EXPERIMENTAL INVESTIGATION OF MECHANICAL CHARACTERISITICS OF PROSOPIS JULIFLORA FIBER COMPOSITES

C.M.RaviRaghul[1], J.Surya Narayanan[1], T.Surulivel Rajan[2], S.Srinivasan[2]

[1] *Student, Department of Mechanical Engineering, Prince Shri Venkateshwara Padmavathy Engineering College, Chennai 600127, Tamil Nadu, India*
[2] *Assistant Professor, Department of Mechanical Engineering, Prince Shri Venkateshwara Padmavathy Engineering College, Chennai 600127, Tamil Nadu, India*

ABSTRACT

Composite material replaces conventional material like metal, wood etc due to its light weight, high strength to weight ratio and stiffness properties. Natural fibers like Prosopis juliflora, bamboo fiber, banana plant fiber etc has low cost, easily availability and less harmful to human. In this work, Prosopis jusliflora fiber is used as a reinforcement material in Polymer Matrix composite and its effects are investigated. This fibre is abundantly available in the nature and has paved way to its usage as a natural fibre of the fabrication of a composite. Composites were prepared with Prosopis jusliflora fibers and epoxy resin by hand lay-up method. The composites were prepared in 3 different ratios of fiber which are 8%, 12% and 16%. The mechanical properties of composites are tested by conducting tensile, impact, compression and flexural test on the prepared specimens.

Keyword : - *Mechanical Properties , Prosopis Juliflora Fiber, Hand Lay-Up method, , and Epoxy Resin*

1. INTRODUCTION

The field of composite materials has progressed considerably over the last few decades. Properties like low density, high strength and stiffness, chemical and corrosion resistance, etc. make composite materials an attractive alternative to metals and alloys. The abundant availability of natural fiber gives attention on the development of natural fiber composites primarily to explore value-added application avenues. Reinforcement with natural fiber in composites has recently gained attention due to low cost, easy availability, low density, acceptable specific properties, etc. While composites have already proven their worth as weight-saving materials, the current challenge is to make them cost effective. The efforts to produce economically attractive composite components have resulted in several innovative manufacturing techniques currently being used in the composites industry. It is obvious, especially for composites, that the improvement in manufacturing technology alone is not enough to overcome the cost hurdle. It is essential that there be an integrated effort in design, material, process, tooling, quality assurance, manufacturing, and even program management for composites to become competitive with metals. The composites industry has begun to recognize that the commercial applications of composites promise to offer much larger business opportunities than the aerospace sector due to the sheer size of transportation industry. For certain applications, the use of composites rather than metals has in fact resulted in savings of both cost and weight.

1.1.Composites

A material made from two or more constituent materials with significantly different physical or chemical properties that, when combined, produce a material with characteristics different from the individual components is called as a composite material. The individual components remain separate and distinct within the finished structure, differentiating composites from mixtures and solid solutions. The new material may be preferred for many reasons: common examples include materials which are stronger, lighter, or less expensive when compared to traditional materials.More recently, researchers have also begun to actively include sensing, actuation, computation and communication into composites, which are known as Robotic Materials. Composite materials are generally used for buildings, bridges, and structures such as boat hulls, swimming pool panels, racing car bodies, shower stalls, bathtubs, storage tanks, imitation granite and cultured marble sinks and countertops.The most advanced examples perform routinely on spacecraft and aircraft in demanding environments. Fibre-reinforced polymers (FRP) include carbon-fibre-reinforced polymer (CFRP) and glass-reinforced plastic (GRP). If classified by matrix then there are thermoplastic composites, shortfibre thermoplastics, long fibre thermoplastics or long fibre-reinforced thermoplastics. There are numerous thermoset composites, including paper composite panels.

1.2.Polymer Matrix Composites

A polymer matrix composite is a composite material composed of a variety of short or continuous fibers bound together by an organic polymer matrix. PMCs are designed to transfer loads between fibers through the matrix. Some of the advantages with PMCs include their lightweight, high stiffness and their high strength along the direction of their reinforcements. The PMC is designed so that the mechanical loads that are being applied to the material is being supported by the reinforcements. The function of the matrix is to bond the fibers together and to transfer loads between them.

1.3.Natural Fibers

Natural fibers are fibers that are produced by plants, animals, and geological processes. They can be used as a component of composite materials, where the orientation of fibers impacts the properties. Natural fibers can also be matted into sheets to make products such as paper, felt or fabric. Natural fibers can be used for high-tech applications, such as composite parts for automobiles. Compared to composites reinforced with glass fibers, composites with natural fibers have advantages such as lower density, better thermal insulation, and reduced skin irritation. Natural fibers are also available in abaundance like plants, animals , etc. Further, unlike glass fibers, natural fibers can be broken down by bacteria once they are no longer in use

2.Materials

2.1.Prosopis Juliflora Fiber

From the literature review it is clear that natural fibers from plants have good strength due to the presence of cellulose and can be used as a reinforcement material in order to achieve good strength to weightratio. The fibers used are Bast fibers of prosopis juliflora.Bast fiber is plant fiber collected from the phloem bast surrounding the stem of certain dicotyledonous plants. Prosopis Juliflora is also a type of dicotyledonous plant . It supports the conductive cells of the phloem and provides strength to the stem.

Fig-1: Prosopis Juliflora Fiber

2.2.Epoxy Resin

Epoxy LY556 is anhydride-cured, low-viscosity standard matrix system with extremely long pot life. The reactivity of the system is adjustable by variation of the accelerator content. The system is easy to process, has good fiber impregnation properties and exhibits excellent mechanical, dynamic and thermal properties. The hardener used for curing is HY951, since it is the best suited and most widely used curing agent for epoxy LY556.

3. SPECIMEN FABRICATION

3.1.Fiber Extraction

The fibers were extracted from the stem of the prosopis juliflora tree. Initially the stems of the trees were cut down from the trees which are mostly situated near the areas with increase ground water level like areas near lakes and rivers. The stems were then brought to home and their barks were stripped before the stem gets dried. Once the fibers are extracted they are stored in a dry place.

3.2.Alkaline Treatment

The fibers extracted from the stem are then treated with alkaline solution which was formed by dissolving sodium hydroxide in distilled water. The fibers are soaked in the alkaline solution for a period of 24 hours. The fibers were then dried at room temperature for a period of 48 hours.

3.3.Hand Lay-Up Process

The mould is placed in a smooth surface at first. The resin is then spread slowly and uniformly in the mould using a brush. 40% of the resin is utilized for this purpose initially. The fibers in the form of mat is then placed over the epoxy which is in the mould and a roller is moved with a mild pressure on the mat-polymer layer to remove any air trapped as well as the excess polymer present. The remaining 60% epoxy is then poured over the surface. Finally an OHP sheet is placed over the surface and a mild pressure is applied in order to squeeze out the excess resin. The curing process will take place and the resin is allowed to set for 24 hours. After 24 hours the specimen is taken out from the mould. 6 different specimens with 3 different ratios of fiber were prepared. The weight of fibers used are 8%, 12% and 16% of total weight of composites respectively.

4.TESTING

The basic mechanical properties testing of composite materials includes Tensile strength test, Flexural strength test, Impact strength test and Compression strength Test. The tests are conducted on the work piece which are machined from the composites as per the ASTM-D standards which is used for testing the mechanical properties of natural fiber composites.

4.1.Tensile Strength Test

Tensile strength test of composites are carried out as per standard ASTM D 638. This test method uses standard “dumbbell” or “dog bone” shaped specimens. A universal testing machine (tensile testing machine) is used to perform this test. Fabricated laminates are cut in size as specified in standards.

Fig-2: Tensile Test Specimen

4.2.Flexural Strength Test

The most common purpose of a flexural test is to measure flexural strength The flexural test measures the force required to bend a beam under three point loading conditions. Flexural strength test of composites are carried out as per standard ASTM D 790. The data is often used to select materials for parts that will support loads without flexing. A universal testing machine is used to perform this test. ASTM D 790 specifies the standard test specimen size that is to be used for testing. Fabricated laminates are cut in size as specified in standards.

Fig-3: Flexural Test Specimen

4.3.Impact Strength Test

The impact test is a method for evaluating the toughness and notch sensitivity of engineering materials. The impact test is a method for evaluating the toughness and notch sensitivity of engineering materials. Notched Izod Impact is a single point test that measures a materials resistance to impact from a swinging pendulum Izod specimens are notched to prevent deformation of the specimen upon impact. Impact test of composites are carried out as per standard ASTM D 256. This standard specifies the test specimen size that is to be used for testing. Fabricated laminates are cut in size as specified in standards.

Fig-4: Impact Test Specimen

4.4. Compression Strength Test

Compressive strength is a key value for design of structures. The compressive strength is usually obtained experimentally by means of a compressive test. The apparatus used for this experiment is the same as that used in a tensile test. However, rather than applying a uniaxial tensile load, a uniaxial compressive load is applied. The compression test is done as per the ASTM D695 standards.

Fig-5: Compressive Test Specimen

5.RESULTS

The composites were tested in testing center and the mechanical properties such as Tensile , Impact , Compression and Flexural strength are found out. The values are tabulated in the following table.

Table -1: TEST RESULTS

SPECIMEN		TENSILE STRENGTH **MPa**	FLEXURAL LOAD **KN**	COMPRESSION LOAD **KN**	IMPACT VALUES **JOULES**
NUMBER	RATIO				
1	8%	5.67	0.11	5.46	6
2	12%	3.74	0.12	6.04	4
3	16%	3.99	0.18	10.17	4

5.1.Tensile strength

From the test results it is clear that the specimen 1 with 8% fiber ratio has the maximum tensile strength. The graph ploted for the tensile testing of specimen 1 is shown below.

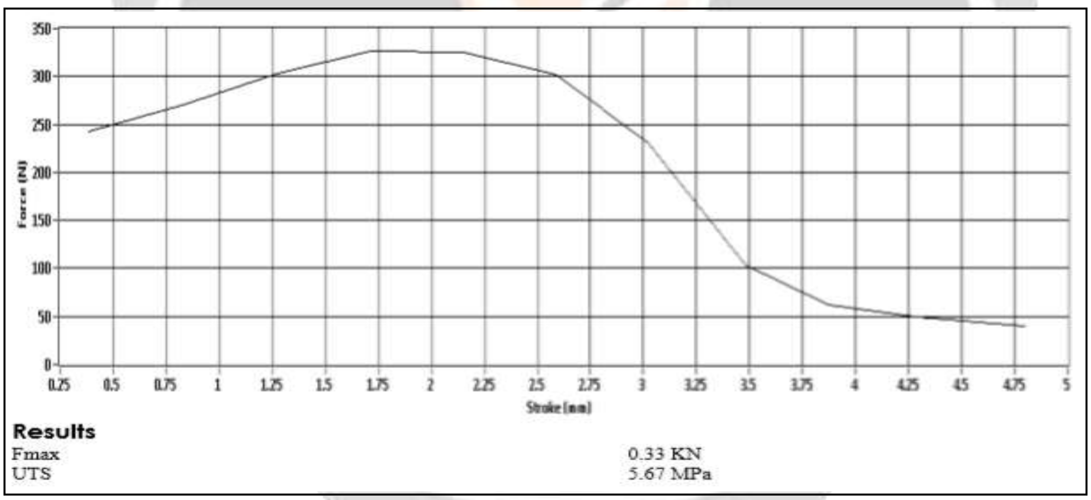

Chart-1: Tensile Test Result for Specimen 1

5.2.Flexural Strength

From the maximum Flexural Load value obtained from flexural strength test the flexural strength of composite for each fiber ratio was calculated.

Table-2: Flexural Strength of Composites for Different Fiber Ratio

SPECIMEN NUMBER	1	2	3
FIBER RATIO	8%	12%	16%
FLEXURAL STRENGTH	38.14 MPa	24.53 MPa	20.7 MPa

The graph plotted for the Flexural test of specimen 1 is shown below

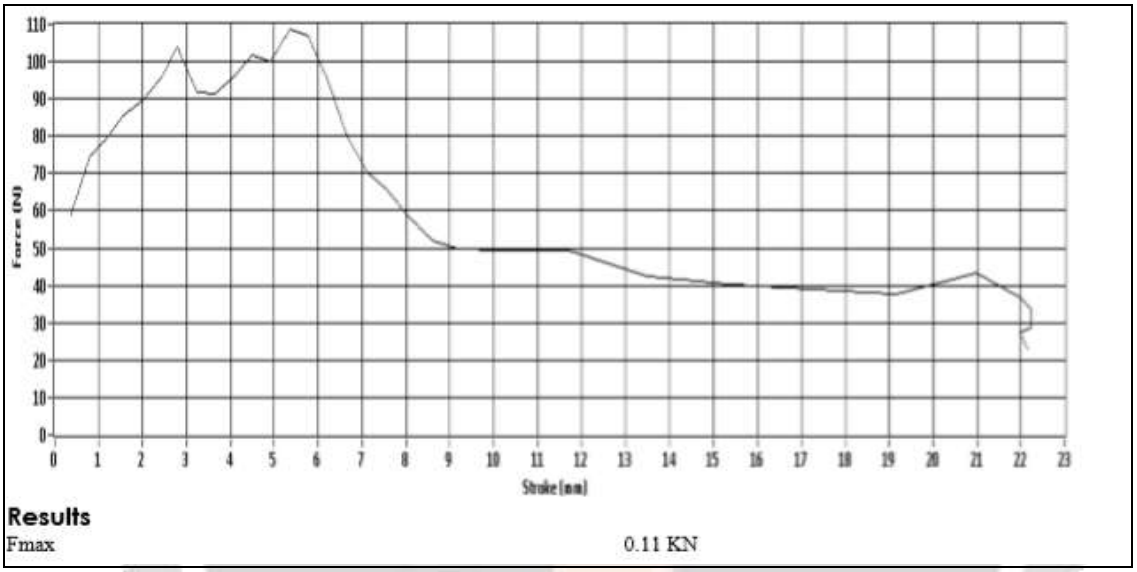

Chart-2: Flexural Test Result for Specimen 1

5.3. Impact Strength

The impact strength of the specimen was calculated from the impact value obtained from izod impact test. The impact strength of the specimens is tabulated in the following table.

Table-3: Impact Strength of composites for Different Fiber ratio

SPECIMEN NUMBER	1	2	3
FIBER RATIO	8%	12%	16%
IMPACT STRENGTH	0.6 J/mm^2	0.326 J/mm^2	0.296 J/mm^2

From the table we can see that the specimen 1 with fiber ratio 8% has the maximum impact strength. This shows that as the fiber content increases the impact strength of the composite decreases.

5.4. Compression Strength

From the maximum compression load value the compressive strength of the specimens is calculated. The compressive strength of composites for each fiber ratio is tabulated in the table below.

Table-4: Compressive Strength of composites for Different Fiber ratio

SPECIMEN NUMBER	1	2	3
FIBER RATIO	8%	12%	16%
COMPRESSIVE STRENGTH	29.96 MPa	26.61 MPa	36.58 MPa

It is clear that Specimen 3 with 16% fiber ratio has increased compressive strength when compared to other specimens. The graph plotted for the Compression test of the specimen 3 is given below.

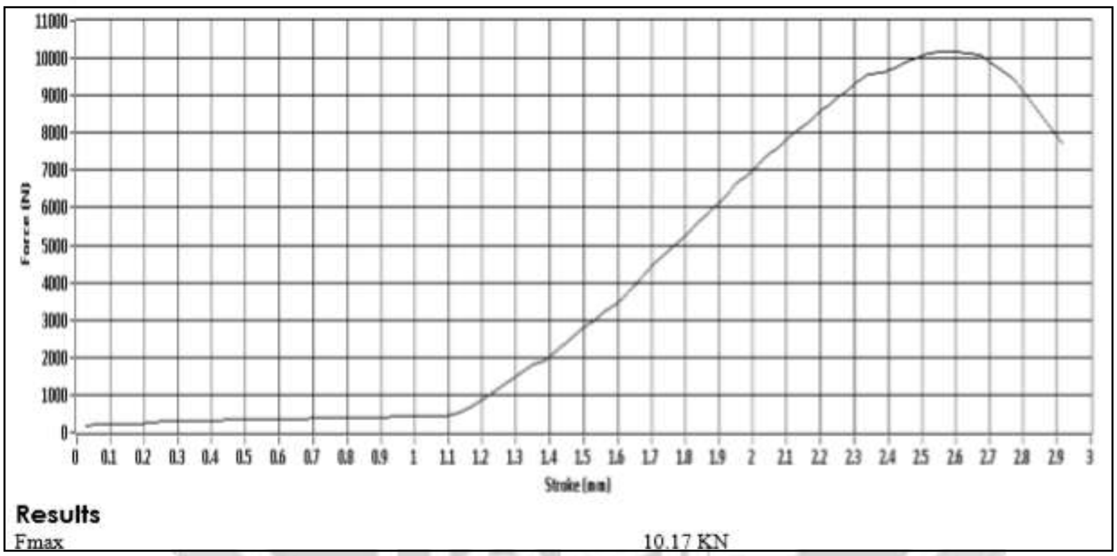

Chart-3: Compression Test Result for Specimen 3

5.5. Mechanical Charecteristics of Composites

Table-5: Mechanical Charecteristics of Composites

SPECIMEN NUMBER	1	2	3
FIBER RATIO	8%	12%	16%
TENSILE STRENGTH	5.67 MPa	3.74 MPa	3.99 MPa
FLEXURAL STRENGTH	38.14 MPa	24.53 MPa	20.7 MPa
IMPACT STRENGTH	0.6 J/mm^2	0.326 J/mm^2	0.296 J/mm^2
COMPRESSIVE STRENGTH	29.96	26.61	36.58

5. CONCLUSIONS

The use of Prosopis Juliflora Fiber to make polymer renforced fiber composites is investigated experimentally . The variation of mechanical properties for the various ratio of fiber used has also been studied. The composites are made using Prosopis Juliflora fiber and epoxy resin by hand lay-up method for 3 different ratios. The specimen 1 with 8% of fiber content has better Tensile, Impact and Flexural strength. As the ratio of fiber is increased the Tensile, Impact and Flexural strength gets decreased. The specimen 3 with 16% fiber content has high compressive strength. As the ratio of fiber is increased the compressive strength also gets increased. The ratio of the fibers used has an effect on the mechanical charecteristics of the composite material. The use of Prosopis Juliflora fiber to make natural fiber composites can be used as an alternative for glass fiber composites and plywood for specific applications. As the compressive strength of the prosopis juliflora fiber composite is high, it can be used for load withstanding applications such as chairs, tables , office cabin partitions. The composite can be used as an economic alternative for other natural fiber composites such as jute fiber composites and coconut fiber composites due to the availability of Prosopis Juliflora trees in abaundance.

6. REFERENCES

[1].Bull,t.[2000].the sugarcane plant.in'manual of cane growing',m Hogarth,p allsopp,eds.bureau of sugar experimental stations,indooroopilly,Australia.pp71-83

[2].Mackintosh d.2000.sugar milling.in 'manual of cane growing',m Hogarth,p allsopp,eds.bureau of sugar experiment solution,indooroopilly Australia,pp369-377

[3]. Dr.bill Broughton, techniques for monitoring water absorption in fibre reinforced composites.

[4]. Moore,p.h., nuss,k.j. flowering and flowersynchronization.in'sugarcane improvement through breeding',dj Heinz,ed.elsevier, Amsterdam.pp 273-311

[5]. Cesar benigna grande costlier.sugarcane extraction and prevention, and long lime pretreatment of Aloe vera pp353-355

[6]. Material science and engineering an introduction,6th edition by William D Calister, Jr.

[7]. Leslie,n Philips,[editor]design with advanced composite materials,the design councillondon

[8]. Daniels,j.roach,b.t.[1987].taxonomy and evolution in 'sugarcane improvement through breading',dj Heinz,ed vol 11. Elsevier,Amsterdam,Netherlands.pp7-84