Mechanical and Scanning Electron Microscopic Analysis of Hybrid Plain Woven Fabrics Reinforced Biodegradable Composites

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Abstract— Now days many researchers are working on the natural fiber because of it having its own positive point (i.e. easily available, low cost and etc.). The strength of the fibers can be depends on the stacking sequence and number of layers used for preparing the composite laminates. In the present work the natural fiber hybrid composite specimens were prepared with different stacking sequence by using hand layup method as per the ASTM standards and tested for tensile, flexural and impact strength. Also studied the how surface modifications done with the SEM analysis after the tensile test.

Keywords: Composite, Layup, Tensile Test, Natural Fiber

I. INTRODUCTION

A composite material (also called a composition material or shortened to composite, which is the common name) is a material which is produced from two or more constituent materials. These constituent materials have notably dissimilar chemical or physical properties and are merged to create a material with properties unlike the individual elements. Within the finished structure, the individual elements remain separate and distinct, distinguishing composites from mixtures and solid solutions.

Composites, also known as Fiber-Reinforced Polymer (FRP) composites, are made from a polymer matrix that is reinforced with an engineered, man-made or natural fiber (like glass, carbon or aramid) or other reinforcing material. The matrix protects the fibers from environmental and external damage and transfers the load between the fibers. The fibers, in turn, provide strength and stiffness to reinforce the matrix and help it resist cracks and fractures.

The matrix is basically a homogeneous and monolithic material in which a fiber system of a composite is embedded. It is completely continuous. The matrix provides a medium for binding and holding reinforcements together into a solid. It offers protection to the reinforcements from environmental damage, serves to transfer load, and provides finish, texture, color, durability and functionality.

Many materials are capable of reinforcing polymers. Some materials, such as the cellulose in wood, are naturally occurring products. Most commercial reinforcements, however, are man-made. There are many commercially available reinforcement forms to meet the design requirements of the user. The ability to tailor the fiber architecture allows for optimized performance of a product that translates to weight and cost savings.

Fibres which are obtained from the natural origin directly or indirectly referred as natural fibres. Fibres obtained from the natural origin can be further sub-classified into three different categories based on their different natural origins.

II. LITERATURE SURVEY

Adarsh Kulkarni et al. [1] worked on the hybrid composites and concluded that the combination of jute and kevlar hybrid composite specimen found best tensile strength in 2004.

Murugan et al [2] compared the mechanical and dynamic mechanical behavior of woven and non-woven fabrics and recommended that the woven hybrid composite got more strength in 2014.

Sudhir et al. [3] justified that the combination of jute and sisal hybrid composite samples got more strength in 2014.

Braga [4] worked on mechanical properties of hybrid composite (jute/glass) with different weight fractions (30%, 40% and 50%) and noticed that the as the percentages of weight increased up to 40% there is an continuous improvement in the strength in 2015.

Silvio Leonardo Valenca et al. [5] worked on the mechanical behavior of hybrid composites with different percentages of weight fraction (30%, 40% and 50%) and found that 40 wt.% jute and banana fiber got more strength in 2015.

Gupta et al. [6] compared water absorption and hybrid composite behavior of jute fiber epoxy composite in 2015.

Alavudeen et al [7] worked on mechanical properties of banana/kenaf woven fabrics hybrid composites and observed that the plain woven fabrics got superior properties in 2015

Sam Ashworth et al [8] worked on mechanical and damping properties of jute and carbon hybrid composite specimens and reported that the variation in tensile strength with different injection pressure in 2016.

Saba et al. [9] worked on natural fiber hybrid composites and recommend that the storage modulus of hybrid composite got more in 2016.

Rajesh et al. [10] worked on the free vibration analysis of natural fiber hybrid polymer composite in 2016.

Sanjay et al. [11] concluded that the tensile strength of hybrid composite specimens got more strength in 2016.

III. OBJECTIVES OF THE RESEARCH WORK

The objectives of this research work as follows

1) To study the effect of stacking sequence on the strength and level of bonding.
2) Number of Jute/banana/sisal plain woven fabrics used for preparing hybrid composite specimens.
3) To prepare the natural fiber hybrid composite specimens by using hand layup method as per ASTM standards
4) Hybrid composite laminates tested for mechanical behavior (tensile, flexural and impact)

5) Nature of fracture behavior studied by using SEM analysis

IV. MATERIALS & METHODOLOGY

A. *Materials Used*

The Materials used in this project as follows:

1) Plain woven jute, banana and sisal fabrics
2) Polyvinyl Alcohol (PVA)

Fig. 1: Plain woven jute, banana fabrics

Fig. 2: Plain woven sisal fabrics & Polyvinyl Alcohol

B. *Methodology Followed*

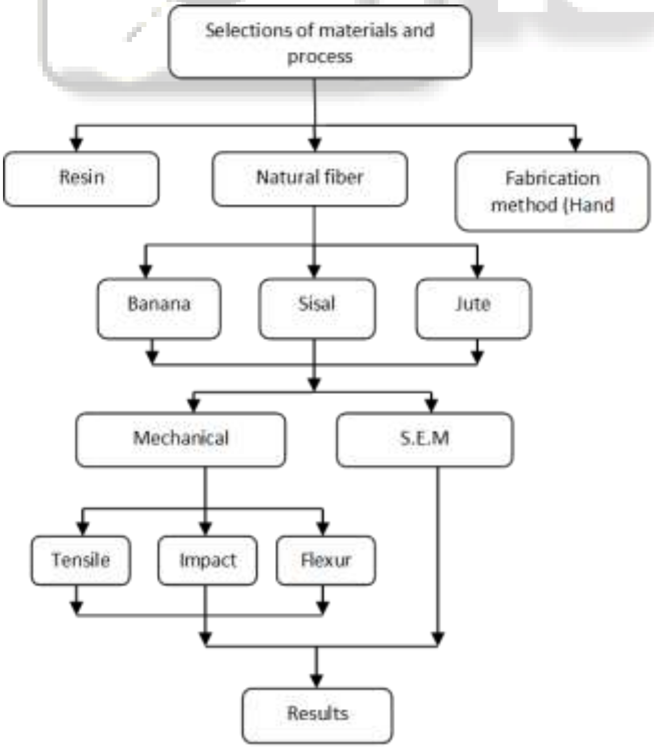

Fig. 3: Methodology

V. RESULTS & DISCUSSION

A. *Tensile test*

The sample manufactured from composites material reinforced with polyvinyl alcohol has been subjected to tensile test. Figure 4 shows the characteristics increment and decrement of test sample by applying tensile test.

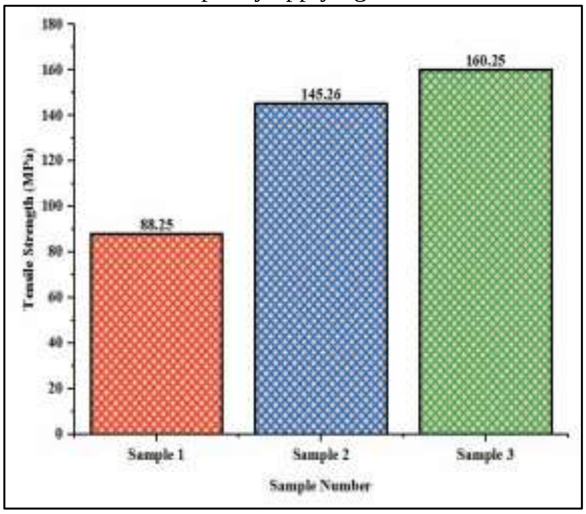

Figure 4:- Tensile test graph

By comparing the composite laminate of tested tensile strength sample here the results are shown below the table 1 the sample3 (jute/banana/sisal) got maximum tensile strength as compared to sample2 (banana/sisal/jute) and sample1 (jute) respectively.

Sample Number	Tensile Strength (Mpa)
S1	88.25
S2	145.26
S3	160.25

Table 1: Tensile testing result

B. *Flexural test*

The sample manufactured from composites material reinforced with polyvinyl alcohol has been subjected to Flexural test. Figure5.2 shows the characteristics increment and decrement of test sample by applying flexural test.

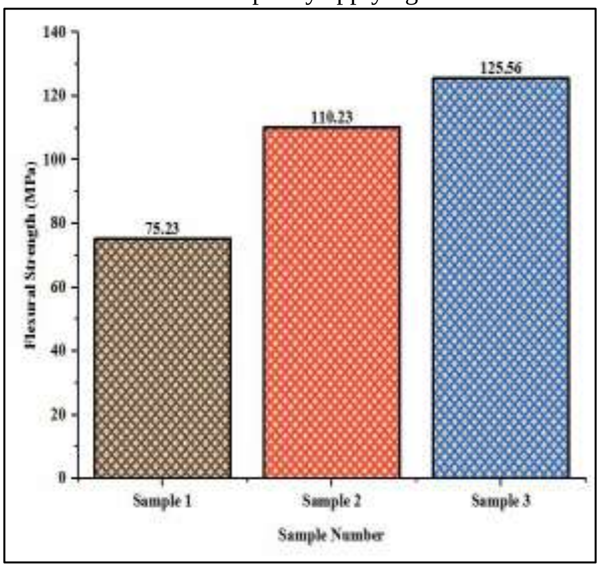

Fig. 5: Flexural test graph

By comparing the composite laminate of tested flexural strength sample, here the results are shown below the table 2 the sample3 (jute/banana/sisal) got maximum flexural strength as compared to sample2 (banana/sisal/jute) and sample1 (jute) respectively.

The sample3 (jute/banana/sisal) having more strength of 125.56 Mpa as compared with sample2 (banana/sisal/jute) of 110.23 Mpa and non hybrid composite sample1 (jute) of 75.23 Mpa as show in above figure 5.

Sample Number	Flexural Strength (Mpa)
S1	75.23
S2	110.23
S3	125.56

Table 2: Flexural testing result

C. Impact test

The sample manufactured from composites material reinforced with polyvinyl alcohol has been subjected to impact test. Figure 6 shows the characteristics increment and decrement of test sample by applying impact test.

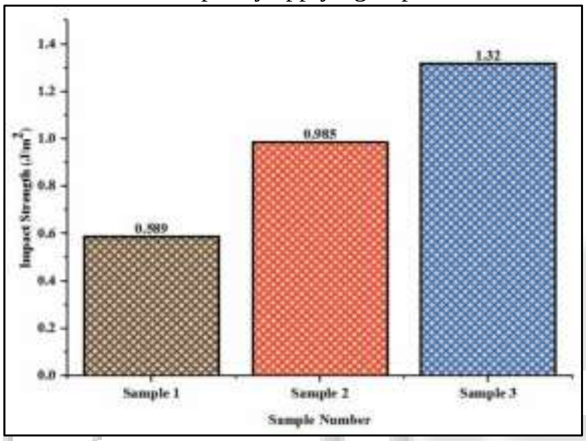

Fig. 6: Impact test graph

By comparing the composite laminate of tested Impact strength sample, here the results are shown below the table 3 the sample3 (jute/banana/sisal) got maximum flexural strength as compared to sample2 (banana/sisal/jute) and sample1 (jute) respectively.

The sample3 (jute/banana/sisal) having more strength of 1.32 j/m² as compared with sample2 (banana/sisal/jute) of 0.985 j/m² and non hybrid composite sample1 (jute) of 0.589 j/m² as show in above figure 6.

Sample Number	Impact Strength (J/m²)
S1	0.589
S2	0.985
S3	1.32

Table 3: Impact testing result

D. Scanning Electronic Microscope

The fracture behavior of hybrid and non hybrid composites specimen after the tensile test, flexural test& impact, the test was conducted using SEM as shown in below figures

The front views of non hybrid composites laminates shown in below figure non hybrid material contain hemicelluloses, lignin, waste impurities and dust particle were responsible for weak internal reinforcement and lower strength. Hence, to overcome this, Chemical treatment is necessary for improving strength and internal bonding.

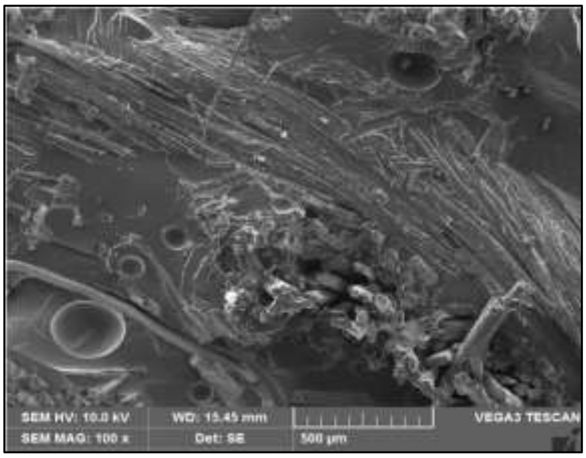

Fig. 7: Sample1 non hybrid Composite

By comparing with hybrid and non-hybrid composites the strength of the material is more in sample2 (banana/sisal/jute) because, the number of reinforcement material was increased so that the fracture of material probability is less, this concluded that the sample2 has more strength as compared to the sample1 (jute).

SEM image shown below in figure 8 the abrasive hole is less as compared to the SEM image of sample1(jute), this shows that the strength is more in sample2(banana/sisal/jute).

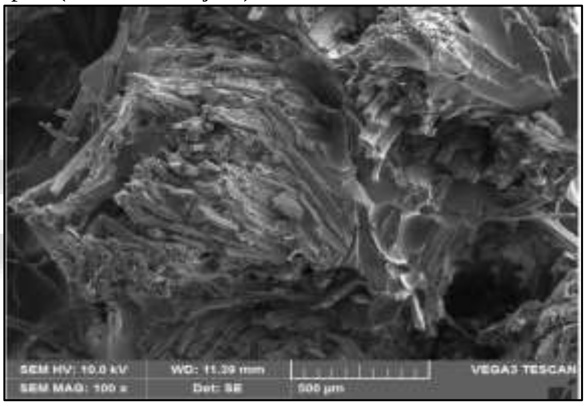

Fig. 8: Sample2 hybrid composite

BY comparing with the SEM image of sample1 (jute) and sample2 (banana/sisal/jute) the tensile, flexural and impact strength is more in sample3 (jute/banana/sisal) because, in sample3 (jute/banana/sisal) the number of reinforcement material stacking sequence is altered so that the strength is more in sample3 (jute/banana/sisal).

SEM image of sample3(jute/banana/sisal)shows that, the material of reinforcement and matrix material is strongly bonded and it is compacted so the hole in material are invisible so that the strength of the material was increased and that leads to less probability of fracture as shown in below figure 9.

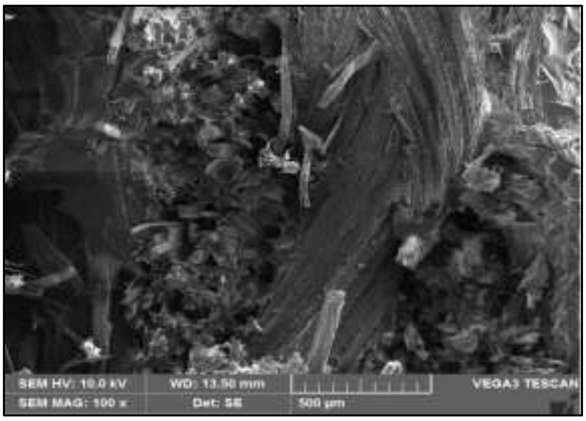

Fig. 9: Sample3 hybrid composite

Nature of facture behavior was analyzed by using SEM analysis and concluded that formation of smooth surface take place in case of sample3 (jute/banana/sisal). Hence natural fiber composites are widely suitable for industrial application.

VI. CONCLUSION

Test sample were successfully fabricated by using hand lay-up method and tested for tensile, flexural, impact and SEM analysis and the following conclusions are made.

- Hand layup method is a superior method for fabricating the composite laminate.
- Sample3 (jute/banana/sisal) got maximum tensile strength as compared with sample2 (banana/sisal/jute) and non hybrid composite sample1 (jute).
- Flexural strength and impact behavior of hybrid composite were analyzed and concluded that sample3 (jute/banana/sisal) found maximum flexural and impact behavior of hybrid composite specimen.
- Natures of facture behavior were analyzed by using SEM analysis and concluded that formation of smooth surface take place in case of sample3 (jute/banana/sisal).
- Hence natural fiber composites are widely suitable for industrial application.

VII. SCOPE FOR FUTURE WORK

The following are scope for future work are suggested

There is a wide scope of composite material in automotive, aerospace, wind energy, electrical, sports, domestic purpose, civil construction, medical chemical industries etc. Composite materials have a great potentiality of application in structures subjected primarily to compressive loads. Composite materials have attractive aspects like the relatively high compressive strength, good adaptability in fabricating thick composite shells, low weight, low density and corrosion resistance.

Composite materials have good mechanical, electrical, chemical properties, due to which we can use composite material in many various industries. Various parts of automobile and aerospace are manufactured by composite material due to good properties. Composite materials are used for domestic purpose like furniture, window, door, mating, civil construction etc. In the marine, chemical industries, sports, we can use composite material for better performance of the parts. With the help of review, we conclude that composite materials have wide advantages & application in various industries; we can make better life style with the help of composite material.

ACKNOWLEDGMENT

We take this opportunity to express our deepest gratitude and appreciation to all those who have helped us directly or indirectly towards the successful completion of this project.

Foremost, we sincerely express our deep sense of gratitude to our guide Asst Prof. AMARESH GUNGE for his advice, constant support, encouragement and valuable suggestions throughout the course of our project work helped us successfully complete the project.

Besides our guide, we would like to thank entire teaching and non-teaching staff in the Department of Mechanical Engineering for all their help during our tenure at NCET.

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