied by Algarraja et.al (10). The mechanical properties of the sea grass fiber reinforced composites were studiedby Milan et.al (11). Short banana fiber reinforced natural rubber composites were studied by Raghavendra et.al. Mechanical properties of kenaf and oil palm fibers were studied by Ngo et al (12). Upto now much of work is not reported on the okra fibers. Hence in the present work the okra fibers extracted from the okra plant are used as the reinforcement material in the polymer.

II. EXPERIMENTAL PROCEDURE

The details of the reinforcement material, matrix material and their fabrications process is as given below.

2.1 Reinforcement Material

Okra fibers extracted from okra plant are used as reinforcement material. Fresh okra stems collected from farm are immersed and held in water for 20 days. The microbial degradation allows the stems to degrade sufficiently to enable fiber extraction. The extracted fibers are washed several times using water. The washed fibers are dried in open air and kept in moisture proof container. Two types of chemical treatments were performed on the fibers. First the fiber are soaked in 2% NaOH solution at 70^{o}C for about 2.5 hours, washed with water. In the second stage the fibers are soaked in basic sodium sulphate (PH_4) for three hours washed with water and dried in open air. The fibers used in the present study are shown in Fig.2.1

Fig 2.1 Dry Okra Fibers

2.2 Matrix

Araldite LY556 resins with HY951 hardener shown in Fig.2.2 are used as matrix material. LY556 is an epoxy resin, has good fiber impregnation properties and exhibits excellent mechanical, dynamic and thermal properties. It has excellent chemical resistance especially to acids upto 80^{o}C. The resin and hardener are mixed in 10:1 ratio in a container and mixed for about five minutes.

Fig 2.2 Araldite LY556 and HY951 Hardener

2.3 Specimen Preparation

The specimens are prepared by using hand layup technique. For this purpose a mould made of nuwood shown in Fig.2.3a is used. The size of the mould is 169X19X3 mm. The required weight of fiber is laid in the mould and the resin mixture is poured. Pressure is applied on the mould using the roller to remove the entrapped air. The mould is allowed to dry for 24 hours and the dried samples are stripped off from the mould and cut into the shape of standard specimens. The specimen used for tensile test is shown in Fig.2.3b. Electronic tensometer is used for determining the tensile and flexural strength of the composites. Testing of specimens on tensometer is shown in Fig 2.3c. The designation of the specimens is shown in Table 2.1.

Fig. 2.3a Mould Used for Preparing Composites

Fig.2.3b Tensile Specimens

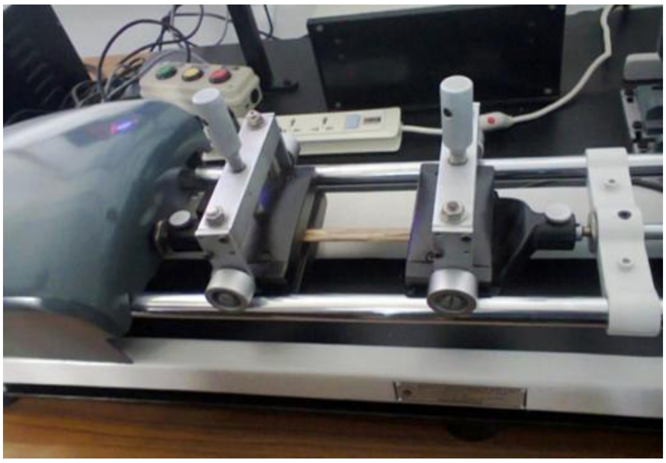
Fig.2.3c Testing of Specimens on Tensometer

Table-2.1: Designation of the Specimens.

S.No	Specimen Designation	% of Okra Fiber	Weight of Okra Fiber (grams)
1	S1	0	0
2	S2	5	0.7
3	S3	10	1.4
4	S4	15	2.1
5	S5	20	2.8
6	S6	25	3.5

III. RESULTS AND DISCUSSIONS

3.1 Tensile Strength

The effect of Okra fiber content on the tensile strength of the composite is shown in Fig.3.1. It is observed that the tensile strength varies from 23MPa to 51.15MPa. The tensile strength increases with the increase in fiber content upto 20% and thereafter it decreases. The increase in tensile strength with the increase in fiber content is due to increase in the reinforcing material and also good interfacial bonding between the fiber and the matrix in the composite. As the fiber content is further increased the matrix content decreases, this leads to decrease in bonding strength and hence the tensile strength decreases.

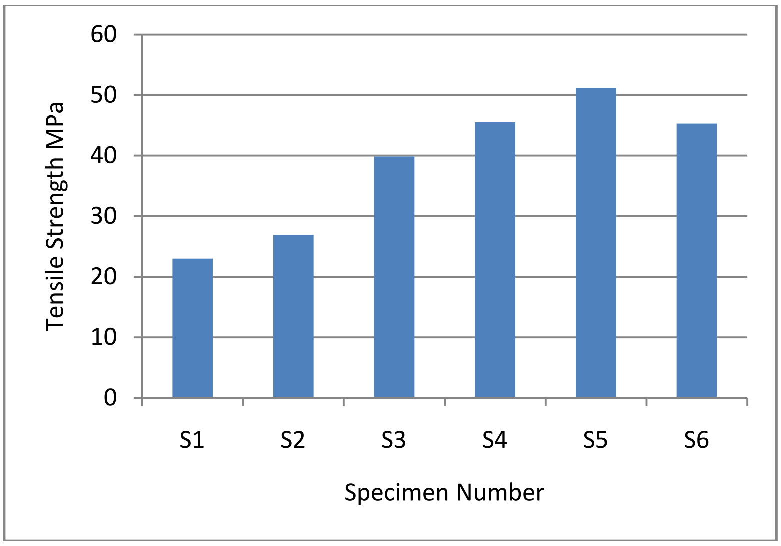

Fig.3.1 Tensile Strength of the Composites

3.2 Percentage Elongation

The percentage elongation obtained by conducting the tensile test is shown in Fig.3.2. The percentage elongation varies from 1.895% to 2.465% and the maximum is obtained for 10% okra fiber composite.

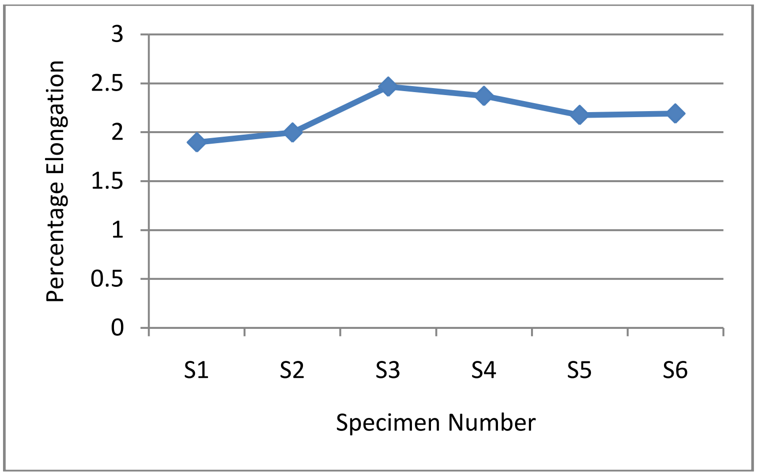

Fig.3.2 Percentage Elongation of the Composites

3.3 Flexural Strength

The flexural strength of the composite is determined from 3-point bend test. The flexural strength for various composites is shown in Fig.3.3. The flexural strength of the composites varies from 64.434MPa to 169.384MPa and the maximum value is obtained for composite with 10% okra fiber. The flexural strength decreases, reaches a maximum value and again decreases with the addition of okra fiber to the matrix.

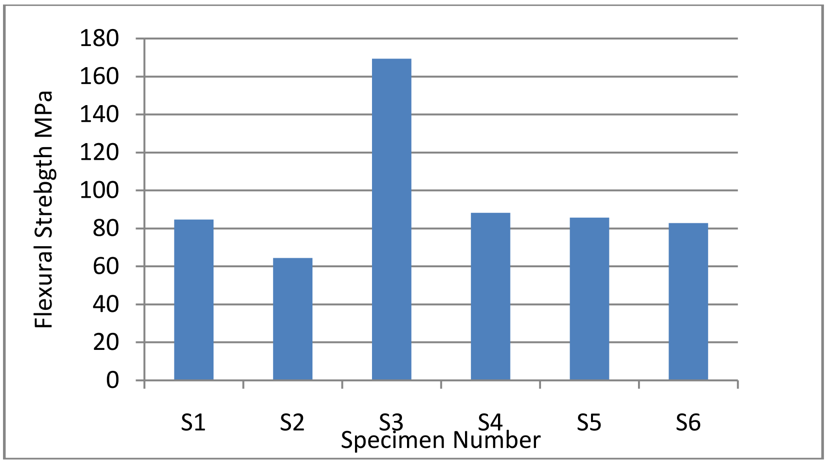

Fig.3.3 Flexural Strength of the Composite

IV. CONCLUSIONS

The experimental investigation on tensile and flexural behaviour of okra fiber reinforced composites with different weight percent of okra fiber have been carried out. The conclusions drawn from the present work are.

1. The tensile strength of the composites varied from 23MPa to 51.15MPa and the maximum is obtained for composite with 20% okra fiber.
2. The percentage elongation of the composite is maximum for 10% okra fiber composite.
3. The flexural strength of the composite varies from 81.648MPa to 110.497MPa. The maximum flexural strength is obtained for the composite with 10% okra fiber.

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