Experimentation on Mechanical Properties of Fiber Reinforced Polymer Composite Material

C.Naveen Raj, Drs Narsingh Rao, N Praveen, G.Sravya

Abstract: ***The naturally available material such as Sisal has been using in several applications in fabricating composite materials due to its exceptional durability with a minimum wear and tear and due to its ability to stretch. Using sisal fiber as reinforcement to form sisal fiber reinforced polymer composites, strengthen the study of mechanical properties of the composites. In this project, we have enhanced the mechanical properties of the sisal/glass fiber incorporated with polyurethane. Polyurethane is an extremely versatile elastomer used in countless applications worldwide. It has some excellent properties like high abrasive resistance, wide range of hardness, high load bearing capacity, wide resilience range, flexibility, strong bonding properties which makes it an ideal choice in the field of composite preparation. In this study, the composite material is fabricated by mixing Polyurethane proportionally with the sisal/glass fiber. After the fabrication is done, it is planned to study the mechanical properties of the composite material using different testing tools like Universal Testing Machine, Izod test, and hardness tester.***

Keywords: polyurethane, strength, composites, fibers.

I. INTRODUCTION

India endowed with an abundant availability of natural fiber such as Jute, Coir, Sisal, Pineapple, Ramie, Bamboo, Banana etc. has targeted on the event of natural fiber composites primarily to explore value-added application avenues. Such natural fiber composites are compatible as wood substitutes within the housing and construction sector. The development of natural fiber composites in India relies on 2 pronged strategy of preventing depletion of forest resources likewise as making certain smart economic returns for the cultivation of natural fibers. Composites are one among the foremost wide used materials due to their ability to totally different things and also the relative simple combination with different materials to serve specific functions and exhibit desirable properties. In surface transportation strengthened plastics are the sort of composites used due to their immense size. They provide ample scope and receptiveness to design changes, materials and processes. The strength-weight ratio is higher than other materials. Their stiffness and value effectiveness offered, apart from easy availability of raw materials, make them the obvious choice for applications in surface transportation. Polyester resin with appropriate fillers and reinforcements were the primary applications of composites in road transportation. The choice was determined by properties like low price, ease in designing and production of functional parts. Sisal fiber may be a kind of fiber that possesses high specific strength and modulus, low price, recyclability, simple accessibility. Using sisal fiber as reinforcement to form sisal fiber strengthened polymer composites has aroused nice interest of materials scientists and engineers everywhere the globe. Many researches have been done in recent years, that embrace the study of mechanical properties of the composites, finding an economical thanks to improve the surface bonding properties between sisal fiber and polymeric matrices and fiber surface treatment on the mechanical performance of the composites.

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II. PROBLEM STATEMENT

Almost every abiotic things around us is made of metals as they endure the physical properties of all the load carrying components. This high reliability on metals may also make them scarce in the near future. There must be some equal or better alternative to the metals which could at least replace them in some of the applications. And this could be composite materials as they can be cost effective and biodegradable in a long run. Owing to environmental awareness and resource sustainability, this paradigm shift from metallic resources to composites can really be the next big thing in the concept of resource sustainability. The current project focuses on improving the mechanical strength of the natural composite making them viable for some applications.

III. OBJECTIVES

1)To study the mechanical properties of the fiber reinforced polymer composite material.
2) To see the variation of mechanical properties of the fiber reinforced polymer composite material with increase/decrease in the percentage of PU powder.
3)To perform mechanical tests like
a) Hardness test
b) Impact test
c) Tensile test

IV. LITERATURE REVIEW

Manjunath G. Prasad. A. G. Girimath, Sharath Rao, A. J. Vinekar, D. C Patil, S. N. Timmanagoudar, S. N. Mathad [1] Investigated the Mechanical Properties of Sisal Fiber Reinforced Polymer Composites. The composite was prepared by melt-mixing

method, followed by compression molding process. They observed that Increase in fiber loading enhances the hardness value of the sisal fiber reinforced epoxy composites. Impact energy of the composite was found to be constant irrespective of fiber loading.

A. Francis S. Rajaram A. Mohanakrishnan B. Ashok [2] studied the Mechanical Properties of Sisal Fiber Reinforced Polymer Matrix Composite the materials are blended with ratio of ten percentage of fiber and ninety percentage of plastic material. The final output has obtained by using the injection moulding machine. They studied and compared the sisal fiber by having two different compositions and preparation processes. They observed that tensile strength and tensile modulus is very high for polymer matrix composites. Also flexural strength and modulus, impact strength is maximum for the polymer matrix composites. It is concluded that all the properties of the sisal fiber having high strength is polymer matrix composites when compared to the inter cohesion of sisal fiber reinforced composites.

Waleed Shaikh, Supreeth, Prashantha Nayak, Karthik, Narayan Nayak [3] has studied the effect of sisal fiber on the mechanical properties of polypropylene the Sisal fiber reinforced Polypropylene Composites are manufactured using compression molding technique. They observed that 10% weight short sisal fiber reinforced composite showed good mechanical properties compared to the all other composites. In all composites with different fiber ratio, as the fiber weight percentage increases there was a decrease in strength. The decrease of strength may be due to the improper bonding between fiber and matrix the strength of the composites can be improved by the suitable fiber treatment methods. They stated that necessity of fiber treatment before fabricating sisal fiber reinforced polypropylene composite for better strength.

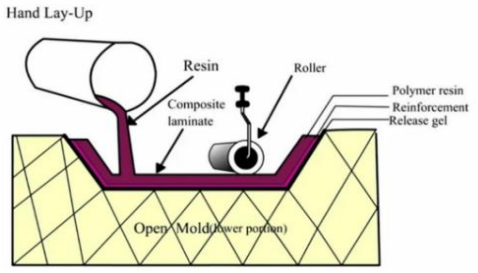
V.Subashini, N.Sakthieswaran, G.Shiny Brintha, O.Ganesh Babu[4] has studied the Fabrication and Study of Mechanical Properties of Composite Panel Using Sisal/Glass/Basalt Fibers. Based on the studies conducted it is observed that the natural fiber composites are good alternative for the conventional construction materials. They are renewable, cheap, recyclable, and biodegradable. Sisal fiber possesses high specific strength and modulus, low price, recyclability, easy availability. Glass fibers bulk and weight properties are also very favorable when compared to metal. Basalt is the natural material that is found in volcanic rocks. It possesses high thermal and sound insulation production. Vinyl ester resin is becoming increasingly important for fiber reinforced composites. By using these materials the composites are prepared and analyzed for its tensile, flexural, impact strength.

V. EXPERIMENTAL SETUP AND METHODOLOGY

A.Hand Layup Technique

It is the oldest, simplest, inexpensive and widely used method for processing of fiber reinforced polymer composites. This method is mostly suitable for continuous type of flat fiber reinforcements of any size (However size is restricted depending on the ease of use and curing time). This method does not require any tooling or equipment setups and as the name suggests, its basic principle underlies in manually laying up the fiber reinforcements over the alternate layers of polymer matrix and then finally bonding all the layers together under pressure using rollers.

In this process initially a release gel or wax is applied thoroughly over the open mold surface. Fiber reinforcements in the form of sheet or strands are placed over the surface of mold plate. The next layer is the polymer matrix which binds the reinforcements together. A known composition of polymer resin in prepared and is then slowly poured over the top of the fibers. Second layer of fiber is then stacked over alternately and then finally this sandwiched composite is rolled over by means of a roller which removes the trapped air and excess resin till it achieves the desired thickness. Now the composite is allowed to cure at room temperature or elevated temperature.



Hand Lay-up technique

Mixing of Resin-Hardener-PU

Pouring of mixed Resin mixture

B.Raw Materials Used

1. Sisal fibers (Continuous Strands) and E-Glass fibers
2. Epoxy Resin (CY230) and Hardener (HY951)
3. Polyurethane (PU) Powder.

C.Steps Involved In the Preparation Of Fiber Reinforced Polymer Composite

1. Drying Of Fibers after Water Treatment

2. Combing Of Raw Fibers

3. Chopping Of Combed Fibers to Required Length

4. PU Resin Preparations

5. Alternate Matrix-Reinforcement Stacking And Compaction of Composite

6. Cutting of Cured Composite to Give Its Final Shape

D. Hardness And Impact Test Specimen

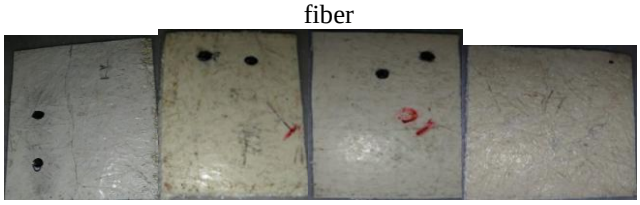
Specimen No	Specimen composition	Dimension (cm)	Resin (gm.)	Hardener (gm.)	PU powder (gm.)
1	G+S+G+S+G	10*10	40	4	7
2	G+S+G+S+G	10*10	30	3	10
3	G+S+G+S+G	10*10	48	4.8	0
4	2(G+G+G+G)	10*10	65	6.5	8
5	2(G+G+G+G)	10*10	80	8	10
6	2(G+G+G+G)	10*10	80	8	12
7	2(G+G+G+G)	10*10	84	8.4	0

E. Tensile Test Specimen

Specimen No	Specimen composition	Dimension (cm)	Resin (gm.)	Hardener (gm.)	PU powder (gm.)
1	G+S+G+S+G	25*7	40	4	5
2	G+S+G+S+G	25*7	50	5	10
3	G+S+G+S+G	25*7	50	5	0
4	G+G+G+G	25*7	82	8.2	5
5	G+G+G+G	25*7	64	6.4	10
6	G+G+G+G	25*7	64	6.4	0

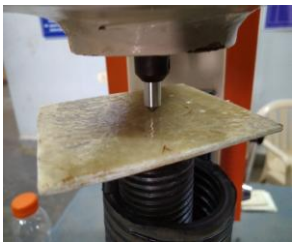
Tensile Test Specimens

Tested Specimens Combination of Sisal fiber and E-glass fiber



Tested Specmens with only E-glass fibers

F. Few Images During Specimen Testing

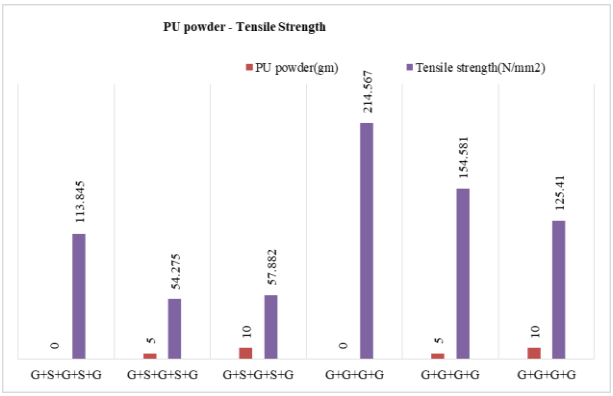


VI. RESULTS AND DISCUSSIONS

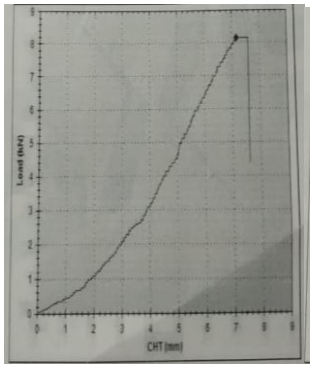
A.Tensile Test Results

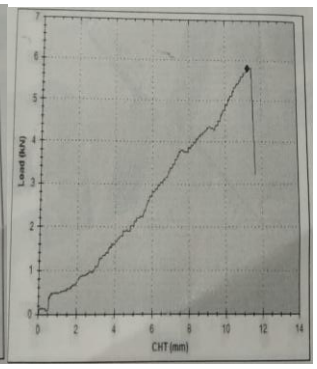
Specimen No	Specimen composition	PU Powder (gm.)	Tensile strength (N/mm2)
1	G+S+G+S+G	0	113.845
2	G+S+G+S+G	5	54.275
3	G+S+G+S+G	10	57.882
4	G+G+G+G	0	214.567
5	G+G+G+G	5	154.58
6	G+G+G+G	10	125.41

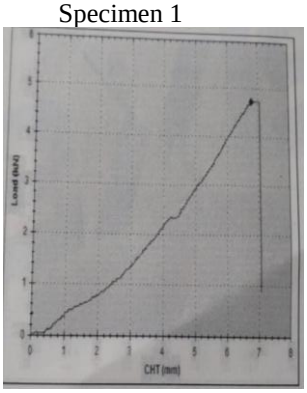
B.BAR DIAGRAM

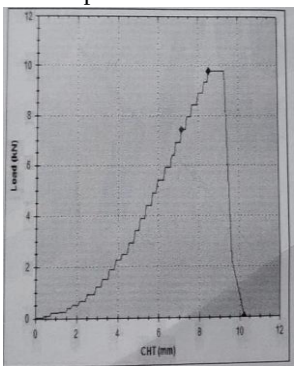


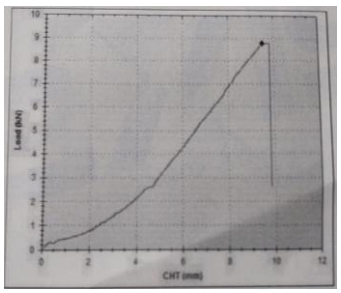
C.GRAPHICAL RESULTS

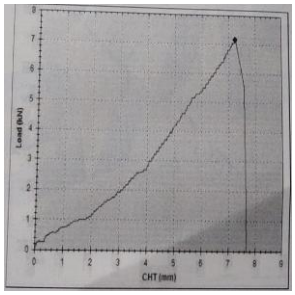

Specimen 1


Specimen 2


Specimen 3


Specimen 4

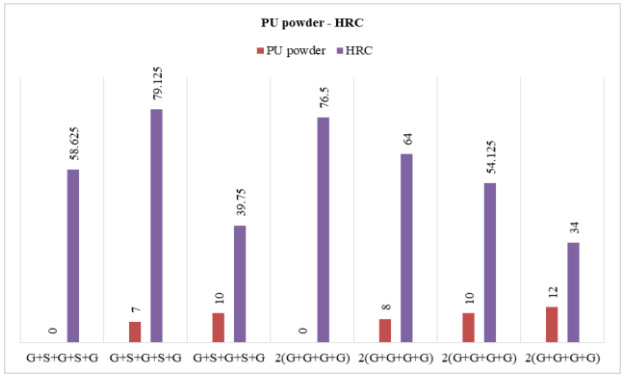

Specimen 5


Specimen 6

D.HARDNESS TEST RESULTS

Specimen no	Specimen composition	PU Powder (gm.)	HRC
1	G+S+G+S+G	0	58.625
2	G+S+G+S+G	7	79.125
3	G+S+G+S+G	10	39.75
4	2(G+G+G+G)	0	76.5
5	2(G+G+G+G)	8	64
6	2(G+G+G+G)	10	54.125
7	2(G+G+G+G)	12	34

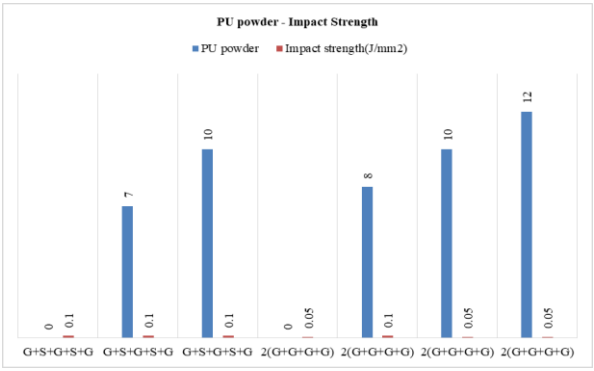
E.BAR DIAGRAM



F. IMPACT TEST RESULTS

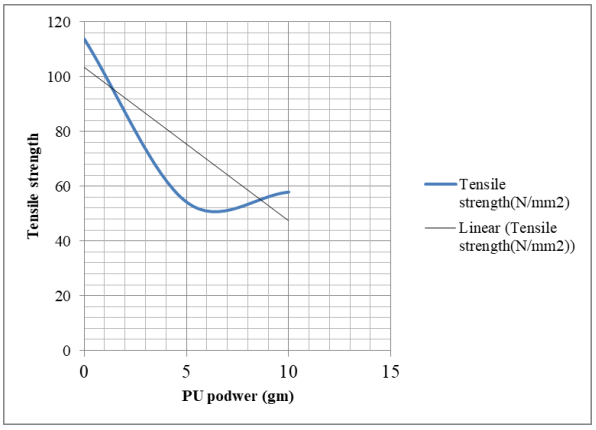
Specimen No	Specimen composition	PU Powder (gm.)	Impact strength (J/mm2)
1	G+S+G+S+G	0	0.1
2	G+S+G+S+G	7	0.1
3	G+S+G+S+G	10	0.1
4	2(G+G+G+G)	0	0.05
5	2(G+G+G+G)	8	0.1
6	2(G+G+G+G)	10	0.05
7	2(G+G+G+G)	12	0.05

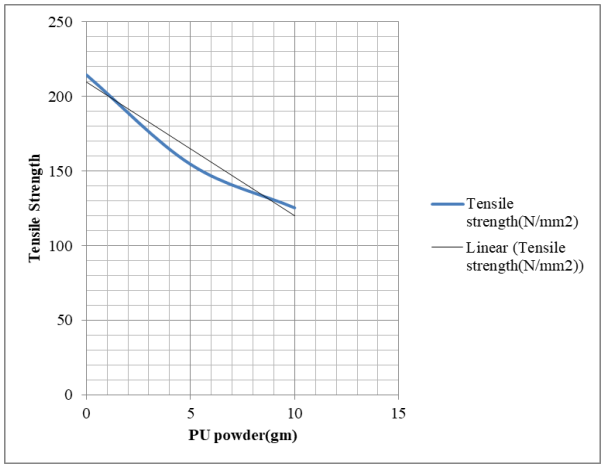
G. BAR DIAGRAM



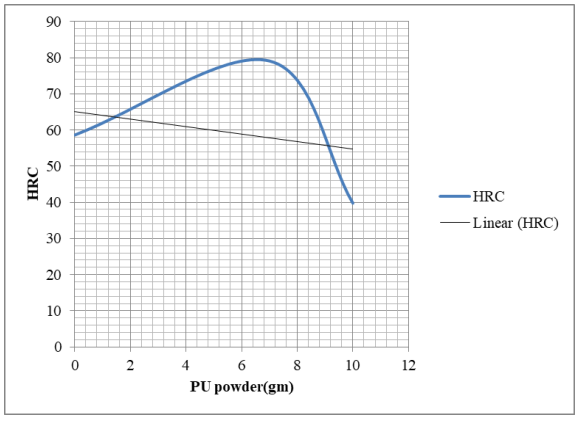
F. GRAPHS

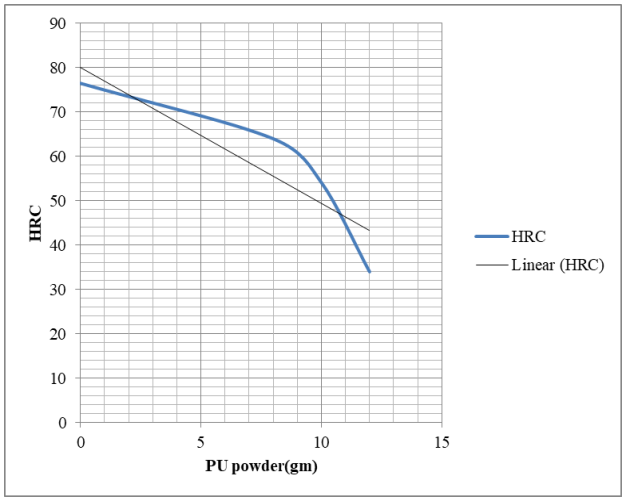
1. Tensile Test



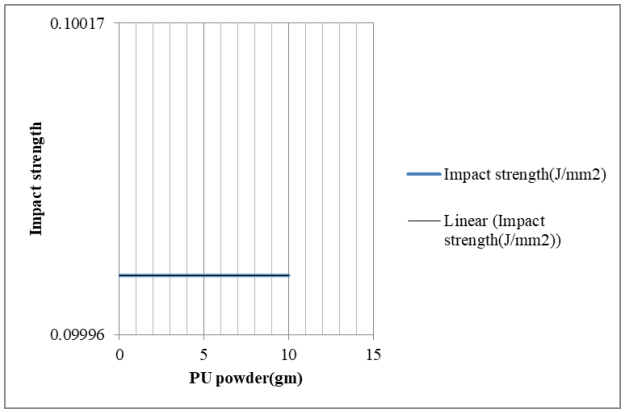


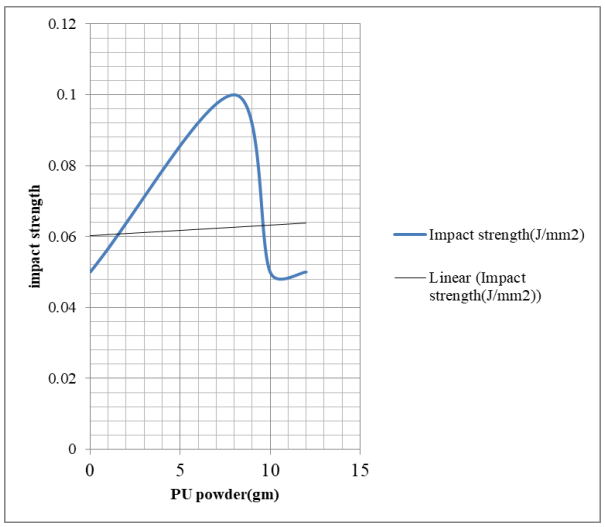
2. Rockwell Hardness Test





3. Impact Test





VII. CONCLUSION

The experimental study on the effect of the fibre loading on mechanical behaviour of sisal/glass fibre reinforced epoxy based composite results to following conclusions

1. It is observed that with the incorporation of PU (in ascending wt.%) into the glass/sisal fiber, the tensile strength of the specimen 3 has been increased when compared to specimen 2.

2. It is also observed that when there is no mixture of PU (i.e., 0% of PU) into glass/sisal fiber, the tensile strength of specimen 1 is increased rapidly compared to the specimen 2 and specimen 3.
3. It is concluded that when there is a combination of E-Glass fiber and Sisal fiber with PU, the tensile strength of the composite is increased with increase in the percentage of the PU, whereas when the PU was incorporated into only E-glass fiber, the tensile strength of E-Glass is decreased with increase in the percentage of the PU.
4. It is observed that when there is a combination of E-Glass fiber and Sisal fiber with PU, the hardness value of the composite is decreased with increase in percentage of PU and similarly the same variation in the value of hardness was observed for E-glass fiber.
5. It is then observed, the composite with E-glass /sisal fiber with PU, the impact strength remains unchanged with increase in the percentage of PU, whereas a small deflection was found when it was a combination of only E-Glass fiber with PU.

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