



Effect of Fiber length on the Tensile Properties of Coir and Wild date palm Reinforced Epoxy composite

¹Bharath kiran N, ¹Jakirhusen P, ²Vinod B, ²Naveen Ankegowda

¹Student, ²Assistant Professor,

^{1,2}Department of Mechanical Engineering, Vidyavardhaka College of Engineering, Mysore, Karnataka, INDIA.

Abstract: The present experimental study aims at learning the mechanical behaviour of hybrid natural fiber composites. Samples of several Coir-Wild date palm-Epoxy hybrids were manufactured using hand layup method where the stacking of plies was alternate and the weight fraction of fibre and matrix was kept at 40%-60%. Specimens were cut from the fabricated laminate according to the ASTM standards for different experiments. For Tensile test samples were cut in Dog-bone shape. After that experiment is performed under Universal testing machine (UTM). Tensile strength was observed that the fiber length greatly influences the tensile properties of reinforced composites. A higher tensile strength of 26.27 MPa was obtained for the fiber length of 12mm compared to the fiber length of 3, 6, 9 and 15mm.

Keywords: Coir, Wild date palm, Epoxy resin, Mechanical Property, Tensile strength

I. Introduction

The interest in using natural fibres such as different plant fibres and wood fibres as reinforcement in plastics has increased dramatically during last few years. With regard to the surrounding aspects it would be very interesting if natural fibres could be used instead of glass fibres as reinforcement in some structural applications. Natural fibres have many advantages compared to glass fibres, for example they have low density, and they are recyclable and biodegradable. Additionally they are renewable raw materials and have relatively high strength and stiffness. Their low-density values allow producing composites that combine good mechanical properties with a low specific mass.

Natural fibers are classified on the basis of the origin of source, into three types

1. Plant Fibers
2. Mineral Fibers
3. Animal Fibers

1. Plant Fibers: Plant fibers are usually consists of cellulose: examples cotton, jute, bamboo, flax, ramie, hemp, coir and sisal. Cellulose fibers are used in various applications. The category of these fibers is as following: Seed fibers are those which obtain from the seed example Kapok and Cotton. These fibers have superior tensile properties than other fibers. Because of these reason these fibers are used in many applications such as packaging, paper and fabric. Fruit fibers are the fibers generally are obtain from the fruit of the plant, e.g. banana fiber and coconut fiber. Similarly, stalk fiber are the fibers which are obtain from the stalks (rice straws, bamboo, wheat and barley). Leaf fibers are the fibers those are obtain from the leaves (agave and sisal). Skin fibers are those fibers which are obtaining from the Bast or skin surrounding the stem of the plant.

2. Mineral Fibers: Mineral fibers are those which are get from minerals. These are naturally happening fiber or somewhat changed fiber. It has different classifications they are taking after: Asbestos is the main characteristically happening mineral fiber. The Variations in mineral fiber are the serpentine, amphiboles and anthophyllite. The Ceramic filaments are glass fiber, aluminum oxide and boron carbide. Metal filaments incorporate aluminum strands.

3. Animal Fibers: Animal fiber by and large comprises of proteins; cases, silk, alpaca, mohair, downy. Animal hairs are the strands got from creatures e.g. Sheep's downy, goat hair, horse hair, alpaca hair, and so forth. Silk fiber is the filaments gathered from dry saliva of bugs or creepy crawlies throughout the time of planning of cocoons. Avian strands are the fiber from fowls [1]. Composites of natural fiber used for drives of structural, but typically with synthetic thermoset matrix which of course bound the environmental benefits. Now a days natural fiber composites application are usually found in building and automotive industry and the place where dimensional constancy under moist and high thermal conditions and load bearing capacity are of importance [2,3]. Natural fibers like cotton, sisal, jute, abaca, pineapple and coir have already been studied like a reinforcement and filler in composites. Among various natural fibers, banana fiber is considered as a potential

reinforced in polymer composites due to its many advantages such as easy availability, low cost, comparable strength properties etc.

II. Materials and Methodology

Coir is a natural fiber extracted from the husk of coconut and used in products such as floor mats, doormats, brushes, mattresses, etc. Coir is the fibrous material found between the hard, internal shell and the outer coat of a coconut. Brown coir is also used in upholstery padding, sacking and horticulture. White coir, harvested from unripe coconuts, is used for making finer brushes, strings, rope and fishing nets. Table 2.1 shows physical and mechanical properties of coir fiber.

Table 2.1: Properties of Coir fiber

Property	Values
Density (g/cm ³)	1.40
Tensile strength (MPa)	175
Young's modulus (MPa)	3790
Breaking Elongation (%)	30
Moisture at 65%RH (%)	10.50

The date palm is a mono cotyledon of the family of the palmate. It is a feather palm, characterized by compound leaves with a series of leaflets on each side of a common petiole, originating from one growing point at the top of the trunk. The date palm may reach an age of over 100 years and reach up to 24m in height. Table 2.2 shows physical and mechanical properties of Wild date palm fiber.

Table 2.2: Properties of Wild date Palm fiber

Property	Values
Density (g/cm ³)	1-1.20
Tensile strength (MPa)	97-196
Young's modulus (MPa)	2500-5400
Breaking Elongation (%)	2-4.5

Lapox L12 is a liquid, unmodified epoxy resin of medium viscosity which can be used with various hardeners for making glass fiber reinforced composite. The choice of hardener depends on the processing method to be used and on the properties required of the cured composite.

Table 2.3: Properties of Epoxy Resin

Property	Values
Tensile strength (MPa)	20
Flexural strength (MPa)	130-150
Impact strength (MPa)	17-20
Young's modulus (MPa)	4400-4600
Compressive strength (MPa)	110-120

A. Extraction of fibers

The coir and wild date palm fiber is obtained from coir and wild date palm plant, which has been collected from local sources. The extracted coir and wild date palm fiber were subsequently sun dried for 8 hours to remove free water present in the fiber.

B. Chemical treatment

Alkali treatment using sodium hydroxide (NaOH) is the most commonly used treatment for bleaching and cleaning the surface of natural fibers to produce high-quality fibers. Modifying natural fibers with alkali has greatly improved the mechanical properties of the resultant composites. The following steps were carried out during chemical treatment:

- 5% NaOH solution was prepared using sodium hydroxide pellets and distilled water.
- Coir and wild date palm fibers were then dipped in the solution for 1hour.
- After 1 hour fibers were washed with 1% HCl solution to neutralize the fibers.
- Then it is washed with distilled water. It was then kept in hot air oven for 3hours at 65-70°C.

C. Manufacturing of composite

For the sample preparation the first and foremost step is the preparation of the mould which ensures the dimension of 200×150×4 mm the composite to be prepared. We have to prepare moulds for the preparation of 50% coir and 50% wild date palm of the composite having 3, 6, 9, 12 and 15mm fiber length. Clean smooth surfaced granite is taken and washed thoroughly. The laminates are prepared using hand layup method. This method of manufacturing is a relatively simple method compared to other methods like vacuum bag molding, resin transfer molding, autoclave molding etc.

III. Results and Discussion

The tensile property of the Coir and wild date palm reinforced laminated composites with fiber length of 3, 6, 9, 12 and 15mm was studied and compared. ASTM D638 is one of the most common plastic strength specifications and covers the tensile properties of unreinforced and reinforced plastics. The tensile test were conducted following the standard of ASTM D638 (150*10*4mm) is type IV using JJ Lloyd universal testing machine with load cell of 1kN and using crosshead speed of 5 mm/min. The test was performed until the tensile failure occurred.

Figure 3.1 Tensile test specimen



Figure 3.2 Specimen under tensile test



The results of the tensile test are put forth in the form of stress-strain curves. Figures 3.2(a), 3.2(b), 3.2(c), 3.2(d), and 3.2(e) show the stress-strain curve for the Coir and wild date palm reinforced laminated composites with fiber length of 3, 6, 9, 12 and 15mm respectively. The maximum load, Young's modulus and tensile stress obtained from the experimental study are given in Table 3.1. Figure 3.3 shows the variation of tensile stress for different fiber lengths in the laminated composite.

Figure 3.2(a): Stress-strain curve for 3mm fiber length

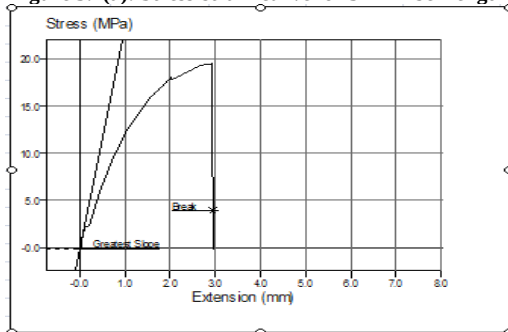


Figure 3.2(c): Stress-strain curve for 9mm fiber length

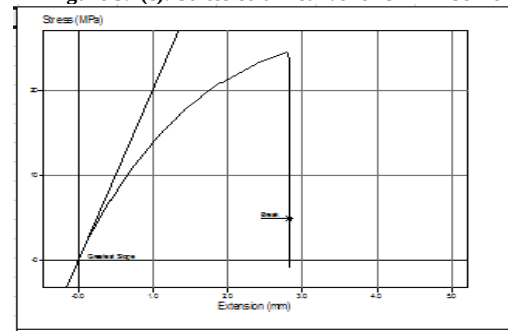


Figure 3.2(b): Stress-strain curve for 6mm fiber length

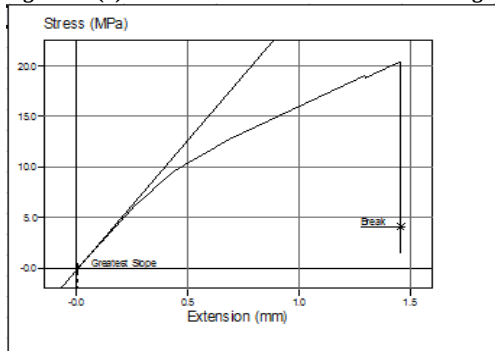


Figure 3.2 (d): Stress-strain curve for 12mm fiber length

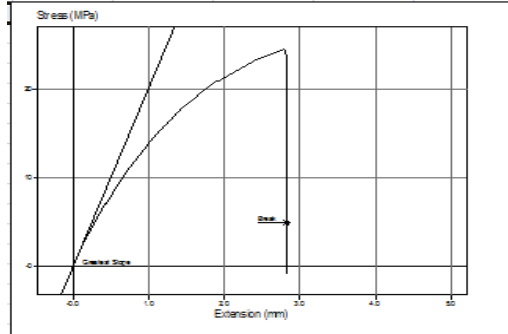


Figure 3.2(e): Stress-strain curve for 15mm fiber length

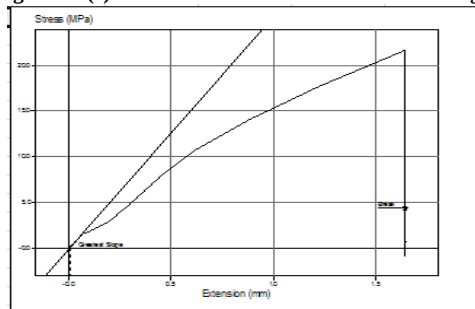
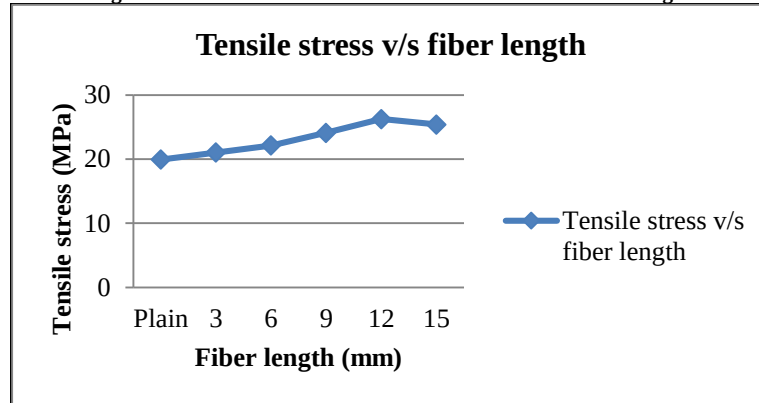


Table 3.1 shows the maximum load, Young's modulus and tensile stress obtained from the experimental study for the Coir and wild date palm reinforced laminated composites with fiber length of 3, 6, 9, 12 and 15mm.

Table 3.1: Maximum load, young's modulus and stress at maximum load

Fiber length (mm)	Maximum load (kN)	Young's Modulus (MPa)	Stress at maximum load (MPa)
3	1.257	3658.716	21.04
6	1.321	4294.513	22.132
9	1.448	5185.643	24.11
12	1.565	5701.416	26.27
15	1.505	5542.956	25.406
Plain	1.18	3454.75	19.94

Figure 3.3: The variation of tensile stress for different fiber length



IV. Conclusion

Effort is made to check the feasibility of utilizing natural fibers as reinforcing material. Above results us that natural fibers can be effectively used as reinforcing material similar synthetic fibers. The tensile strength of the unreinforced composite is 19.94 MPa. Initially for the fiber length of 3mm, young's modulus value is slightly higher than unreinforced composite by 5.22%. But as the fiber length increases, the value is increased by 9.9% for 6mm and furthermore increased by 17.29%, 24.09%, and 18.29% for fiber length of 9, 12 and 15mm with respect to unreinforced composite. Tensile stress also shows same variation as that of young's modulus. The highest value of tensile strength is 26.27 MPa is obtained for laminated composite of fiber length of 12mm.

V. References

- [1] U.S.Bongarde, V.D.Shinde. "Review on natural fiber re-inforcement polymercomposites" ISSN: 2319-5967, Volume 3, Issue 2, March 2014
- [2] C.Chaithanyan, H. Venkata subramanian, Dr. S.Raghuraman, T.Panneerselvam. "Evaluation of Mechanical Properties of Coir-Sisal Reinforced Hybrid Composites Using Isophthalic Polyester Resin" ISSN: 2319-8753, Vol. 2, Issue 12, December 2013.
- [3] Sapuan SM, Harimi M, Maleque MA. Mechanical properties of epoxy/coconut shell filler particlecomposites. Arab J Sci Eng 2003;28(2B):171–81.
- [4] Luo S, Netravali AN. Mechanical and thermal properties of environmentally friendly green composites made from pineapple leaf fibers and poly(hydroxyl butyrate-co-valerate) resin. PolymCompos 1999; 20(3):367–78.
- [5] Belmares H, Barrera A, Monjaras M. New composite materials from natural hard fibers. Part 2: Fatigue studies and a novel fatigue degradation model. Ind Eng Chem Prod Res Dev 1983; 22:643–52.