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Surface Modification of Kenaf Fiber Reinforced Epoxy based Composite

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Abstract*: *In day today life, the awareness to the public along with the ease in the fabrication of polymers, has let to the frequent polymer useage. Few developing industries have started using the materials that are renewable. In the present work, the mechanical behavior of short un-treated and treated ($KmNO_4$) kenaf fiber reinforced epoxy based composites was investigated. Fabrication of composite materials were carried out with volume percentage (10 %, 20 %, 30%) of treated and un treated kenaf fibers. The polymer used as matrix was epoxy resin. The composite was fabricated by using hand layup method. The various fiber loading was performed and their properties studied. The mechanical strength like tensile, flexural and impact of the composite was analysed. The effect of treatment had showed improvement in the composite properties. It was found that $KmNO_4$ treatment and kenaf fiber loading has enhanced the synergetical effects on the composite. These chemically surface modified composites with natural fiber reinforcement can have a chief role in the development of structural component parts. These materials may be used for light weight applications, especially in automobile sector and structural components.

Keywords* : *Epoxy, Kenaf fiber, $KmNO_4$, Mechanical strength.

I. INTRODUCTION

Suardana et al. (2011) did experimental work on the chemical treatment of surface on hemp fiber reinforced composite material. Their wieght loss, density of the material were observed. The 2 percentage by weight NaOH treated fiber showed better effects on the properties of hemp reinforced composites. The morphologies of surface were observed and it showed best results. Li et al.(2006) studied the treatment on naturally available fibres with chemicals. The chemical treatments improved the fibre fitness and fiber matrix interaction in degradeable material reinforced composites. Uma Maheswari*et al.* (2010) made experimental studies of the mechanical properties of Tamarind Fibre - Epoxy composites. It was found a drastic increase in the mechanical properties when treatment with alkaline and silane.

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Tran *et al.* (2012) discussed the effect of the weight content of fiber in the composite. The alkali treated coir fibres increased the fibre-matrix adhesion and the wettability of the resin. Thus it lead to the enhancement of the mechanical properties of short coir/poly butylene succinate biodegradable composites. Prithivirajan*et al.* (2016) investigated the properties of hybrid composites fabricated from agricultural residue. They used coir pitch, ground nut and rice husk in an epoxy matrix. The results revealed improvements in the materials mechanical strength and dimensional stability. Mishra *et al.* (2001) investigated the chemically modified sisal fibres. $NaClO_4$ and $CuSO_4$ were used as initiator. The effect of various parameter were investigated. Comparison were made for Water absorption and tensile properties of chemically surface modified composite. Microscopic morphologies reveals that there is improvement in the mechanical properties and dimensional stability.

II. EXPERIMENTAL WORK AND PREPARATION

A. Procedure for preparation and Testing

Reinforcement material that was used in the fabrication of the composites was Kenaf short fibers. The kenaf fiber was surface modified with 7% $KmNO_4$. The composite material were manufatured by using hand layup method. This method is followed by adding load on the top, so that the resin gets equally distributed . Two sets of samples were prepared, samples treated with $KmNO_4$ and untreated samples. For the testing, the samples were prepared as per ASTM standards. ASTM D638 standard was performed for test of tensile strength, ASTM D790 standard was performed for test of flexural strength and standard ASTM D256 was followed for impact strength. The preparation procedure is shown in the figure 1. Step by step procedure is followed in the fabrication of the composite material.

- Preparation of the mould
- Application of resin to the mould
- Stacking the laminar films
- Air bubbles removal
- Load the component with weight
- Finished composite

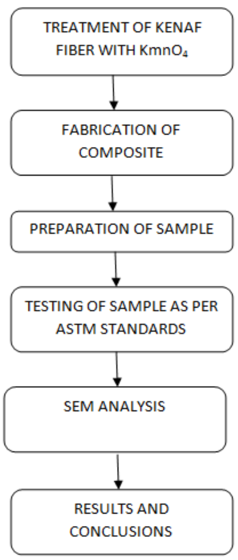

Fig-1 Morphology of the Experiment

Each and every steps involved in fabricating the composite are provided and shown in figure-2.

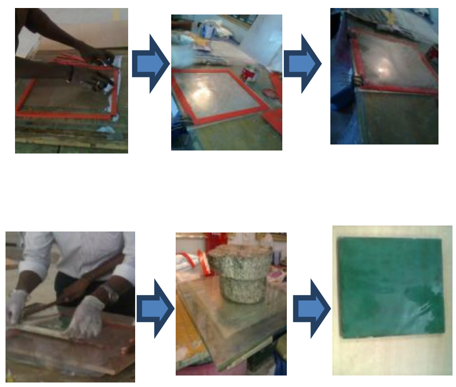

Fig-2 Steps involved in fabrication of composite

III. RESULT AND DISCUSSION

Effects of the surface modification on the tensile properties, compressive strength and impact strength of the composite are compaired. Percentage difference (10%, 20% and 30%) of fiber loading also shows effect on the properties of the composite.

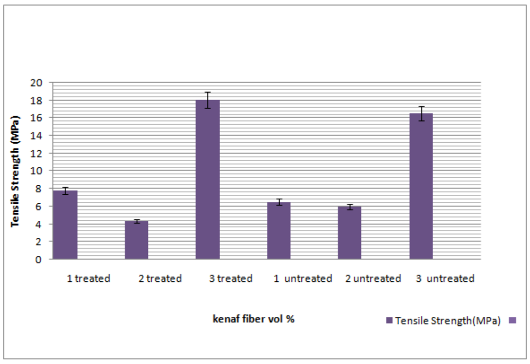

Fig-2 Effects of Tensile strength for variation in fiber parameters

A. The Effects of Tensile Strength for Variation in Fiber Parameters on the Composite

The Tensile strength can be refered as the objection that is found in the material to offer itself to be broken when there is pulling action. The effects of the tensile strength on loading of fibers on different volume percentage of treated and un treated kenaf fiber for the composite is shown in Figure 2. From the observations, the strength varies with different composition and it shows slight improvement in the values of strength. This is due to the percentage increase of treated fibers in the composite.

The tensile properties shows that there is better fiber interation when they are treated with potassium permanganate. The fiber adhesion with the matrix have favoured the improvement of the tensile strength of the material. Higher volume percentage of fiber and treatment, when measured showed peak tensile strength improvements within the material. Better values were found for the composite material tensile strength. It is found to better at treated and 30% loading of fiber condition, which is evident from fig-3 SEM image showing better fiber interaction and matrix interface.

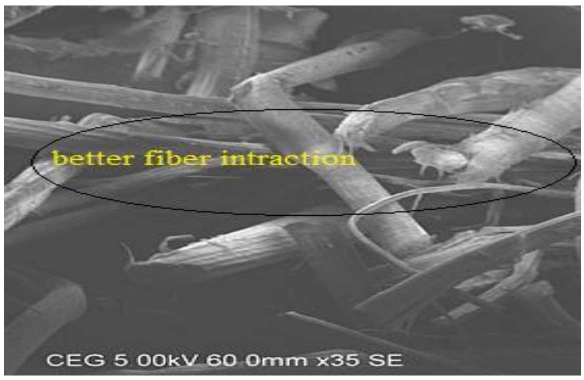

Fig-3 fractured specimen SEM image of treated fiber and matrix better interaction

B. The Effects of Flexural Strength for Variation in Fiber Parameters on the Composite

Flexural strength is defined as the opposing force to the bending of material when load is applied. Figure 4 shows the benefits of loading of fiber and length of fiber on the samples. Test is done with a rate of 1mm per minute speed and the load is applied to the sample gradually until the failure. The strength of the composite increases with additional loading of fiber. The bonding strength between the reinforcement and resin is good relatively because of the increase in the addition of fiber content in the material. Treated Fiber loading favours the improved distribution of Flexural strength, that may be seen in the chart. The higher matrix in the lesser fiber loaded samples has favoured the load to be insufficiently distributed to the reinforcement in the composite.

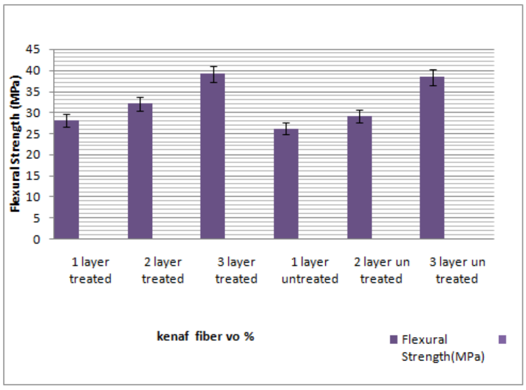

Fig-4 Effects of Flexural strength for variation in fiber parameters

Lesser volume of fiber has not paved way for stresses, due to the uneven load transfered from the resin matrix and poor bonding interface. The fiber pull out condition introduces empty spaces in fractured composite material, that is between the resin matrix and the reinforcement thus leading to a weaker structure. This is evident from figure 5 SEM image.

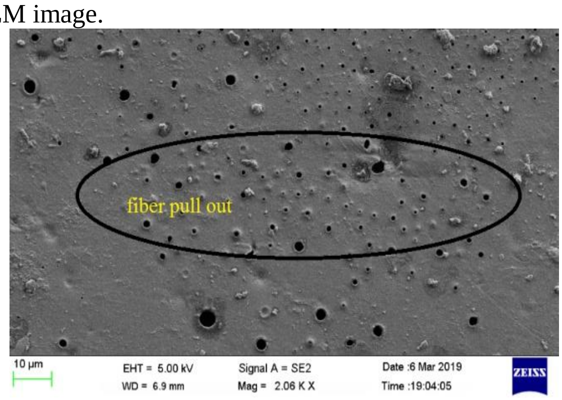

Fig-5 SEM image of fractured specimen fiber pull out condition

Table- I: Mechanical Strength of the Composite

S.No	Mechanical Strength		
	Details of the Properties	***Treated***	***Un-treated***
1.	Tensile Strength (Mpa)	6.67	6.43
		4.42	6.05
		18.01	16.48
2.	Flexural Strength (Mpa)	28.10	26.04
		32.17	29.30
		39.22	38.91
3.	Impact Strength (J/m^2)	3518	3411
		3765	3924
		3589	3797

C. The Effects of Impact Strength for Variation in Fiber Parameters on the Composite

It refers to the capability with which the material can under go shock absorbtion. This is entirely associated with the toughness of the composite material. The influence of loading of fiber on impact strength of composites is shown below in Figure 6.

Slight variation are seen in the impact strength of the material. This change occurs due to induced micro pores between the reinforcement and resin matrix. While impact test is conducted, numerous micro cracks develop. Propagation of crack is possible and it happens easily and thereby lowering the strength of the material.

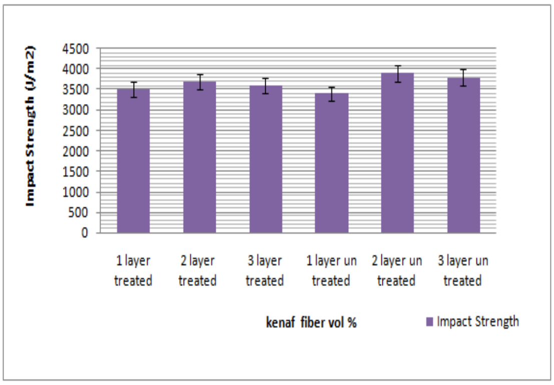

Fig-6 Effects of Impact strength for variation in fiber parameters

Addition of fiber in the composite does make few changes in the impact strength of the material. Contribution of the fiber had shown variation with treated and untreated fibers. Hence it is more evedent that matrix is not able to transfer the load to its fibers in the distribution.

IV. CONCLUSION

Hand layup method was adopted for the fabrication of epoxy resin matrix and Kenaf fiber reinforcement. The study was conducted for mechanical strength and results were observed. The following details are the conclusions obtained for the work.

1. Sucessfull fabrication of natural fiber reinforced epoxy resin based composite material was done.
2. The mechanical properties such as tensile, flexural, and impact strength shows improvement of the composites.
3. The fiber composite's average values of tensile strength doesnt show any change in lower loading of fiber, as shown in the table-I. Maximum value is observed in the higher fiber loading and this is because of the fiber matrix interaction within the composite. The treated sample is 9.28 percentage greater than the untreated samples at 30% loading favouring better strength.
4. The treated sample flexural strength is 7.91 and 9.79 percentage higher than the untreated sample at 10% and 20% fiber loadings. This is because at 20% fiber loading the matrix fiber interaction is good, above this percentage the addition of fibers have favoured the crack propagation on distribution of load, so it shows a very little change.
5. Resin matrix and reinforcement bonding in the material has favoured the improvement of the properties of tensile and flexural cases. But exceptionally in analysing the flexural strength, fiber pull out may be reason for the lower difference values at lesser fiber loadings. Variations in the impact strength is due to the micro pores that induces the crack propagation, delevoping earlier failure of material on impact.
6. The treatment of potassium permanganate on the Kenaf fibers has highly influence the behavioural properties of composite material. This work presents that there is improvement in the properties when there is increase in fiber loading and the treatment of the fiber.

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