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Effect of Fiber Content on Mechanical Properties of Alkali treated Unidirectional Long Kenaf Fiber Reinforced Epoxy Composites.

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ABSTRACT

Environmental awareness of the general public and depletion of petroleum resource have trigged an enormous interest in utilizing the natural fibers, and their composites as environmentally friendly. Now a days, the numerous researchers, scientists and engineers have explored the production and properties of natural fibers and utilization of natural fibers as effectively and economically as possible to produce good quality fiber reinforced polymer composites. This will be helpful to evaluate the development and properties of natural fiber reinforced polymer composites. The use of natural fiber as reinforcement for polymer composites have generated much interest due to their availability, renewable, low cost, light weight, relative high specific strength and modulus, in explosive, minimal health hazardous, biodegradable and possibility of environmental protection. Also the use natural fibers offer some advantages regarding mechanical thermal properties.

Keywords: *Natural fiber, Kenaf, Epoxy, Alkali, Tensile test, Fexural test, Impact test, Hardness test.*

1. INTRODUCTION

Composite material is a materials system composed of a suitable arranged mixture or combination of two or more micro or macro constituents with an interface separating them that differ in form and chemical composition and are essentially insoluble in nature. The engineering importance of a composite material is that two or more distinctly different material combines to form a composite material that possesses properties that are superior or important in some other manner, to the properties of the individual components [1]. Generally composites are made of just two materials one is the matrix or binder, which surrounds and binds together fibers or fragments of the other material which is called the reinforcement. By choosing an appropriate combination of matrix and reinforcement, a new material can be made that exactly meets the requirements of a particular application. Due to their low weight and ability to be tailored for specific end use, they have gained a considerable ground in high performance applications such as aerospace and automobile industry.

2. MATERIALS, EQUIPMENT'S AND METHODS:

2.1 Materials:

The raw materials used in this study are Kanaf fiber (cannabinus –hibiscus) due to its high toughness and high aspect ratio, Epoxy resin LY-556 due to its excellent adhesion property, hardener HY-951 and sodium hydroxide. Kenaf fiber is the natural fiber available in all over places. Kenaf or hibiscus cannabisnus is a member of Malvaceae family having good mechanical and other properties also. Cannabinus as shown in figure1. Hibiscus Cannabinus is in the genus Hibiscus and is probably native to southern Asia, though is exact natural origin is unknown. The name also applies to the fiber obtained from this plant. The fiber forms are the long bast fiber. The epoxy resin, hardener and sodium hydroxide were obtained from zenith industrial suppliers, Bangalore. The epoxy LY-556 has a density of 1.16 gm/cc and a specified modulus of 3.45GPa. The Kenaf fiber has a density of 1.13gm/cc and elastic modulus of 53GPa.

Figure 1.1: Kenaf plant

Figure 1.2: Kenaf stem

2.2 Equipment's:

1. A mold
2. Mold releasing spray/wax
3. Mixing container
4. Brush and roller
5. Scissors
6. hand gloves
7. Weighing Machine
8. Stirring stick

Preparation of Mold:

For making the composite, a molding box was prepared with 300 mm × 200 mm × 6 mm mold cavity using mild steel plates. Interior surfaces of the molds were finely polished and chrome plated.

Figure 1.3: Mold box

2.3 Alkali Treatment of Kenaf fibers:

The alkali treatment involves NaOH solution, water washing and drying. Alkali treatment removes a certain amount of lignin, wax and oils covering the external surface of the fiber cell wall, depolymerizes cellulose and exposes the short length crystallites. It increases surface roughness resulting in better mechanical interlocking and it increases the amount of cellulose exposed on the fiber surface, thus increasing the number of possible reaction sites. Alkaline treatment also significantly improved the mechanical, impact fatigue and dynamic mechanical behaviors of fiber-reinforced composites[2]. In this study the long fibers was soaked in 6% NaOH solution for 12 hours at room temperature [8]. After treatment, the fibers are washed and rinsed several times with running water. Afterwards, fibers were dried at room temperature for 24 hours and at hot sun for 30 minutes to get alkali treated fibers.

Figure 4: Treatment of Fiber

Figure 5: Treated Kenaf fiber

2.4 Fabrication of composite laminate:

The composite laminate is fabricated by hand layup technique. Hand layup is an oldest and simplest method for composite production. The process consists of building up or placing layers of fibers in a sequenced layup using a matrix of resin and hardener.

Figure 6: Combing of treated fiber

The first step in this process is to spray the mold releasing agent for easy removal of composite material and prevents it from sticking to the mold. Mix the resin and the hardener in the ratio of 10:1.

Figure 7: Placing of fiber in hand layup process

The mixing is performed in the mixing container with mixing stick and should be done slowly so as to not entrain any excess air bubbles in the resin. Next an adequate quantity of mixed resin & hardener is deposited in the mold and a brush or roller is used to spread it around all surface. It is important not to add too much resin, which will cause too thick of a layer, nor to add less than the necessary amount, which will cause holes in the surface of the part when it is cured. The first layer of fiber reinforcement is then laid. This layer must be wetted with resin and then softly pressing using a brush or a roller make the resin that was added in the previous step wick up through the fiberglass cloth. If the fiber is not completely wet, more resin can be added over the top and spread around. At this stage a second layer of glass fiber is added and special care must be taken to eliminate all air bubbles possible. This can be accomplished by either rolling any air bubbles out with a small hand rolling tool or brushing out the air bubbles with a paintbrush. This step is repeated until the desired thickness is achieved.

Table 1.1: The composition of the composite specimen

Specimen nomenclature	Kenaf Fiber (%)	Epoxy resin (%)
A	10	90
B	20	80
C	30	70
D	40	60
E	50	50

3. TESTING

After preparing the composite laminates, the specimens are cut as per the ASTM standards to find the tensile strength, flexural strength, impact strength and hardness. These tests were carried out using ASTM standards. For each different composite laminate, 3 samples are tested and the average value is recorded.

3.1 Tensile test:

Figure 8: Tensile test specimens

In general, tensile test is a measurement of the ability of a material to withstand loads that tend to pull it apart and to what extent the material stretches before breaking. The tensile tests were conducted according to ASTM D638 standard on a computerized Universal Testing Machine. The dimensions are 165mm x 20mm x 3mm with 54mm gauge length which is in dumbbell(dog-bone) shaped. A uniaxial load is applied on the specimen until it fractures.

Table 1.1 Tensile strength and tensile modulus with different weight fraction of Kenaf fiber

Specimen	Tensile strength(MPa)	Elastic modulus(MPa)
A	92	3600
B	124.23	3712
C	152.46	3784
D	112.6	3155
E	108.3	1950

3.2 Flexural test:

Figure 9: Flexural strength specimens

Flexural strength is the ability of the material to withstand bending loads applied perpendicular to its longitudinal axis. Sometimes it is also known as cross breaking strength. There are two methods that cover the determination of flexural properties of material: three-point loading system and four point loading system. In this study flexural strengths of the specimens were determined for specimens using the three-point bending test as per ASTM-D790. The sample is in a rectangular shape whose dimensions are 80mm x 12.7mm x 3mm. The specimen was tested on computerized UTM machine. Flexural test is carried out to find the ability of material to be bent before the breaking point.

Table 1.3: Flexural strength and flexural modulus with different weight fraction of Kenaf fiber

Specimen	Flexural strength(MPa)	Flexural modulus(MPa)
A	186	3900

B	198	4150
C	126	4375
D	168	3200
E	158	3112

3.3 Impact test:

Impact is a single point test that measures a materials resistance to impact from a swinging pendulum. Impact is defined as the kinetic energy needed to fracture the specimen which determines the amount of energy absorbed by a material during fracture. This absorbed energy is a measure of a given material's. Impact test is performed on the pendulum impact testing machine as per ASTM D256. A 'V' notch is created at the centre of the specimen having notch depth of 2.54 mm and notch angle of 45°. The specimen is tested on Izod Impact Testing Machine. The test specimen is clamped upright in an anvil, with a V-notch at the level of the top of the clamp. The test specimen will be hit by a striker carried on a pendulum which is allowed to fall freely from a fixed height**.** The respective values of impact energy of different specimens are recorded directly from the dial indicator.

Table 1.4: Impact strength with different weight fraction of Kenaf fiber

Specimen	Impact Strength(J/mm2
A	24.54
B	29.42
C	32.22
D	17.13
E	13.5

3.4 Hardness test:

Hardness of the material is the mechanical parameter of that material which shows how resistant the material is to the permanent deformation when they are subjected to compressive forces. The Rockwell number is defined as the difference in the depth pierced by the indenter and the position of the indenter at surface (zero reference). Rockwell. Hardness number is represented in a different scale depending upon the scale used.

Table 1.5 Hardness with different weight fraction of Kenaf fiber

Specimen	Hardness(Shore-D)
A	73
B	71
C	68
D	68
E	66

4. RESULT AND DISCUSSIONS

From the results it is evident that all the specimens show appreciable improvement of mechanical properties with the addition of fibers, up to 30%. In the composites beyond 30% of fiber, tensile properties decrease due to poor bonding of resin over the reinforcement.

5. CONCLUSION

Based on the experimental investigations in this work, following conclusions can be made:

1. Tensile properties of composite increases with increase in fiber loading and it is found maximum at 30% wt. fiber loading due to the strong adhesion between fiber and matrix.
2. Flexural properties of composite is found maximum at 30% wt. fiber loading due to the tough adhesion between fiber and matrix.
3. Impact strength of composite is found maximum at 30% wt. fiber loading due to the tough adhesion between fiber and matrix.

Hardness decreases gradually with respect to the percentage of fiber. This might be because as the fiber percentage increases the ductility also increases alongside the resistance to the indentation also decreases.

REFERENCES

1) A. Ticoalu, T. Aravinthan and F. Cardona, A review of current development in natural fiber composites for structural and infrastructure applications, November 2010, Southern Region Engineering Conference, University of Southern Queensland.

2) Dr. Navdeep Malhotra, Khalid Sheikh and Dr. Sona Rani, A Review on Mechanical Characterizationof Natural Fiber Reinforcemed Polymer Composites, Journal of Engineering Research and Studies, ISSN0976-7916.

3) D. Chandramohan1 and .K. Marimuthu, Review on Natural fibers, IJRRAS 8 (2), August 2011.

4) C. W. Nguong, S. N. B. Lee and D. Sujan, A Review on Natural Fibre Reinforced Polymer Composites, International Journal of Chemical, Nuclear, Materials and Metallurgical Engineering, Volume 7, World Academy of Science, Engineering and Technology, 2013.

5) A.O. Abdul Salam Sait and Venkatraman Subramaniam, Composites from Natural Fibers, IJRET, eISSN: 2319-1163, pISSN: 2321-7308.

6) Ing. Eva Akova, Developement Of Natural Fiber Reinforced Polymer Composites, Transfer inovácií, 25/2013.

7) P.Vignesh and M.Sengottaiyan, A Study on Mechanical Behaviour of Hybrid Reinforced Composite, IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE), Volume 11, e-ISSN: 2278-1684,p-ISSN: 2320-334X, Nov- Dec. 2014

8) 8).S. Sunil Kumar Reddy and S.P. Akbar Hussain, Development and Testing Of Natural Fiber Reinforced Composites With Polyester Resin, IJESRT, October-2013, ISSN: 2277-9655

9) K.Alagarraja, A.Dhamodharan , K.Gopinathan, R.Mathan Raj and K.Ram Kumar, Fabrication And Testing Of Fibre Reinforced Polymer Composites Material, IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE), e- ISSN: 2278-1684, p-ISSN : 2320–334X PP 27-34.

10) S. Jeyanthi and J. Janci Rani, Influence of natural long fiber in mechanical, thermal and recycling properties of thermoplastic composites in automotive components, International Journal of Physical Sciences Volume 7(43), pp. 5765-5771, 16 November- 2012, ISSN-1992.

11) Ramanpreet Singh, Lakshya Aggarwal and Mohit Sood, Investigation of Flexural behavior of hybrid natural fiber composite with recycled polymer matrix, American International Journal of Research in Science, Technology, Engineering & Mathematics, ISSN 2328-3491.

12) S.Nakkeeran, Mechanical Charactoristics Of Polymer Composites, International Journal of Biotech Trends ad Technology (IJBTT) – Volume1, Issue 1, Number1–May 2011.

13) W.L. Ngo, M.M. Pang, L.C. Yong and K.Y. Tshai, Mechanical Properties of Natural Fibre (Kenaf, Oil Palm Empty Fruit Bunch) Reinforced Polymer Composites, American- Eurasian Network for scientific and information, Advances in Environmental Biology-2014.