To Evaluate the Comparison of Mechanical Properties of Sisal/Hemp Fibers Reinforced Unsaturated Polyester Resin

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Abstract— Today the use of composite material in the manufacturing field is increasing day by day. The composite material consists of two or more different forms of material. The natural fiber like sisal, hemp, jute, flax, and silk plays an important role to enhance the properties of composite material. In the present work polyester is used with natural fiber i.e. sisal and hemp. The composite material (Polyester & Sisal fiber and Polyester & Hemp fiber) having weight percentage 90%&10% respectively. The fibers are treated with NaOH and water solution. The specimen of composite material are manufactured by hand layup method. The mechanical properties such as tensile, flexural and shear are calculated and analyzed. In this conclusion sisal is better than hemp in tensile strength, hemp is better than sisal in flexural and shear strength.

Keywords: Polyester Resin, Hemp Fiber and Sisal Fiber

I. INTRODUCTION

The material which is reserved of at least two comprehensive constituents that vary fit as a fiddle and substance piece and which are peculiar in one another, keep up their physical stage and physically as well as artificially alienated by an obvious interface or bury stages called composites. This offers ascend to new material with an amalgamation of properties of both the stages. It comprises of a fortifying material which is dug in another stage called lattice. Framework keeps the strands in favored area and perspective averts their scraped spot and exchanges load between filaments.[1] In this work mechanical properties of chemically treated random short fiber and aligned long hemp fiber reinforced PLA composites were investigated over a range of fiber content (0-40wt.%). It was found that tensile strength, young's modulus and impact strength of short hemp fiber reinforced PLA composites increased with increased fiber content. It was found that PLA could be reinforced with a maximum of 30wt.% fibers using conventional injection moulding, but could not be processed at higher fiber content due to poor melt flow of the compounded material of the composites decreased with increased fiber.[2]

Hybrid Reinforced Composite. Composite materials, plastics & ceramics have been the dominant emerging materials. The volume & number of applications of composite materials have grown steadily, penetrating and conquering new markets relentlessly. The increasing demand for using environmentally friendly materials leads to usage of natural fibers. The fibers are reinforcement with polymers have gained importance due to its better properties. Natural fibers are not only strong and light weight but also relatively very cheap materials and these fibers improve the environment sustainability of the parts being constructed. [3] sisal fiber as concrete reinforcement material in cement based composites have been carried out in many countries on varies mechanical properties , physical performance and durability of cement based matrices reinforced with naturally occurring fibers including sisal, coconut, jute, bamboo and wood fiber. These fiber have always been considered promising as reinforcement of cement based matrices because of their availability, low cost and low consumption of energy. The general properties of the composites are described in relation to fiber content, length, strength and stiffness in this work.[4] Studied on the tensile properties and scanning electron microscope analysis of Bamboo/glass fibers reinforced polyester hybrid composites. They observed that tensile properties of the hybrid composite increase with glass fiber content. These properties found to be higher when alkali treated bamboo fibers were used in the hybrid composites. The elimination of amorphous hemi-cellulose with alkali treatment leads to higher crystalline of the bamboo fibers with alkali treatment may be responsible for these observations.[5] investigated the effect of chemical treatment of hemp fiber on thermal and mechanical properties of hemp fiber composites with recycled high density polyethylene matrix. The chemical composition effect on the surface modification was analyzed by means of Fourier transform infrared spectroscopy (FTIR) and the thermal stability of composites properties were studied by thermo gravimetric analysis (TGA). The mechanical properties of the composites were tested in accordance to ASTM D790 with fiber volume fractions in the range of 20-40%. The results showed that the chemical treatment of hemp fiber improved the thermal stability of the fiber. [6] Natural fibers have gained recognition as reinforcements in fiber polymer–matrix composites because of their mechanical properties and environmental friendliness. The mechanical properties of sisal fiber-reinforced polymer composites have been studied by many researchers and a few of them are discussed in this article. Various fiber treatments. [7] Bagasse Fiber polymer Composites with an objective to explore the potential of the bagasse fiber polymer composites and the mechanical properties of composites. Natural fabric-based thermoset composites are generally lower in strength performance compared to hybrid composites. However, they have the advantages of design flexibility, cost effectiveness, lack of health-hazard problems and recycling possibilities. [8] Mechanical and thermal conductivity properties of hemp fiber reinforced polyurethane composites of rigid polyurethane (PU) and hemp fiber (H.F) were prepared at different loading rates in (H.F) (5%, 10%, 15%, 20%, 25% and 30%). Water absorption, thermal conductivity, and mechanical properties of composite were investigated as a function of fiber content. The results suggest that the thermal composite behavior evidence its application in thermal insulation, this finding can be supported by the lowe density values obtained.

II. PROBLEM FORMULATION

In the wake of experiencing the above explored writing it is seen that in the previous couple of years common strands in polymer framework have kept on demonstrating its systematic potential as helpful assets for both basic and non-auxiliary applications Agrarian squanders incorporate wheat husk, rice husk, and their straw, hemp fiber and shells of different dry organic products. These horticultural squanders can be utilized to get ready fiber fortified polymer composites for business use.

Endeavors have been done to use the preferences offered by sustainable assets for the advancement of composite materials dependent on Polymer and common strands for preservation of regular assets, for better execution because of its biodegradable nature. Further the parameters in the assembling of Natural fiber fortified composites are concoction treatment, reflection of the filaments in grid, strategy for blending of the strands influences extraordinarily the execution of the composite. These parameters have been examined by different specialists. Synthetic treatment is considered in altering the fiber surface properties, this adjust the fiber surface as well as increment fiber quality .Water retention of composites is decreased and mechanical properties are improved. At least two filaments are hybridized to give a significant methods for structuring materials for different administration prerequisites. From open writing it has been discovered that little work is done on hybridized normal fiber strengthened composite. In this manner from above talk it is required to get ready and Study the Mechanical Properties of Hybridized sisal/hemp Fiber Reinforced with polyester pitch Composites by treating the strands and with various fiber stacking.

III. EXPERIMENTATION PROCEDURE

A. Material used

1) Sisal fiber

Raw and plain continuous fiber from Go Green Products Chandra Parkash, jaipur, Chennai India. It is untreated extracted from sisal trunk. Fiber layer are prepared and separated mechanically from sisal stalk.

2) Hemp fiber

Continuous fiber from Go Green Products Chandra Parkash, jaipur, Chennai India.

3) Polyester Resin

Cheaply available everywhere brought from local shop Happy fabrics, Amritsar. It is used as base matrix in the composite. Cobalt napthanate is added as an accelerator. It is used as 0.9% of volume in entire mixture. The solution is mixed and stirred before applying on the laminate. Methyl ethyl ketone peroxide, which acts as a catalyst, was received from Happy Fabrics Amritsar.

B. Surface Treatment of Fabrics

The hemp fabric was taken in a glass tray. Two percent of NaOH was added into the tray and the fabric was allowed to soak in the solution for half an hour to remove the soluble greasy material. In order to enhance the adhesion uniqueness between the fabric/fiber and the matrix. The fiber was then washed thoroughly with water to remove the excess NaOH. Finally, the fiber was washed with distilled water and dried in a hot air oven at 710 C for 1 h. This method was also repeated for sisal fibers, soaking the fiber in alkali solution for 1 h.

C. Composite Fabrication

A glass mould of required dimensions was used for making the composite. The mould cavity was coated with a thin layer of aqueous solution of polyvinyl alcohol which acts as a good releasing agent. The uncured matrix mixture was poured into the mould up to a quarter of its volume. Over this the chopped fabrics were placed, to which another layer of matrix was poured. This was continued until the complete mould was filled and air bubbles were uninvolved carefully with a roller. The top of the mould was covered with Teflon release film to prevent the cured composite from sticking to the top plate. Then the mould was closed for curing. The closed mould was kept under pressure for 24 h at room temperature. To ensure complete curing the composite samples were post cured at 800C for 1 h and test specimen of the required size were cut according to American chemical Society Standard Test Methods (ASTM) standard. The composite having different fabric content were prepared by varying the volume ratio of two fabrics, keeping the volume percent constant at 3% volume (hybrid composite).

D. Mechanical testing

1) Tensile Testing

The tensile test is done by cutting the composite specimen as per ASTMD-638 standard. A universal testing machine (UTM) as shown in figure is used for testing with a maximum load rating. The tensile test is generally performed on flat specimens. The commonly used specimens for tensile test are dog-bone type.

Fig. 1: Universal testing machine

Composite specimens with different fiber combinations are tested, which are shown in figure. The specimen is held in the grip and load is applied and the corresponding deflections are noted. The load is applied until the specimen breaks and break load, ultimate tensile strength are noted. Tensile stress and strain are recorded and load v/s displacement graphs are generated.

Tensile strength=peak load/maximum displacement.

Fig. 2: Tensile test specimen

2) Flexural Test

The flexural test is done in a three point flexural setup as per ASTMD-790 standard. When a load is applied at the middle of the specimen, it bends and fractures. It is a 3-point bend test, which generally promotes failure by inter-laminer shear.

Formula;

Flexural strength=3pl/2wT2

P=peak load

L=Gauge length

W=width

T=thickness

Fig. 3: Universal Testing Machine

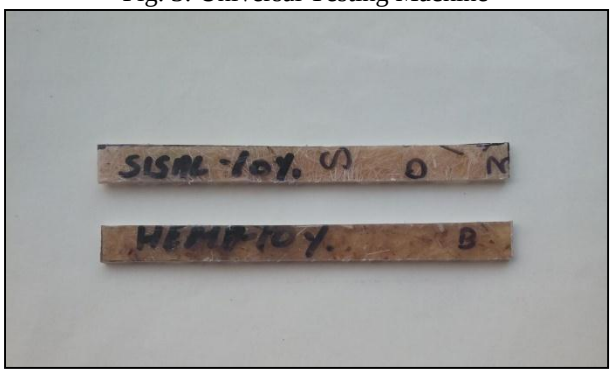

Fig. 4: Flexural Test specimen

3) Shear Test

This test is based on the force which is required to measure the shearing force required to make holes or tears in the plastic. The shear test is useful in structural calculations for parts that may fall in shear. This is based on the force required to rip the plastic divided by the thickness. Test specimens shall be at least 3mm thick.

Fig. 5: Universal Testing Machine

Fig. 6: Shear Test specimen

IV. RESULTS AND DISCUSSION

The composite samples 1, 2, 3, 4 and 5of sisal are tested for tensile properties , flexural and shear in UTM machine and obtain tensile properties are shown in table 1.

Sample No		Tensile Strength(Mpa)	Flexural strength(Mpa)	Shear strength (Mpa)
Sisal 10% UPR 90%	1	28.63	51.79	29.17
	2	35.05	52.56	33.48
	3	33.5	38.63	29.17
	4	29.84	49.13	29.84
	5	30.42	44.64	31
	Avg.	31.48	47.35	30.53

Table 1: Mechanical properties of different samples of sisal fiber

The composite samples 1, 2, 3, 4 and 5 of hemp are tested for tensile, flexural and shear properties in UTM machine and obtain tensile properties are shown in table 2.

Sample No		Tensile Strength(Mpa)	Flexural strength(Mpa)	Shear strength (Mpa)
Hemp10% UPR 90%	1	21.17	46.81	32.37
	2	25.26	47.97	29.10
	3	24.13	50.14	33.85
	4	26.69	44.11	30.26
	5	29.36	48.02	30.19
	Avg.	25.32	47.41	31.15

Table 2: Mechanical properties of different samples of hemp fiber

The comparison of the hemp and the sisal in different mechanical properties are shown in table 3.

Sample No		Tensile Strength(Mpa)	Flexural strength(Mpa)	Shear strength (Mpa)
Sisal 10%	1	31.48	47.35	30.53
Hemp 10%	2	25.32	47.41	31.15

Table 3: Comparison of mechanical properties of sisal and hemp fiber

The graph is to be plotted between the hemp and sisal fiber as shown in fig 7. In the graph it clearly shows that sisal is better than hemp in tensile strength.

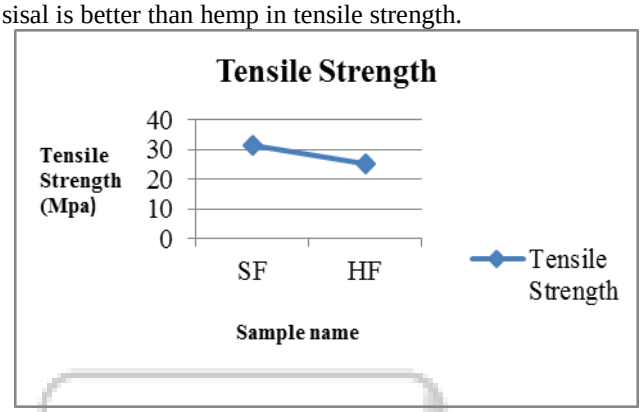

Fig. 7: Tensile properties of sisal and hemp fiber

The graph is to be plotted between the hemp and sisal fiber to measure the Flexural strength as shown in fig 8. In the graph it clearly shows that hemp is better than sisal in flexural strength.

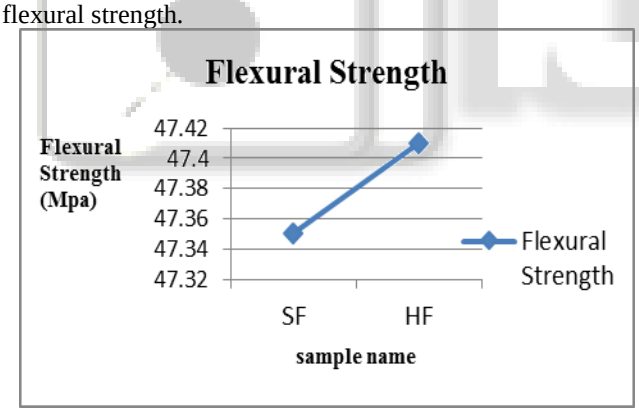

Fig. 8: Flexural strength of sisal and hemp fiber

The graph is to be plotted between the sisal and hemp fiber to measure the Shear strength as shown in fig 9. In the graph it clearly shows that hemp is better than sisal in shear strength.

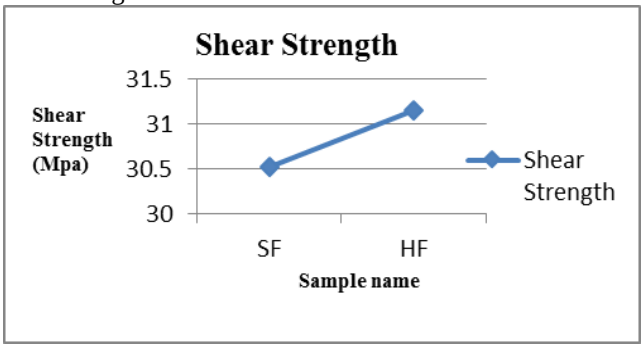

Fig. 9: Shear strength of sisal and hemp fiber

In fig 9 shows that the comparison between the hemp and sisal fiber for measuring the mechanical properties like tensile, flexural and shear strength. The tensile strength is increasing in case of hemp fiber but the flexural and shear strength is increasing in the case of sisal fiber.

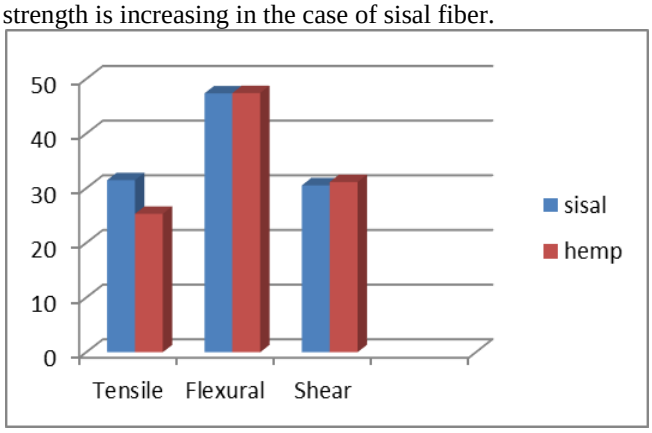

Fig. 9: Comparison of mechanical properties of sisal and hemp fiber

V. CONCLUSION

In this work it is concluded that:

- The tensile strength increases in case of the sisal fiber (SF 10%, UPR 90%) as compared to hemp fiber (HF 10%, UPR 90%) due to adhesion.
- The flexural strength in Hemp fiber (HF 10%, UPR 90%) is more than sisal fiber (SF 10%, UPR 90%).This is because of high stiffness.
- Shear strength also increases in case of sisal fiber (SF 10%, UPR 90%) as comparison of hemp fiber (HF 10%, UPR 90%) due to saline treatment.

REFERENCES

[1] Mirjana M. Kostic, Biljana M.Pejic, Koviljka A.Asanovic, Petar D. Skundric, et.al, (2010), "Effect of hemicelluloses and lignin on the sorption and electric properties of hemp fibers" Research of Industrial crops and products Vol. 32 pp. 169-174

[2] Yogesh Ravindra Suryawanshi, Jitendra Dalvi, et.al, (2013), "study of sisal fiber as concrete reinforcement material in cement based composite" International Journal of Engineering Research & Technology. vol. 2 pp.165-179

[3] Dasong Dai, Mizi Fan, Philip Collins et.al, (2013), "Fabrication of nanocelluloses from hemp fibers and their application for the reinforcement of hemp fibers" Industrial Crops and Products. Vol. 44 pp. 192–199

[4] M. Ramesh, K. Palanikumar, K. Hemachandra Reddy et.al, (2013), "Mechanical property evaluation of sisal–jute–glass fiber reinforced polyester composites" International Journal of Engineering Research & Technology. Vol. 48 pp. 1-9

[5] V.P. Arthanarieswaran, A. Kumaravel, M. Kathirselvam et.al, (2014), "evaluation of mechanical properties of banana and sisal fiber reinforced polyester composites. Influence of glass fiber hybridization" Journal of Materials and Designs. Vol. 64 pp. 194-202

[6] Raghavendra H et.al, (2014), "Studied on the tensile properties and scanning electron microscope analysis of

Bamboo/glass fibers reinforced polyester hybrid composites" International Journal of Engineering Research & Technology. Vol. 45 pp. 65-78

[7] Oza S et.al, (2014), "studied Thermal and Mechanical Properties of Recycled High Density Polyethylene/hemp Fiber Composites" Journal of Research in materials Science and technology. Vol. 52 pp. 456-475

[8] Navjot Pal Singh, Lakshay Aggarwal, V.K. Gupta, et.al, (2015), "Tensile behavior of sisal/hemp reinforced high density polyethylene hybrid composite" International Conference on Materials Processing and Characterization. Vol. 2 pp. 140-148

[9] Idowu David Ibrahim, Tamba Jamiru, Agwuncha & Gbenga Ekundayo et.al, (2015), "Mechanical properties of sisal fiber-reinforced polymer composites: a review" Composite Interfaces. Vol. 23 pp. 15-36

[10] R.S. Rana, Ashish kumar, Saraswati Rana and Rajesh Purohit, et.al, (2017), "Characterization of Properties of polyester sisal / Glass Fiber Reinforced hybrid composite" International Conference of Materials Processing and Characterization. Vol. 4 pp. 445-451

