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Impact and Hardness Characteristics of Cfrp-Kenaf-Abaca Fiber Composites

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Abstract*: Industries call for green materials which will supervene upon the ancient materials through virtue of their high strength to weight ratio. Composite substances of herbal behavior satisfy the above desires with a aggregate of one or more materials. In this paper, the combination of herbal fibers mainly Abaca and Kenaf are taken as reinforcement and CFRP as matrix medium. Here the Composite is laminated using Compression Moulding Method. Impact and Hardness Tests has been done to determine the mechanical behavior of the composite laminate. It has been concluded that the Category II suggests better mechanical property when compared to the other two categories and observed Impact energy of 6 Joule and Hardness of 108 HRB respectively. Scanning Electron Microscope was done to observe the internal mechanical behaviour of the composite laminate. From SEM it is noted that minimum propagation of crack and voids present in the composite laminate. It has been observed that this hybrid composite laminate can be implemented wherever high impact energy demands.

***Keywords* : : Abaca, Kenaf, CFRP, Compression Moulding, Mechanical Testing, SEM**

I. INTRODUCTION

Natural fibers have several applications in various fields such as Construction, Transportation, Military, Marine, automobile, textile applications etc. The Hybrid Composites are mainly consists of reinforcements and matrix which leads to high strength to weight ratio and hence in this paper combination of natural fibres has been incorporated to determine the mechanical behavior of the composite laminate. [6,7] Based on the various literature surveys so far, the combined effect of CFRP with natural fibers has been done minimal. It has been concluded that the combined effect of natural fibers and CFRP shows most significant mechanical properties.

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II. MATERIALS USED

A. Abaca Fibre

Fig. 1 Abaca Fiber

Abaca is one among cellulose fibers extracted from pseudo-stem of the plant. It belongs to banana own family cultivated as waste product. It may be very reasonably-priced, mild weight and its without difficulty expandable. Abaca fiber may be very tons call for for reinforcement for diverse polymer composites. It has extra blessings and it may be applied in various engineering fields due their flexibility in nature. Many industries are the usage of the abaca fiber as outdoors lining elements in car industries. Hence, abaca fiber is one among the strongest natural fibers which may be implemented to change traditional substances for vehicle industries. Fig.1 indicates the abaca fiber.

B. Kenaf Fiber

The botanical name of kenaf fiber is hibiscus cannabinus which belongs to malvaceae family. Kenaf fiber has were given excessive capability to fulfil the necessities in diverse industries to trade the traditional substances due to its mild weight and eco friendly environment. Also it has lower thermal resistance whilst it's far as compared with artificial fibers. The software of kenaf has got good sized demand to apply in wide sort of engineering industries. Fig.2 suggests kenaf fiber.

Fig. 2 Kenaf Fiber

.Carbon Fiber Reinforced Polymer (CFRP)

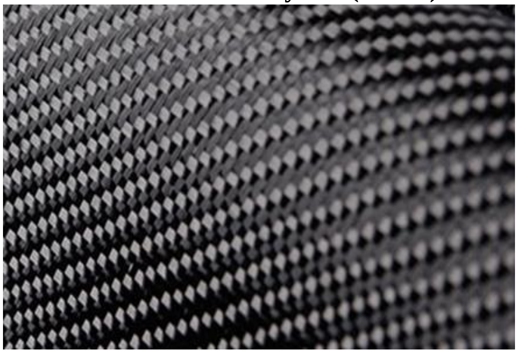

Fig. 3 CFRP Mat

CFRP is an natural polymer that is made out of Poly Acrylo Nitrile (PAN). Carbon fibers are very strong in nature in comparison to different natural and artificial fibers. It has high yield energy and young's modulus whilst compared to aramid fiber. Due to its excessive electricity and low density, it could be extensively used as reinforcement in aerospace industries. Only downside of the usage of CFRP is high value. Fig. Three indicates CFRP Mat.

III. FABRICATION METHODS

Table I Arrangement of Fibers

Category I	Category II	Category III
CFRP	CFRP	CFRP
Abaca	Abaca	Kenaf
CFRP	CFRP	CFRP
Abaca	Kenaf	Kenaf
CFRP	CFRP	CFRP

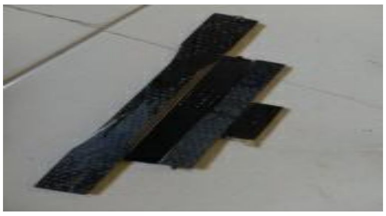

Fig.4 (a), (b) & (c) Preparation of laminate

IV. TESTING OF COMPOSITES

A. Impact Test

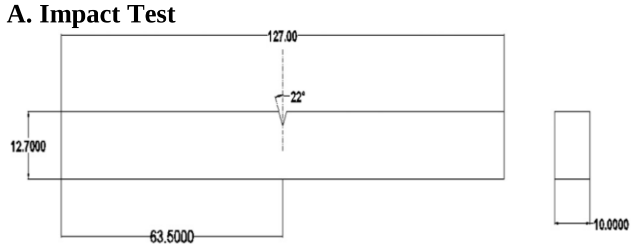

Fig. 5 ASTM Standard for Impact Test [ASTM D256]

Fig. 5 shows the ASTM standard for Impact test. Impact test is one of the simplest destructive methods to determine the hardness of the composite specimen. The amount of energy absorbed by the material can be determined during impact. The impact can be achieved by involving the use of a test apparatus which consist of simple pendulum swing from one end to other with the help of hammer attached to it for impact. The pendulum is dropped from a known height and the category of the specimen is placed on the fixture. When pendulum dropped, the maximum energy hits the specimen and hence the value in joules has been recorded. The amount of energy of the material is directly proportional to the brittleness of the material. Hence, the amount of energy stored in the material is absorbed for every specimen. Fig.8 shows the impact tested specimen.

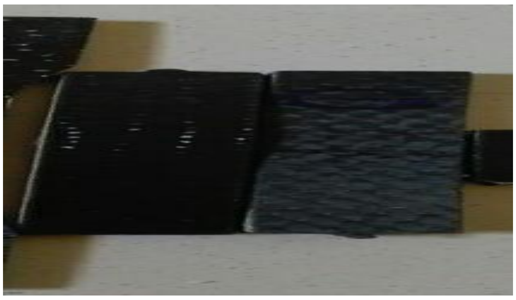

Fig.6 Impact tested Specimen

B. Hardness Test

This hardness test is to determine the hardness of the material. Hardness of the material is directly proportional to resistance to indentation. In this experimentation, Rockwell hardness test is incorporated. When applied the load, smaller the indentation, harder the material. Standard for Hardness Test used is ASTM D2583.

V. RESULTS & DISCUSSION

A. Impact Test

Table 2 shows the results of impact test. The sudden impact on the composite has many significant factors which include orientation of the fiber, layering sequence, stacking methods etc. but, for hybrid composites, it is clearly show that the maximum impact strength can be obtained because of the fiber orientation.

Table II Results of Impact test

Sl.No	Category	Sample	Energy Absorbed (J)
1	CI	S1	04
		S2	02
		S3	04
2	CII	S1	04
		S2	06
		S3	05
3	CIII	S1	04
		S2	03
		S3	04

It is understood that CII absorbed more energy of 6J than CI and CIII. Hence it is concluded that energy absorbed by a composite increased when there is multiple fibers are used instead of non-hybrid ones. Also, being CFRP layers outside, the impact properties are highly significant due to its high mechanical strength.

B. Hardness Test

Table III Results of hardness test

Sl.No	Category	Sample	Rockwell Hardness Value (HRB)
1	CI	S1	98
		S2	91
		S3	89
2	CII	S1	105
		S2	108
		S3	102
3	CIII	S1	96
		S2	99
		S3	104

It is inferred from the tabulation that Rockwell Hardness Number (HRB) for category CII is the highest among other categories with 108 HRB. It means that, hybrid composite can react better to indentation than category CI and category CIII. The hardness value implies better indentation property which leads to high energy absorption capacity.

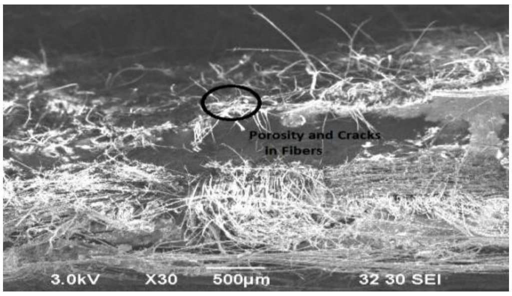

Fig.7 Porosity and cracks of fibers C. Morphological Analysis of composites

Scanning Electron microscope is used to look at the inner structure of the hybrid composite. It focuses an electron beam over the surface of the specimen. It creates an image with the assist of signals wherein it is able to be used to acquire the data about the surface topography and diverse composition chances. SEM is the first-class approach to study the inner shape of the composite. It simply shows the adhesion of fiber and the matrix in the shape. Various magnification factors show better photo clarity. It additionally shows the presence of voids, blow holes, cracks, and so on. Within the shape. The inference of the pix may be actually seen with the help of SEM.

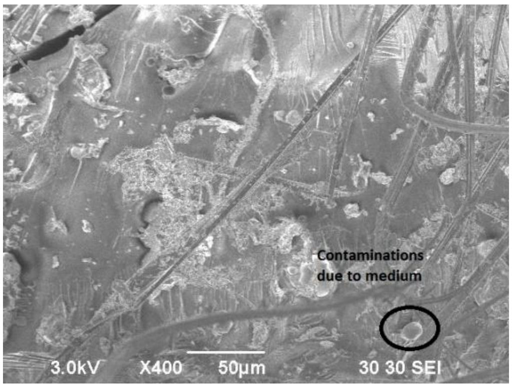

Fig.8 contaminations due to medium

Fig. 7 indicates Porosity, Voids and Cracks which can be because of thermal and adhesive homes of various herbal fibers. Circles imply Deboning of fibers, Contaminations shown in Fig.8 which solely takes place because of fiber incorrect cohesiveness.

VI. CONCLUSION

Based on the experimental effects it has been concluded tha the category II which consists of combination of CFRP, Abaca and Kenaf fibers shows significant improvements in mechanical properties. In Impact test, the Category II of Sample 2 was found to soak up more impact energy of 6 Joules while in comparison with Category I & III. From Hardness check, Category II has maximum of 108 HRB when compared with Category I & III. From Morphological analysis, it has been noted that some misalignments and overlap observed in the hybrid composite laminate.

REFERENCES

1. K. Poyyathappan, G. B. Bhaskar, S. Rajesh, K. Pazhanivel, Experimental Analysis and Comparative Mechanical testing on Glass-Carbon Hybrid Composites Materials Today: Proceedings, Volume 16, Part 2, 2019, Pages 612-620
2. B. Vijaya Ramnath, J. Jeykrishnan, C. Elanchezhian, Ashok Kumar, Arvind Narayan Investigation of flexural behaviour of polymer composite golf shaft. Materials Today: Proceedings, Volume 4, Issue 8, 2017, Pages 9341-9345
3. Mulat Alubel Abtew, François Boussu, Pascal Bruniaux, Carmen Loghin, Irina CristianBallistic impact mechanisms – A review on textiles and fibre-reinforced composites impact responses. Composite Structures, Volume 223, 1 September 2019, Article 110966
4. R. Vijayan, A. Krishnamoorthy Review On Natural Fiber Reinforced Composites Materials Today: Proceedings, Volume 16, Part 2, 2019, Pages 897-906.
5. A.Shalwan, B. F. Yousif In State of Art: Mechanical and tribological behaviour of polymeric composites based on natural fibres Materials & Design, Volume 48, June 2013, Pages 14-24.
6. B Vijaya Ramnath, C Elanchezhian, PV Nirmal, G Prem Kumar, V Santhosh Kumar, S Karthick, S Rajesh, K Suresh, Experimental investigation of mechanical behavior of jute-flax based glass fiber reinforced composites. Fibers and polymers: Volume 15, 2014,Pages 1251-1262.
7. C Elanchezhian, B Vijaya Ramnath, G Ramakrishnan, M Rajendrakumar, V Naveenkumar, MK Saravanakumar, Review on mechanical properties of natural fiber composites, Materials Today: Proceedings: January 2018, Volume 5, January 2018, Pages 1785-1790.
8. B Vijaya Ramnath, S Rajesh, C Elanchezhian, A Santosh Shankar, S Pithchai Pandian, S Vickneshwaran, R Sundar Rajan, Investigation on mechanical behaviour of twisted natural fiber hybrid composite fabricated by vacuum assisted compression molding technique, Fibers and polymers : January 2016, Volume 17, Pages 80 – 87.

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