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COMPARISON OF TENSILE PROPERTIES ON SILK AND COTTON NATURAL FIBERS REINFORCED HYBRID EPOXY COMPOSITE

Mr. R MANJUNATHA[1] Dr. SANJEEVAMURTHY [2]

Abstract— Now- a-days, the natural fibers from renewable natural resources offer the potential to act as a reinforcing material for polymer composites alternative to the use of, carbon and other manmade fibers. Among various fibers, cotton silk is the most widely used natural fiber due to its advantages like easy availability, low density, low production cost and satisfactory mechanical properties. For a composite material, its mechanical behavior depends on many factors such as fiber content, orientation, types, length etc., attempts will be carried to find the tensile, compression &bending properties for the specimen prepared as per ASTM standard. They are insoluble in each other and differ in form or chemical composition. Experimental techniques can be employed to understand the effects of various fibers, their volume fractions and matrix properties in hybrid composites. These experiments require fabrication of various composites with the above mentioned parameters, which are time consuming and cost prohibitive. Therefore, a computational model is created as will be described in detail later, which might be easily altered to model hybrid composites of different volume fractions of constituents, hence saving the designer valuable time and resource.

Index Terms— Natural fiber, epoxy composites, tensile test.

1 INTRODUCTION

THIS module introduces basic concepts of stiffness and strength underlying the mechanics of fiber-reinforced advanced composite materials. This aspect of composite materials technology is sometimes terms micromechanics because it deals with the relations between macroscopic engineering properties and the microscopic distribution of the material's constituents, namely the volume fraction of fiber.

High stiffness means that material exhibits low deformation under loading. However, by saying that stiffness is an important property we do not mean that it should be necessarily high. The ability of a structure to have controlled deformation (compliance) can also be important for some applications (e.g. springs, shock absorbers, pressure, force, and displacement gauges). Stiffness and strength the structure cannot exist. Naturally, both properties depend greatly on the structure s design but are determined by the stiffness and strength of the structural material because a good design is only a proper utilization of material properties.

Fig 1. Different types of materials.

Mr. R Manjunatha Asst.professor, Dept. of Mechanical Engineering, SIET, Tumakuru, Karnataka, India, PH- 9886882569.
E-mail: manjusiragate@gmail.com

Dr. Sanjeevamurthy Asst.professor, Dept. of Mechanical Engineering, SSIT, Tumakuru, Karnataka, India, PH- 9886329281.
E-mail: hodmechssit@gmail.com

2. LITRATURE SURVEY

Sang Muk Lee, Donghwan Cho, Won Ho Park, Seung Goo Lee, Seong Ok Han, Lawrence T. Drzal: shows that, novel short silk fibre (Bombix mori) reinforced poly (butylenes succinate) bio-composites have been fabricated with varying fibre contents by a compression molding method and their mechanical and thermal properties have been studied in terms of tensile and flexural properties, thermal stability, thermal expansion, dynamic mechanical properties and microscopic observations.

N. Venkateshwaran et.al: in this study, the tensile strength and modulus of short, randomly oriented natural fiber reinforced hybrid composites was predicted using the Rule of Hybrid Mixtures equation. It was observed that the Rule of Hybrid Mixtures equation predicted tensile properties of hybrid composites are little higher than experimental values.

M. Ashok Kumar et.al: In this article, the epoxy-based hybrid composites were developed by combining the areca and glass fibers into epoxy matrix. Hardness, impact strength, frictional coefficient, and chemical resistance of hybrid composites with and without alkali treatments.

Mansur and Aziz: studied bamboo-mesh reinforced cement composites, and found that these reinforcing materials could enhance the strength and toughness of the cement matrix, and increase its tensile.

Maryam, Che, Ahmad, Abu Bakar: The effect of surface treatment on the inter-laminar fracture toughness of silk/epoxy composite has been studied. The multi-layer woven silk/epoxy composites were produced by a vacuum bagging process in an autoclave with increasing layers of silk fiber of between 8 and 14 layers.

3. OBJECTIVES

Preparation of hybrid composites – by combining of fibers like cotton and silk fiber with Matrix material Epoxy (CY-230) (20%, 30% and 40%) using hand layup Technique.

Fabricated specimens will be subjected to mechanical testing tensile test of Specimens as per ASTM standards.

Comparison of test results for the combination of cotton-silk fiber

4. EXPERIMENTAL WORK

This chapter describes the details of Fabrication of the composites the raw materials used in this work are:

1. Epoxy resin
2. Silk
3. Cotton

4.1 MATERIAL SELECTIONMATRIX: Epoxy is a thermosetting polymer that cures (polymerizes and cross links) when mixed with a hardener.
Epoxy resin is the most important matrix used in the high–performance of transport system.
Epoxy resin of the grade CY-230 with a density of 1.1 1.3 g/cm3is used. The hardener used is HY-951. The matrix material was prepared with a mixture of epoxy and hardener HY-951 at a ratio of 10:1.

4.2 FIBERS: When natural fiber composite were subjected to at the end of their life cycle, to a combustion process or landfill the amount of CO_2 released of the fibers is neutral with respect to their assimilated amount during their growth.

4.2.1 COTTON FIBERS: Cotton is a natural cellulosic fiber. It is widely used natural fiber. It is a soft, fluffy staple fiber that grows in a boll, or protective capsule. The fiber is almost pure cellulose. Cotton plants of the genus gossypium in the mallow family malvaceae. The cotton fibers contains 91.00% of Cellulose , 0.55% of Protoplasm, Pectins, 0.40% of oil, Waxes and Fatty Substances ,0.2%m of Mineral Salts , 1% of protein and 6.85% of water.

Fig2. Cotton fibers

4.2.2 SILK FIBER: Silk is a natural protein fiber, some forms of which can be woven into textiles. The protein fiber of silk is composed mainly of fibroin and is produced by certain insect larvae to form cocoons. The silk fiber consist of 75% of Fibre in 22.5% of Sericin 1.5% of fat and wax 0.5% Ash of Silk Fibre in 0.5% Mineral Salt.

Fig 3. Silk Fiber

5. PREPARATION OF THE SPECIMEN:

5.1 Mould: A mould made up of GI (gauge 25) sheet of dimension 240X50X10 mm is prepared. Casting of the composite materials is done in this mould by hand lay up process and specimens are cut from the prepared casting according to the ASTM Standard.

5.2 Weight fraction of the fiber: The weight of the matrix was calculated by multiplying volume of the matrix and the density. Corresponding to the weight of the matrix the specified weight% of fibers is taken.

5.3 Specimen: Mixing the Epoxy resin CY-230 and the hardener HY-951 with a ratio of 10:1. This solution is used as Matrix and the different types of natural fibers are silk and cotton used as reinforcements. The natural fibers are used in varying weight % of 20%, 30% and 40%.

5.4 Testing of composite Material:
Tensile test specimens were made according to the ASTM to measure the tensile properties. The samples were 240 mm long, 50 mm wide and 10 mm thick. The size of the test specimen is eight and average tensile strength has been taken. GI sheet tabs were glued to the ends of the specimen with epoxy resin so as to prevent the compression of the sample at the grip.
The samples were tested at a cross speed of 0.5 mm/min and thecorresponding strain occurred was measured using an extensometer.

6. RESULTS AND DISCUSSION

The variation of the mean tensile strength verses fiber percentage is represented in Fig no: 1 to Fig no: 3. For sample 1 Fig: 4 to Fig 6 for sample 2 represent the variation of tensile strength of the composites with individual reinforcements silk and cotton epoxy resin and also the hybrid combinations. The graphs have been plotted taking load on fiber along the Y-axis in kN and Tensile length on the Y-axis in mm.

Tensile test for the sample 1

TABLE 6.1

Composition of Natural fibre 20%

Initital Gauge (mm)	Final gauge (mm)	Load at yield (kN)	Yield Stress (N/mm²)	Load At peak (kN)	Tensile Strength (N/mm²)	% of Elogantion %
50	**51.21**	**2.39**	**22.4**	**3.250**	**30.5**	**2.4**

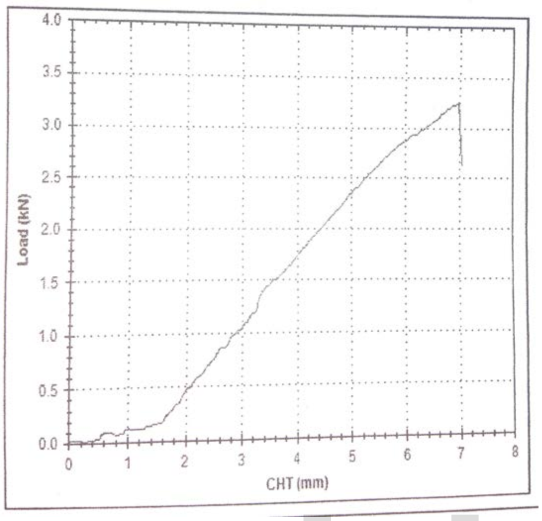

Fig 4 Load V/S length for composition of Natural fibre 20%

In these composites there is a considerable increase of tensile strength as the percentage of fiber increases to a maximum of 3.25 kN and then the strength decreases. The maximum Tensile strength of 30.5 N/mm² is obtained for 20% fiber reinforcement. With % of elongation 2.4.

TABLE 6.2

Composition of Natural fibre 30%

Initital Gauge (mm)	Final gauge (mm)	Load at yield (kN)	Yield Stress (N/mm²)	Load At peak (kN)	Tensile Strength (N/mm²)	% of Elogantion %
50	**51.22**	**2.28**	**17**	**4.490**	**33.6**	**2.4**

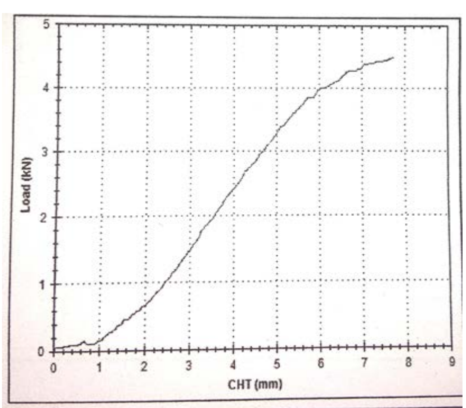

Fig 5 Load V/S length for composition of Natural fibre 30%

In these composites there is a considerable increase of tensile strength as the percentage of fiber increases to a maximum of 4.49 kN and then the strength increase. The maximum Tensile strength of 33.6 N/mm² is obtained for 30% fiber reinforcement. With % of elongation 2.4.

TABLE 6.3

Composition of Natural fibre 40%

Initital Gauge (mm)	Final gauge (mm)	Load at yield (kN)	Yield Stress (N/mm²)	Load At peak (kN)	Tensile Strength (N/mm²)	% of Elogantion %
50	**52.67**	**5.17**	**29.6**	**10.12**	**57.9**	**5.3**

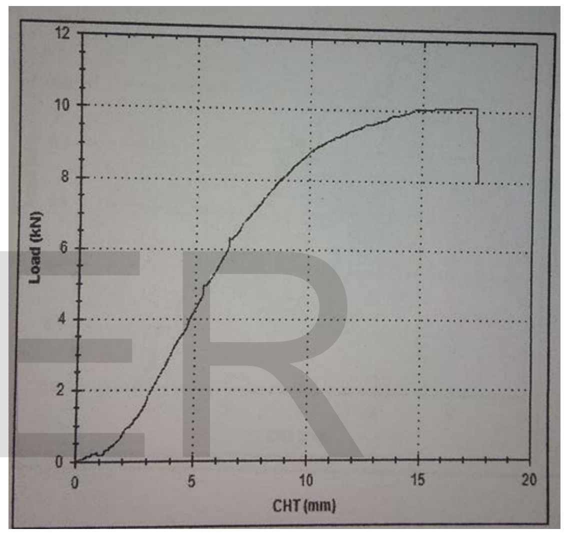

Fig 6 Load V/S length for composition of Natural fibre 40%

In these composites there is a considerable increase of tensile strength as the percentage of fiber increases to a maximum of 10.12 kN and then the strength increase. The maximum Tensile strength of 57.9 N/mm² is obtained for 40% fiber reinforcement. With % of elongation 5.3.

Tensile test for the sample 2

TABLE 6.4

Composition of Natural fibre 20%

Initital Gauge (mm)	Final gauge (mm)	Load at yield (kN)	Yield Stress (N/mm²)	Load At peak (kN)	Tensile Strength (N/mm²)	% of Elogantion %
50	**50.98**	**2.52**	**16.9**	**3.980**	**26.7**	**2.0**

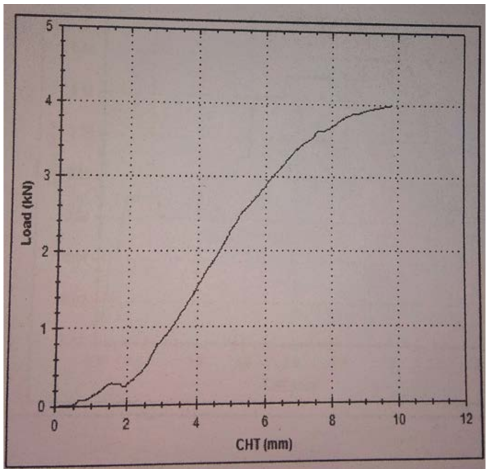

Fig 7 Load V/S length for composition of Natural fibre 20%

In these composites there is a considerable increase of tensile strength as the percentage of fiber increases to a maximum of 3.980 kN and then the strength increase. The maximum Tensile strength of 26.7 N/mm² is obtained for 20% fiber reinforcement. With % of elongation 2.

TABLE 6.5
Composition of Natural fibre 30%

Initital Gauge (mm)	Final gauge (mm)	Load at yield (kN)	Yield Stress (N/mm²)	Load At peak (kN)	Tensile Strength (N/mm²)	% of Elogantion %
50	**50.7**	**1.95**	**15.7**	**3.940**	**31.8**	**1.4**

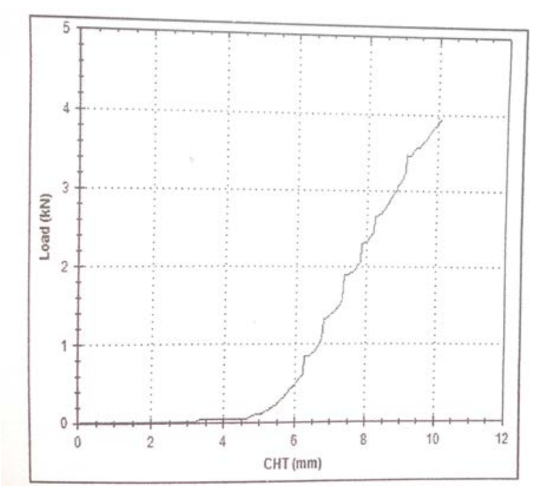

Fig 8 Load V/S length for composition of Natural fibre 30%

In these composites there is a considerable increase of tensile strength as the percentage of fiber increases to a maximum of 3.940 kN and then the strength increase. The maximum Tensile strength of 31.8 N/mm² is obtained for 30% fiber reinforcement. With % of elongation 1.4.

TABLE 6.6
Composition of Natural fibre 40%

Initital Gauge (mm)	Final gauge (mm)	Load at yield (kN)	Yield Stress (N/mm²)	Load At peak (kN)	Tensile Strength (N/mm²)	% of Elogantion %
50	**50.53**	**2.57**	**14.2**	**7.620**	**42.0**	**1**

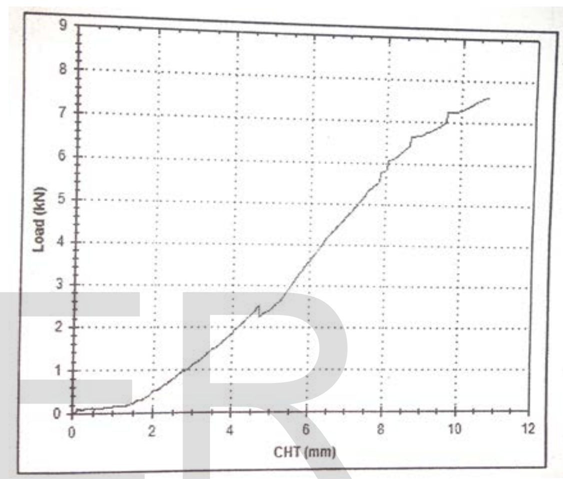

Fig 9 Load V/S length for composition of Natural fibre 40%

In these composites there is a considerable increase of tensile strength as the percentage of fiber increases to a maximum of 7.620 kN and then the strength increase. The maximum Tensile strength of 42.0 N/mm² is obtained for 40% fiber reinforcement. With % of elongation 1.

Conclusion

The hybridization of these natural fibers has provided considerable improvement of tensile strength when compared to individual reinforcement; this is mainly due to transfer of loads and shearing of loads among the fibers.

For all the composites tested the tensile strength of the composite increased for approximately 20% of weight fraction of the fibers. The values decrease further for the increase in the weight fraction.

The tensile strength increased by 57 N/mm² (maximum) for the hybrid combination.

Due to the less density of the natural fibers used compared to the synthetic fibers (Glass fibers, etc...), the composites can be considered as a useful low weight Engineering material.

Refernces

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