ANALYSIS OF MECHANICAL PROPERTIES ON WOVEN ALOEVERA/HEMP/FLAX FIBERS AND THEIR HYBRID COMPOSITES

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Abstract: For manufacturing low-cost materials using Natural fibers as an alternative reinforcement in polymeric composite materials are growing every day. The main intention is to use these natural fibers effectively and economically to produce good quality fibre reinforced polymer composites for various applications. This study was conducted to analyze tensile, flexural, hardness, impact and compression test for the compatibility and suitability of new natural fibers like woven alovera and hemp (AH), alovera and Flax (AF),Hemp and Flax (HF) and alovera, hemp and flax(AHF). Flax fibers have gained popularity due to an increasing requirement for developing sustainable materials and are cost effective. Hemp fibers as a response to the increasing demand for developing biodegradable, sustainable, and recyclable materials. The combination of Natural fibers used is easily and quickly decomposable, low fuel emission and has greater impact in green initiatives rather than glass fibers. From the study, the hybrid composites used by us provide good mechanical properties such as tensile and flexural properties and best impact strength is observed. Hence it has greater implication in the transportation and automobile industry there by making sustainable and eco friendly environment.

Index Terms **- Woven alovera, hemp, flax, tensile, flexural, impact, hardness, compression test**

I. INTRODUCTION

Natural fibers are considered as superior alternatives to glass fiber. They are emerging as low cost, light weight, low density and proven specific strength. The main aim to target the usage of Natural fiber composite is that, natural fiber production has lower environmental impacts compared to glass fiber production [1]. It greatly improves the fuel efficiency and reduces the emission mainly in automobile applications. Natural fibers extracted from Alovera, hemp and flax is examined and the manufacturing process involved in fabrication with different resins is considered as an alternate solution to eliminate glass fibers [2]. The mechanical properties of the natural fiber are increased through chemical process before fabrication [3]. The processing techniques such as fiber diameter length, strain rate, testing temperature, fiber orientation and fiber volume fraction also plays a vital role in affecting the mechanical and physical properties of fibers [4]. Softness of the fiber and its extensibility can be achieved through chemical treatment. The mechanical property can be further improved by increasing the bonding between the fiber bundles and matrix [5]. On rinsing Aloevera, hemp, flax with Kmno4, NaoH solution, the reinforcement shows higher tensile strength and lower moisture absorption

II. MATERIALS

The composite material used for our study such as woven alovera, Hemp and flax are fabricated in figure 1 and figure 2.

Figure1 (a) Woven Aleovera (b)Woven Hemp

Figure 2 (c)Woven Flax (D) Woven Aleovera/hemp/flax

The natural fibres were procured from Go-Green natural fibre, Chennai, India. Matrix material selected is epoxy resin grade LY556 and hardener grade HY971 as binder for the resin, composite fabrication and testing specimens preparation was carried out at B.S. Abdur Raghman university, Chennai, India. Mechanical testing was carried out at Delta inspection and testing service Engineers Chennai, India. From the rule of mixture,it is predicted that the natural woven fibre fabric used in this investigation is 65% and the epoxy resin used is 35%. The pattern of woven fabric is of plain weave type and it offers high fabric integrity and dimensional stability.

Abbreviations and Acronyms

AH → Alovera and Hemp, AF → Alovera and flax, HF → Hemp and Flax, AHF → Alovera, Hemp and Flax, ASTM → American society for testing and materials, NaoH→ Sodium hydroxide, SLS → Sodium Lauryl sulphate, Kmno4 → Potassium Permanganate, SEM → Scanning electron microscopy, J → Joules, UTM → Universal testing machine, KN→Kilonewton, h→ hours, mm→ Millimeter, mi→ Minutes.

2.1 Composite Preparation

We used hand layup process for composite preparation. The advantage of using this process is that, it is very simple and easy. This process involves the mixture of resin and fibre in different forms. In this study, Woven Alovera and Hemp fibre were reinforced separately by alternative layers into epoxy resin grade Ly556 and the hardener grade Hy971 was mixed in a ratio of 10: 1. During the mixing of resin and hardener, Proper stirring was carried out. We employed careful attention to disperse the resin and the hardener into matrix. As the first layer, the Woven aloevera fibre mat measures 300 * 300 mm was kept on the epoxy resin film coating on the entire surface of the fibre mat uniformly. After that, woven hemp fibre mat was kept as the second layer with the same dimensions and the epoxy resin was applied and filled over the entire surface of the fibre mat. The process was repeated by placing the woven alovera and hemp fibre mats alternatively in between each resin coatings until a thickness of 3.2 mm was obtained in the laminates. To remove the air gaps, Rollers are used between the layers. Then the laminates were compressed for a curing of 24 hours. Thus the Alovera, hemp hybrid composite laminate prepared by the hand layup technique as shown in figure 3.

Figure 3

Figure 4

The same procedure is applied for Aloevera,Flax(AF) hybrid composite laminate, the prepared AF composite is in figure 4

Figure 5

Likewise, Hemp and Flax (HF)hybrid composite laminate is prepared by following the same procedure. The prepared HF composite is shown in Figure 5

Similarly ,the woven Aloevera, Hemp and flax(AHF) hybrid composite is also fabricated by the same procedure. Here woven Aloevera fiber is kept as a first layer and woven hemp as a second layer and woven flax as a third layer. The prepared AHF hybrid composite laminate is shown in Figure 6

Figure 6

2.2 Specimen Preparation

In this step, Specimens are prepared according to ASTM standards to carry out different testing. From the prepared AH, AF, HF and AHF composite laminates, the dimensions are marked with the help of the template made according to ASTM D638 standard for tensile testing, ASTM D790 standard for flexural testing, ASTMD256 customary for impact testing, ASTMD695 for compression testing using a saw cutter specimen in all hybrid composites laminates prepared. In order to get a smooth surface file and energy sheet are used at the edge of the specimen. The prepared specimen are shown in figure 7 and 8

Figure 7

Fifure 8

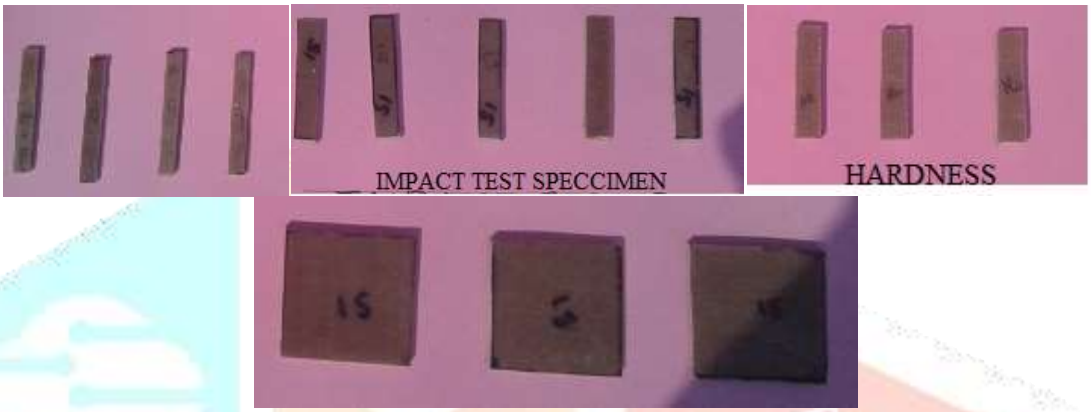


Figure 9

2.4 Mechanical Properties

The performance of four hybrid composite AH, AF, HF and AHF is investigated. This distinctiveness is very essential to predict material capacity and durability over various load settings.

The tensile testing is done on a UTM at a speed of 2.5 mm min^{-1} which follows ASTMD638 standard. Three samples were tested from AH, AF, HF, AHF hybrid composite. It was carried out by clamping the specimen in the required fixture of the machine and load was applied until the specimen breaks. The stress-strain graphs generated from the machine for the woven composite during the test are shown in Fig 6 and 7.

The flexural testing (three point bending) was carried out using UTM according to ASTM D790 standard. Three samples were prepared. The deflection of the specimen was measured under a compressive load, until the specimen breaks. The stress-strain graph generated from the machine during the test are shown in fig 5 a – c.

To carry out impact testing, the impact power of the composite sample is examined with an I-cod impact tester. The specimens are prepared as per ASTMD256 standard. An Impact test is a test for determining the energy absorbed in fracturing a test piece at high velocity. For hardness testing, Rockwell hardness test is used. The specimens were prepared from woven aloevera, hemp and flax hybrid composite according to the …..According to ASTM D 785 standards for composites, the specimens were prepared for Rockwell-B hardness test, the specimen is of 25mm diameter and a length of 20mm.Fiber configuration and volume fraction are two important factors that affect the properties of the composite. In this test, the configuration is limited to unidirectional and continuous fibers equal to the length of the specimen.

The compression test was alone done with UTM Machine.

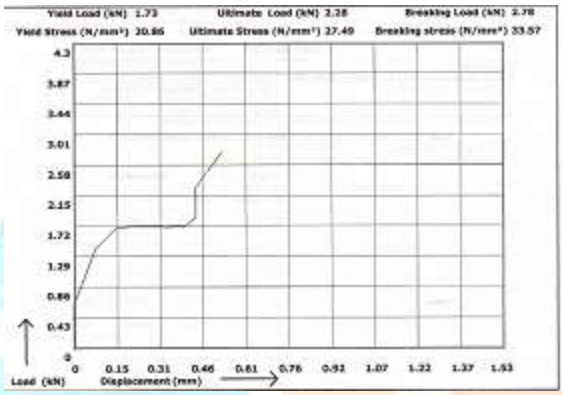
Table 1. laminate orientation of composites.

Samples	Composition of fibre	Staking sequence orentation	Thickness
S1	Aleovera/hemp	(0+90+0+90)	3.4mm
S2	Aleovera/flax	(0+45-45+0)	3.2mm
S3	Hemp/flax	(0+45-45+0)	3.6mm

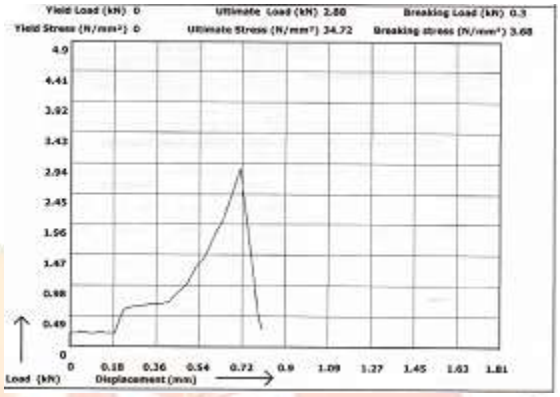
S4	Aleov/flaxera/hemp	(0+90+0+90)	3.4mm

Table 2.mechanical property of tested composites

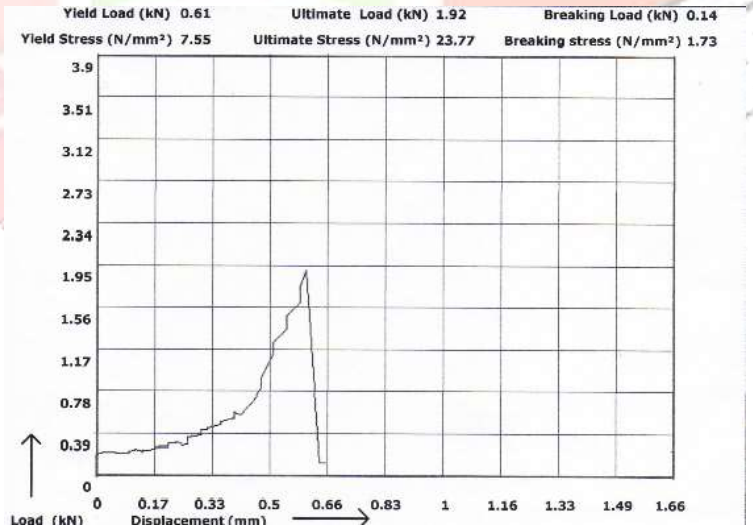
SL.NO	Test Parameters	S1 A/H	S2 AF	S3 HF	S4 AHF
1	Tensile Strength, N/mm²	29	33	28	30
2	Flexural Strength in N/mm	128	141	112	151
3	Impact Energy in J/m	18	17	16	16
4	Hardness, HRR	50	50	47	49
5	Compressive Strength in N/mm	372	359	341	392



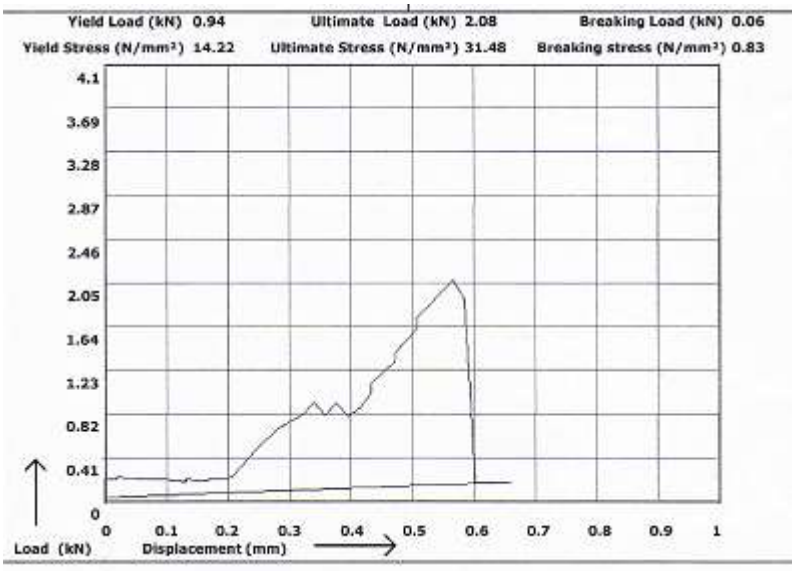
S1-aleovera/hemp load displacement curve



S2-aleovera/flax load displacement curve



S3-hemp/flax load displacement curve



S4—ALEOVERA/hemp/flax load displacement curve

III. RESULTS AND DISCUSSION

The main focus of this study is used to find out the mechanical properties like tensile, flexural, Impact hardness and compression strength for woven natural fibre aloevera, hemp and flax and its hybrid epoxy composites. The analysis of the surface of the tested sample is carried out by using scanning electron microscope.

Tensile Strength: The tensile load observed for the different sample is shown in Figure 10. The result indicates that the average tensile strength is maximum for aleovera and flax composite and it is 33n/mm2. Due to specific properties of aleovera and flax fibre tensile strength is increased. The strength of the joints was increased by using the proper proportion of the matrix and the reinforcement, Provided the woven fibre component additional features such as interlace spacing or gap, Interlace point and unit cell. Further increase in the tensile strength is due to various chemical treatments such as NaoH, Kmno4, sodium lauryl sulphate etc before made into composites. Hence the chemical treatments have improved the surface properties of natural fibres and enhance the adhesive bonding ability of the fibre with the matrix.

Flexural testing: flexural strength observed for aloevera, hemp, flax and are shown in figure .It is observed that the flexural load carrying capacity for the Aloevera, Hemp, Flax composite is 151n/mm.By proper treatment of fibre, the flexural strength of composite found to be enhanced. It is important to note that the natural fibres can be replaced in application where glass fibre is used especially in automotive related industries.

Impact testing: Here is observed that the combination of , hemp and flax fibre sample shows better impact energy than other samples. The maximum impact energy observed is 18j/m. Impact strength depends upon the fibre resistivity during the fracture. Increase of gsm in woven fibre mat may increase the pull out force and further increase impact strength. Investigations on specimen shows mat hybridization of fibre increase the impact strength.

Hardenesstesting: we are observed that better hardness for both the sample aleovera/hemp and aleovera flax other sample also nearer to that by giving proper chemical treatment of all fibre with sodium laurl sulphate the hardness is found to be good.it is very useful in metal making process.

Compression testing: Compressive strength is observed for aloevera, hemp, flax .It is observed that the compressive load carrying capacity for the Aloevera, Hemp, Flax composite is 392n/mm.By proper treatment of fibre, the compressivel strength of composite found to be enhanced. It is important to note that the natural fibres can be replaced in application where glass fibre is used especially in automotive related industries.

In this analysis, Hybrid composites such as woven aloevera, hemp and flax were evaluated for mechanical properties such as tensile, hardness, impact, flexural and compression test. The result shows that the hybrid composites used by us gives better tensile stress, flexural and impact strength than the other hybrid composites. The enhancement we achieved mainly depends on the hybridization of fibre mat and procedure followed for processing. Replacing the glass fibres with the natural fibre hybrid composites, It has greater implication in the transportation and automobile industry ue to low fuel emission and mileage improvement there by making sustainable and eco friendly environment.

4. Conclusion

In this study woven aloevera, hemp,flax and its hybrid epoxy composites, tensile, flexural and impact,hardness,compression strength were deter-mined using universal testing machine and impact tester. Based on the results the following conclusions are drawn:

1. A new form of natural fibre aloevera in woven form is experimented in this study.
2. The hybrid composite sample gives higher displace
   ment of 4.9 mm for an average load of 1.525 kN and gives better tensile stress of 33N mm^{-2} during its tensile test.
3. During flexural test the aleover,hemp,flax composite had a dis-lacement of 2 mm for the average load of151N/mm,
   and uniformity in flexural stress is maintained as 0.003 kN mm^{-2} for all the composite samples.
   4.both aleovera hemp and aleovera/flax has good hardness strength.
   5.good compressive strength wwere observed in hybrid composite so it is better replacement of synthetic fibre
4. The results indicated that woven aloevera , hemp,flax epoxy hybrid composite possess good tensile, flexural and impact strength.
5. From the investigation hybridization of fibres shows good impact strength.
6. Enhancement of mechanical properties may be attained by using the treated fibres and correct method of fabrication.

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