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Fabrication and Investigation of Mechanical Properties Hemp Fiber Rienforced Polyester Composites

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ABSTRACT

Hemp naturally grows in the Asian is a variety of the Cannabis sativa plant species that is grown especially for the industrial purposes of its derived products. It is used for a range of commercial products are including paper, clothing, insulation, biodegradable plastics, textiles, paint, biofuel, animal feed, and food. The main aimed of this work is to fabricate and investigate mechanical properties of hemp natural fiber reinforced polyester composites. The fibers were treated with 10% of NaOH, for 2-3 hours under constant stirring and permit for a day at room temperature and then dried in open air for 3-4 days. The chemical treatment is used to increase the tensile strength and removes the moisture content from the fibers. Test mechanical properties such as Impact strength, Flexural properties (Flexural strength, Flexural modulus) and Tensile properties (tensile strength, tensile modulus) when subjected to varying weights of fiber (0.5, 1.0, 1.5, 2 grams) were determined.

Keywords : Fiber length, Tensile strength, Flexural strength, Impact strength, Hemp fiber, Polyester composite.

I. INTRODUCTION

The composite material means two or more distinct materials physically and chemically bonded together. In this manner, a material having two or more recognizably different constituent materials or phases might be considered a composite material. Fiber-reinforced composite materials consist of fiber of high modulus and strength embedded in or mixed to a matrix with distinct interfaces (like boundary) between them. In this way, both fiber and matrix retain their chemical and physical identities, yet they created a synthesis of properties that cannot be achieved with either of the constituents acting alone. Natural fibers have always found many applications from the time they gained commercial prominence[1]. However, natural fibers are highly moisture absorbers, which can be a significant problem for many applications.

Hemp (Cannabis sativa) is a primitive plant cultivated even in prehistoric times. Hemp fibers are bast fiber they have unique properties that are irreplaceable by those of other fibers such as kenaf, flax, cotton, ramie, and jute. However, marijuana was pertinent to be extracted from it, its cultivation declined around the 1930s[2]. However, hemp cultivation requires to a smaller extent chemical fertilizer and pesticide compared with cotton, and hemp fiber has some outstanding characteristics, including excellent antibacterial qualities, air permeability and others. Many researchers are in the world, having successfully minimizes hemp's content of tetrahydrocannabinol (THC), THC is the main active ingredient of marijuana[3]. Many Industrial purposes hemp can be useful, for example hemp fibers are used to paper, clothing, insulation, heat-insulating materials and more. Hemp seeds are also used in foods such as cake.

In this work, considerable attention has been given to the investigation of the mechanical properties of hemp fiber-reinforced polymer composites. It is believed that little or no work has been published on hemp fiber-reinforced composites.

II. MATERIAL AND METHODS

2.1 Material availability

Hemp fibers are available at Sri Lakshmi group from Guntur and Polyester of moulding grade is purchased from Covai Seenu and Company, Vijayawada. The hemp fiber reinforced polyester composites are fabricated by Hand layup technique.

2.2 Treatment of hemp fibers

A 10% NaOH solution is used to soak these fibers for 2-3 hours to remove any lignin present on the fiber surface. These fibers are then washed thoroughly in purified water and dried in the sun for 3-4 days. A total of 150 gm of hemp fibers, with an initial pH of 10.0, was subjected to chemical Alkali treatment.

2.3 Preparation of Mold

To make a composite specimen, a rubber molding is prepared with rubber shoe sole to the required dimension of 240x180x3mm mold cavity of five specimens. The bottom surface of the cavity placed rigidly on a ceramic tile without sliding. The gap between the rubber and the tile is filled with mansion hygienic wax. The dies has been Prepared dies as per ASTM D 638 for tensile test, ASTM D 790 for flexural test and ASTM D 256 for impact test.

2.4 Preparation of composite specimens

Polyester resin of ECMALON 4413 grade was taken in an open visible bowl and then Catalyst (Methyl Ethyl Ketone Peroxide) is added, accelerator (Cobalt Naphthenate) is added to the resin and the matrix was thoroughly stirred. The The prepared mold of 3mm depth is evenly filled with hemp fibers and matrix mixture containing and before being placed in the die to ensure complete wetting and to avoid air bubbles. The wetted hemp fiber was placed in an aligned longitudinally in the die and remaining depth was filled up with prepared resin. This filling process followed by hand layup technique. After filling die at the top face was covered with a layer of a polythene sheet and a roller was make move one's forward way along the length to drive off excess resin and also to ensure a smooth surface and proper geometry of the test specimen. The preparations were left to cure completely and then were removed from the dies. The samples were made with varying weight fractions of fiber at 0.5, 1.0, 1.5 and 2.0% weight/weight. For each weight fraction, five samples were made and the best three (physically) were picked up for testing.

III. EXPERIMENTATION AND RESULTS

3.1 Tensile behaviour:

This type of test (tensile strength) is performed on the flat specimens. The specimens (unidirectional composite) are making based on ASTM D 638-89 standards to measure the tensile properties of our composite. The dimensions of the specimens were 160mm (length) 12.5mm (width) 3mm (thickness). The maximum tensile strength is find-out before ultimate point. An ultimate point means wherever the material is broken. At the time of the test a uniaxial load is applied to two ends of the specimen. Three samples are prepared with different fiber combinations and all so different weight fractions and all the specimens are tested by electronic tensometer.

Figure 1: Specimen

Table-1: Effect of weight of fiber on Mean tensile strength of with and without NaOH treatment.

S. No	Weight of fiber (grams)	Weight fraction of fiber (%)	Tensile strength without NaOH (Mpa)	Tensile strength with NaOH (Mpa)
1	0.5	04	32.533	68.53
2	1.0	10	88.533	95.2
3	1.5	14	91.73	149.33
4	2.0	18	109.86	161.33

Table-2: Effect of weight of fiber on Mean Tensile modulus of with and without NaOH treatment.

S. No	Weight of fiber (grams)	Weight fraction of fiber (%)	Mean tensile modulus without NaOH (Gpa)	Mean tensile modulus with NaOH (Gpa)
1	0.5	05	2.32	3.0
2	1.0	10	2.9	2.9
3	1.5	15	3.4	3.5
4	2.0	19	4.2	4.8

3.2 Impact properties

The specimens are preparing for impact test according to the ASTM D256-88 to measuring impact strength. The specimen dimensions are 63.5(length)*12.7 mm (deep)* 10 mm (wide). Low velocity instrumented is used impact tests are performed on the composite specimens. The v notch placed on the composite test specimen. The impact testing machine having pendulum strikes the required piece at the point v notch with pendulum hammer, measuring the impact energy of different pieces are noted by dial indicator.

Table- 3: Effect of weight of fiber on impact strength of with and without NaOH treatment of hemp fiber/polyester composites.

S. No	Weight of fiber (grams)	Weight fraction of fiber (%)	Mean impact strength without NaOH (Joules/mm)	Mean impact strength with NaOH (Joules/mm)
1	0.5	05	0.05	0.1
2	1.0	10	0.19	0.22
3	1.5	14	0.28	0.48
4	2.0	20	0.4	0.6

3.3 Flexural properties

The fabricated specimens were tested using a 2 ton capacity - Electronic Tensometer, METM 2000 ERI model, with a cross head speed of 2 mm/min in accordance with standard ASTM D790 under ambient conditions. Load and elongation values are determined for the all samples. Utilizing the experimental values of load and elongation, flexural strength, flexural modulus and elongation at break were determined.

Table- 4: Effect of weight fraction of fiber on Mean flexural strength of with and without NaOH treatment of hemp fiber/polyester composites.

S. No	Weight of fiber (grams)	Weight fraction of fiber (%)	Mean flexural strength without NaOH (Mpa)	Mean flexural strength with NaOH (Mpa)
1	0.5	4	125	175.09
2	1.0	09	158.33	200.00
3	1.5	13	191.66	216.67
4	2.0	18	233.33	275.00

IV. Graphical Representation of with and without NaOH treated composites

4.1 Tensile Properties of Hemp Fiber Composites:

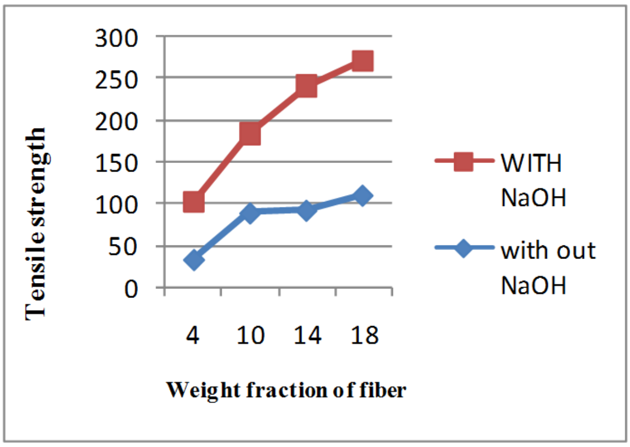

Figure 2: Effect of weight fraction of fiber on Mean tensile strength of with and without NaOH treatment of hemp fiber/epoxy composites.

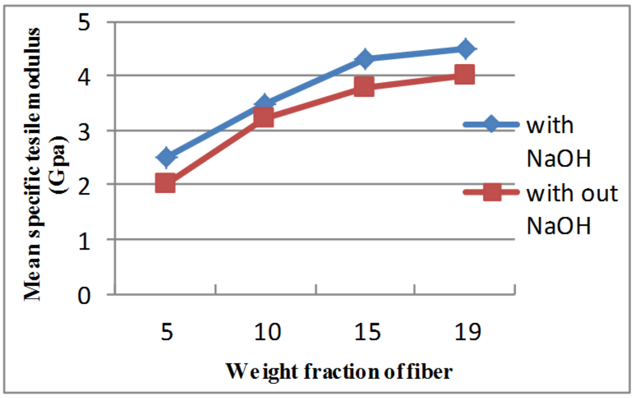

Figure 3: Effect of weight fraction of fiber on Mean specific tensile modulus of with and without NaOH treatment of hemp fiber/polyester composites

4.2 Impact properties of hemp fiber composites

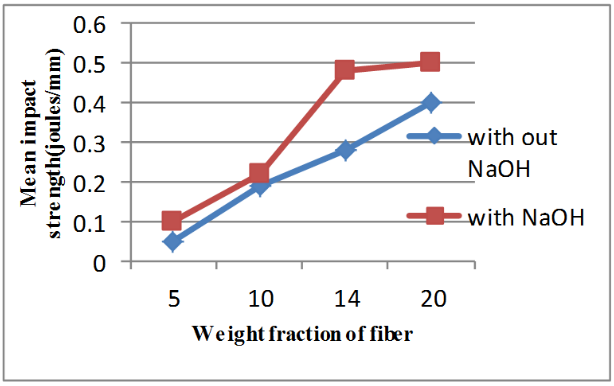

Figure 4: Effect of weight fraction of fiber on impact strength of with and without NaOH treatment of hemp fiber/polyester composites

4.3: Flexural properties of hemp fiber composites

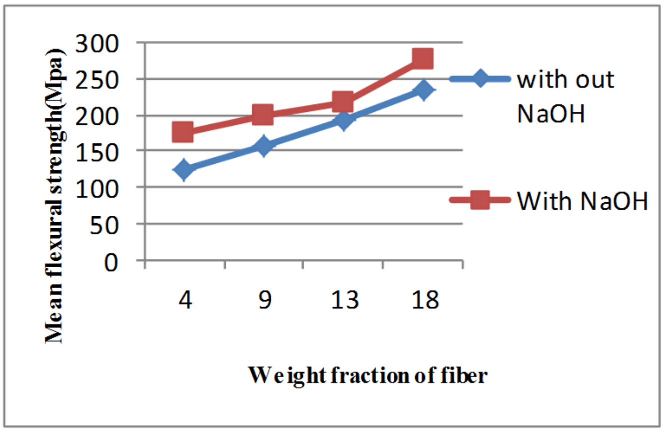

Figure 5: Effect of weight fraction of fiber on Mean flexural strength of with and without NaOH treatment of hemp fiber/polyester composites.

V. CONCLUSION

The mean tensile strength verses weight fraction of fiber for hemp fiber composites, with and without treatment of NaOH is shown in figure. It is observed that the mean tensile strength of hemp fiber polyester composites increases linearly against a weight fraction of the fiber for composites with treatment of NaOH. The hemp fiber content has an influence on the mechanical properties. It was noted in all fiber composites that increasing the amount of fiber resulted in an increase in the tensile strength, elastic modulus, and flexural strength.

On the other hand, the addition of hemp fiber to the matrix was noted that to decrease the impact strength making it more brittle. The specific tensile strength and tensile modulus results follow the same trend approximately as those of the mean tensile strength and modulus as shown in figures respectively.

Finally the tensile, impact and flexural properties are evaluated and compared between untreated and chemically treated reinforced composites in the paper. By the treatment of fiber with NaOH solution the flexural properties are improved compared to the permanganate treated and unread fiber reinforced composite with the increase in the concentration of NaOH there is a decrease in the properties because during the treatment at higher NaOH there is an excess extraction of hemi cellulous and lignin from the fiber thus finally it causes the damage to the cell walls.

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