To Study the Mechanical Properties of the Composite Material by Reinforced in Natural Sisal and Hemp Fiber in Different Compositions

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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 polyester 90% & sisal fiber 5% + hemp fiber 5%, polyester 90% & sisal fiber 7.5% + hemp fiber 2.5% , polyester 90% & sisal fiber 2.5% + hemp fiber 7.5% 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 strength are calculated and analyzed. In this conclusion SF 7.5% + HF 2.5% is better than SF 2.5% + HF 7.5% and SF 5% + HF 5% in tensile strength , flexural and shear strength.

Keywords: Polyester Resin, Hemp Fiber and Sisal Fiber

I. INTRODUCTION

The primary gatherings of plastics that are utilized are polyester resin and polypropylene (PP).Only thermoplastics that dissolve at temperatures underneath 200°C are usually utilized in making the composites in view of the restricted warm unfaltering quality of normal strands. At present, polyester resin is the most appealing thermoplastic in making the common fiber plastic composites which are fundamentally utilized as the outside structure parts. Composited produced using polyester resin are utilized in car application and have as of late been examined for utilizing as structure profiles. [1] The recycling of hemp and sisal fiber reinforced polypropylene composites Microscopic, mechanical, rheological and thermal tests were carried out in order to determine the recycling behaviour of PP/vegetal fiber composites. Different composites using hemp and sisal were characterized. All results were compared with PP-g-MA/hemp composites and PP/glass fiber composites. [2]

The fatigue behavior of sisal fibers. The fatigue behaviour was examined in terms of the stress versus cycles and stress-strain hysteresis behaviour of the fiber were tested at stress levels ranging between 80 and 400 Mpa.. Monotonic tensile tests was performed on fiber that survived 10^6 cycles. An increase the young's modulus was observed with an increase in the maximum fatigue stress. No significant stress-strain hysteresis was observed during fatigue although an increase in young's modulus with the increase of maximum fatigue stress was detected. [3] The dynamic mechanical thermal analysis of sisal fiber thermosetting resin composites a fatigue evaluation of the sisal fiber thermosetting resin composites was under taken at loading levels of 75%,60%,50% and 35% of static tensile strength and at an are ratio of 0.1. s-n curves for the composites are presented for untreated and 0.06 NAOH treated sisal fiber. Polyester matrix composites have a longer fatigue life than polyester matrix composites. In this result, it shows that treatment of sisal fibers with 0.06M NAOH solutions improves the tensile strength of sisal fiber polyester matrix.[4] The fatigue behavior of sisal fibers. The fatigue behaviour was examined in terms of the stress versus cycles and stress-strain hysteresis behaviour of the fiber were tested at stress levels ranging between 80 and 400 Mpa.. Monotonic tensile tests was performed on fiber that survived 10^6 cycles. An increase the young's modulus was observed with an increase in the maximum fatigue stress.[5] Effect of tension on mechanical properties of sisal fiber and fiber-reinforced composites. Sisal fibers were mercerized, under tension and no tension, to improve their tensile properties and interfacial adhesion with soy protein resin. Mercerization of fibers under tension is known to minimize fiber shrinkage and to lower the microfibrillar angle by aligning them along the fiber axis. Mercerization improved the fracture stress and Young's modulus of the sisal fibers while their fracture strain and toughness decreased. [6] Study on Mechanical Behavior of 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 [7] The Fabrication and Experimental Analysis of Pineapple Leaf Fiber Based Composite Material. Their study highlights the fiber preparation using alkali method with different concentrations. Their work proved that PALF has good potential as reinforcement in bio-composites. It was observed that fibers with 10% conc. NaOH displays higher strength with lower elongation when compared to fibers treated with other concentrations.[8] Mechanical Behavior of Hybrid Reinforced 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 composites have already proven their worth as weight-saving materials. 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.

II. PROBLEM FORMULATION

After going through the above reviewed literature it is seen that in the past few years natural fibers in polymer matrix have continued to prove its methodical potential as useful resources for both structural and non-structural applications. India is an undeveloped country and it is the main stay of Indian economy. Thousands of tons of different crops are produced but most of their wastes do not have any useful utilization. Agricultural wastes include wheat husk, rice husk, and their straw, hemp fiber and shells of various dry fruits. These agricultural wastes can be used to prepare fiber reinforced polymer composites for commercial use.Efforts have been done to utilize the advantages offered by renewable resources for the development of composite materials based on Polymer and natural fibers for conservation of natural resources, for better performance due to its biodegradable nature. It has been observed that the Overall properties of the composite are determined by the properties of the fiber, the properties of the resin and the ratio of fiber to resin in the composite (Fiber Volume Fraction). These are also effected by thee geometry and point of reference of the fibers in the composite

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 fiber.

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 0.7% 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 720 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 840C 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 2.8% 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

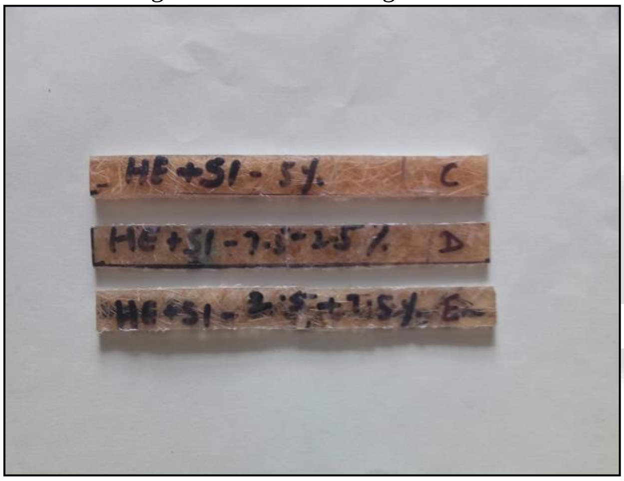

Fig. 4: Flexural Test specimen

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.

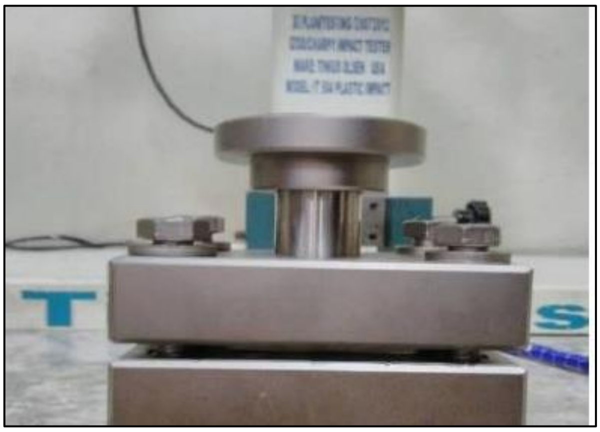

Fig. 5: Universal Testing Machine

Fig. 6: Shear Test specimen

IV. RESULTS AND DISCUSSION

The composite samples 1, 2, 3, 4 and 5of sisal 5% + hemp 5% 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(M pa)	Shear strength (Mpa)
Sisal 5 % Hemp 5 % UPR 90%	1	27.40	42.79	34.39
	2	26.80	42.30	33.93
	3	23.59	39.07	31.91
	4	24.77	42.85	33.42
	5	25.69	41.09	33.45
	Avg.	25.65	41.62	33.42

Table 1: Mechanical properties of different samples of sisal and hemp fiber

The composite samples 1, 2, 3, 4 and 5 of sisal 7.5% +hemp 2.5% 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(Mp a)	Shear strength (Mpa)
Sisal 7.5% Hemp 2.5% UPR 90%	1	23.06	58.62	35.44
	2	27.53	58.29	36.49
	3	28.94	57.14	34.93
	4	26.96	56.29	36.83
	5	24.42	54.42	35.36
	Avg.	26.18	56.95	35.81

Table 2: Mechanical properties of different samples of sisal and hemp fiber

The composite samples 1, 2, 3, 4 and 5of sisal 2.5 % + hemp 7.5 % are tested for tensile properties, flexural and shear in UTM machine and obtain tensile properties are shown in table 3.

Sample No		Tensile Strength(Mpa)	Flexural strength(Mp a)	Shear strength (Mpa)
Sisal	1	27.96	28.16	34.48

2.5% Hemp 7.5% UPR 90%	2	23.00	41.30	35.45
	3	26.19	47.26	35.62
	4	24.48	49.44	31.18
	5	25.21	62.61	35.05
	Avg.	25.36	45.75	34.35

Table 3: Mechanical properties of different samples of sisal and hemp fiber

The comparison of the hemp and the sisal in different mechanical properties are shown in table 4.

Sample No		Tensile Strength(Mpa)	Flexural strength(Mpa)	Shear strength (Mpa)
Sisal 5% Hemp 5%	1	25.65	41.62	33.42
Sisal 7.5% Hemp 2.5%	2	26.18	56.95	35.81
Sisal 2.5% Hemp 7.5%	3	25.36	45.75	34.35

Table 4: Comparison of mechanical properties of sisal and hemp fiber

The graph is to be plotted between the sisal and hemp fiber as shown in fig 7. In the graph it clearly shows that sisal 7.5 % + hemp 2.5% is better than as compared to sisal 2.5% + hemp 7.5% and sisal 5% + hemp 5% in tensile strength.

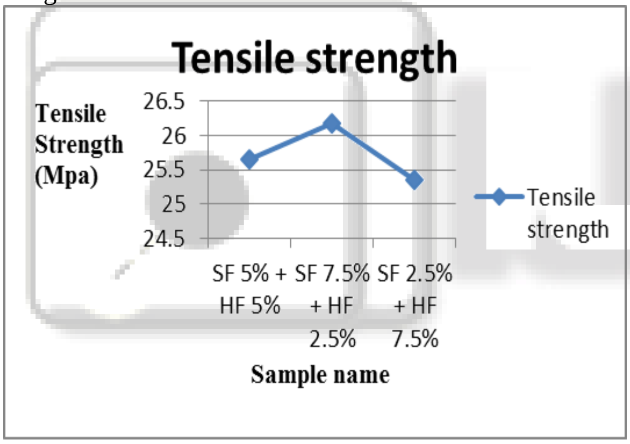

Fig. 7: Tensile properties of sisal and hemp fiber

The graph is to be plotted between the sisal and hemp fiber as shown in fig 8. In the graph it clearly shows that sisal 7.5% + hemp 2.5% is better than as compared to sisal 5% + hemp 5% and sisal 2.5% + hemp 7.5% in flexural strength.

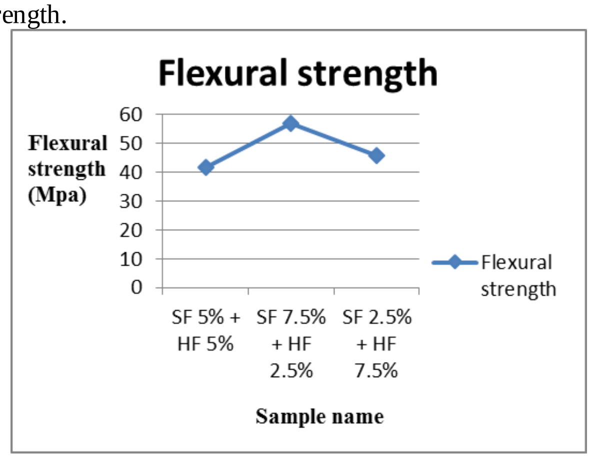

Fig. 8: Flexural strength of sisal and hemp fiber

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 sisal 7.5% + hemp 2.5% is better than as compared to sisal 5% + hemp 5% and sisal 2.5% + hemp 7.5% in shear strength.

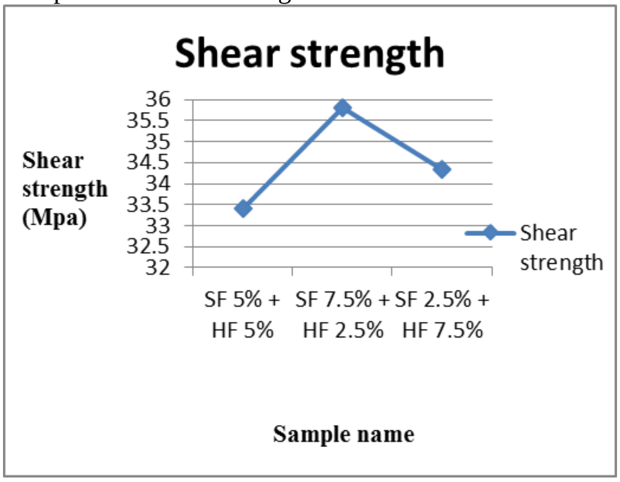

Fig. 9: Shear strength of sisal and hemp fiber

In fig. 10 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 sisal 7.5% + hemp 2.5% fiber but the flexural strength is increasing in case of sisal 7.5% + hemp 2.5% fiber and the shear strength is increasing in the case of sisal 7.5% + hemp 2.5% fiber.

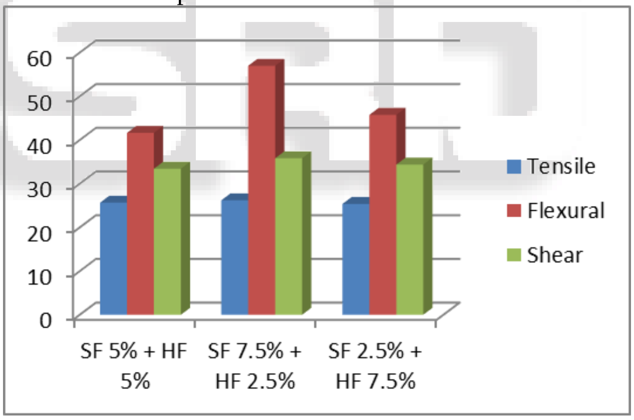

Fig. 10: Comparison of mechanical properties of sisal and hemp fiber

V. Conclusion

In this work it is concluded that:

- The tensile strength increases in case of the sisal fiber and hemp fiber (SF 7.5% +HF 2.5%, UPR 90%) as compared to (SF 2.5% + HF 7.5%, SF 5% + HF 5%, UPR 90%), due to effect of adhesion between the fiber and the matrix.
- The flexural strength increases in case of sisal fiber and hemp fiber (SF 7.5 % + HF 2.5%, UPR 90%) as compared to (SF 5% + HF 5%, SF 2.5% + HF 7.5%,UPR 90%),because of hemp fiber has highest flexural resistance due to the presence of uniformly distributed.
- The shear strength increases in case of sisal fiber and hemp fiber (SF 7.5 % + HF 2.5%, UPR 90%) as compared to (SF 5% + HF 5%,SF 2.5% + HF 7.5%, UPR

90%), the short laminates may be increased by using silane treatment and matrix resin pre-impregnation process.

REFERENCES

[1] M. K. Gupta, R. K. Srivastava et.al, (2015), "Effect of sisal fiber loading on dynamic mechanical analysis and water absorption behaviour of jute fiber polyester composite" International Conference on Materials Processing and Characterization. Vol. 2 pp. 909-917.
[2] Hari Om Mauryaa, M.K. Gupta, R.K. Srivastavaa, H.Singh et.al, (2015), "Study on the mechanical properties of polyester composite using short sisal fiber" International Conference on Materials Processing and Characterization. Vol. 2 pp. 347-355.
[3] Verma D et.al, (2016), "conducted review on Bagasse Fiber polymer Composites with an objective to explore the potential of the bagasse fiber polymer composites and the mechanical properties of composites" Industrial Crops & Products. Vol. 12 pp. 78-89.
[4] Hui Wang, Qing-Hua Qin, Yi Xiao et.al, (2016), "special n-sided voronoi fiber/matrix elements for clustering thermal effect in natural–hemp-fiber-filled cement composites" International Journal of Heat and Mass Transfer. Vol. 92 pp. 228-235.
[5] Riham Ramadana, George Saadb, Elie Awwadc, Helmi Khatibd, Mounir Mabsoute et.al, (2017), "Short-Term Durability of Hemp Fibers" International Conference on Natural Fibers . Vol. 20 pp. 120-127.
[6] R.S. Rana, Ashish kumre, 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.
[7] H. Ravi Kumar, Pradeepa., Arpit Jaketia, Ashish Achha , Lalit Soni, Pranav.P. et.al, (2017), "A Study on Durability of Sisal Fiber Reinforced Concrete Composites" International Journal of Engineering Technology and Advanced Engineering. Vol. 7 pp. 256-265.
[8] R.Sepe, F. Bollino, L.Boccarusso, F.Caputo et.al, (2017), "Influence of chemical treatments on mechanical properties of hemp fiber reinforced composites" International Journal of Engineering Technology and Advanced Engineering. Vol. 4 pp. 565-574.
[9] Tina Haghighatniaa, Ali Abbasianb, Jalil Morshedian et.al, (2017), "Hemp fiber reinforced thermoplastic polyurethane composite: An investigation in mechanical properties" Industrial Crops & Products. Vol.108 pp. 853-863.
[10] S. Sair, A. Oushabi, A. Kammouni, O. Tanane, Y. Abboud, A. El Bouari et.al, (2017), "Mechanical and thermal conductivity properties of hemp fiber reinforced polyurethane composites" Journal of Materials and Designs. Vol.14 pp. 202-218.