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Fabrication and analysing the mechanical properties of Kenaf fibre mat reinforced composites

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ABSTRACT

Natural fibres have recently become attractive to mechanical and automobile industry as an alternative reinforcement for glass fibre. Their availability, renewability and eco-friendly as well as satisfactory mechanical properties make them an attractive reinforcement material. This project highlights the behaviour of Kenaf reinforced composites and laminates are fabricated by hand-layup method by using epoxy, polylite and isopthalic resins as matrix phase. The fabricated specimens are cut down as per ASTM standards. The specimen samples are subjected to tensile and flexural test. The results are compared to show which Kenaf resin based composite possess better mechanical properties.

KEY WORDS: Kenaf fibre mat, epoxy, polylite, isopthalic, reinforcement.

1. INTRODUCTION

The natural fibres have become alternative reinforcement for fibreglass reinforced thermoplastics for their renewability, availability, eco-friendly in many automobile and manufacturing industries. However, it also possess better mechanical properties if the fibres are arranged in a form of a sheet, known as fabric, to make handling possible. The fibre orientation can be assembled in various directions, which leading to different fabric types, which has its own characteristics. Fibre diameter plays a major factor here with more extensive smaller interfacial loads, as a general rule the stiffness strength of a laminate will increase the proportion to the amount of fibre present. Kenaf is one of the natural fibres used as reinforcement in Polymer Matrix Composites (PMC). Kenaf fibre is utilized as reinforcement for polymeric composites as an alternative to fibreglass. The kenaf bast fibre is known to have the potential as reinforcing fibre in thermoplastic composites, because of superior toughness and high aspect ratio with the comparison to other fibres. A single Kenaf fibre can have tensile strength and modulus as high as 11.9 GPA and 60 GPA respectively.

2. METHODS & MATERIALS

Experimental procedure: The kenaf fibres subjected to a water retting process involving soaking kenaf stems in water for a period of 6 to 10 days depending upon the maturity of the crop at that time of harvesting, the temperature of water and the types of micro-organisms present time before extracting the fibres ripening of kenaf plant are shown in Fig.1. Retted bundles are uprooted and the bark is removed for upward direction. The kenaf strips were gently beaten with a mallet and rinsed in water repeatedly to separate the fibres from adhering tissue. The clean fibre is washed and dried in the sun to remove the moisture complete and made into bundles. To improve Fibre-matrix interface adhesion and many chemical modifications of the fibre and one of the familiar and effective modifications applied to kenaf fibre were, an alkaline treatment based on 6% sodium hydroxide (NaOH) is performed. The extracted and separated fibres are shown in fig.2. The fibre strands prepared are cut down into fibres of each length 50 cm and converted as bidirectional mat by handloom process such that the length and width of the stitched mat is 100cm and 50cm respectively. From the stitched mat piles of cross-section 30x30 cm are made. The stitched mat is shown in fig.3.

Figure.1. Ripened Kenaf Plant

Figure.2. Treated Kenaf Fibre

Figure.3. Bidirectionally stitched Fibre mat

Figure.4. Fabrication of Laminate

Fabrication of Laminate: Laminates were fabricated with 3 layers of ply arranged in same orientation using Hand Layup technique in room temperature and curing time depends on the type of resin used. Resins are spread using roller across fibers which are in the form of stitched fabrics. The process is shown in the above fig.4. The three different types of laminate were prepared, for Epoxy LY 556 2% of Hardener HY 951 is used. For Isopthalic Polyester and Polylite Resin were taken along with 2% catalyst-Methyl Ethyl Ketone Peroxide (MEKP) and accelerator-Cobalt octoate. For preparation of laminates the resin and fibre where taken in the weight ratio of 20:1 respectively taken for the laminate. The resin where evenly distributed over laminate in the mould by hand layup method. The top base plate that was already applied to the wax and poly vinyl alcohol (PVA) is placed on the laid resin and a weight of around 500N is placed on top for about 24 hours. Various test specimens were cut down from the prepared laminate as per the ASTM standard as shown in the Table.1 by switch board cutting machine. The specimen samples for flexural and tensile testing are shown below in fig.5 and 6.

Table.1. ASTM Standard for Plastics

Mechanical Test	ASTM Standard	Length (mm)	Width (mm)
Flexural	D-790	127	13
Tensile	D-3039	300	25
Impact	D-256	63	13
Hardness	D-2240	120	13
Shear	D-2344	150	25

Fig.5.Tensile test Specimens

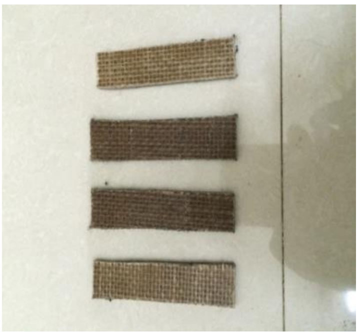

Fig.6.Flexural test Specimens

3. EXPERIMENTAL RESULTS AND DISCUSSION

Tensile Testing: Tensile test specimens were prepared according to ASTM D-3039. Each specimen was loaded to failure. The testing machine is shown below in fig.7. The load-displacement curve was plotted automatically by the equipment software. The ultimate tensile strength and ultimate tensile load of the samples were after that determined from the following plot. The results are plotted in the form of graph as shown below in fig.8.

Figure.7.Tensile Test Machine with Specimen

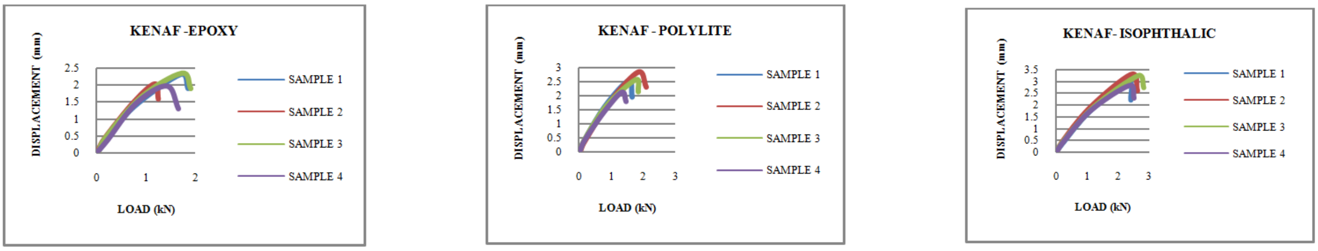

Figure.8.Displacement vs Tensile Test Load for (a) Kenaf/Epoxy Composite (b) Kenaf/Polylite Composite (c) Kenaf/Isophthalic Composites

Flexural Testing: Flexural strength was done by three-point loading system as shown in fig.9 and 10. As described in ASTM D790 specimen were prepared, three-point loading system applied on a supported beam was utilized. The results obtained are plotted in the form of graphs as shown in fig.11.The comparison results of tensile and flexural test results were shown in Table.2.

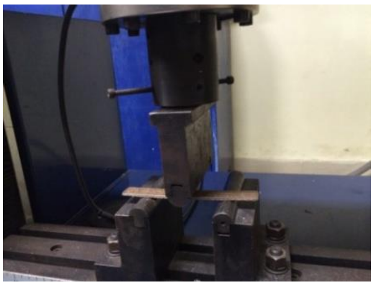

Figure.9. Flexural Test Machine

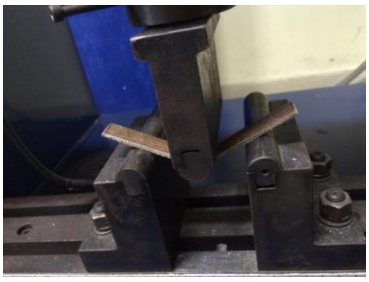

Figure.10. Laminate undergoes three point bending

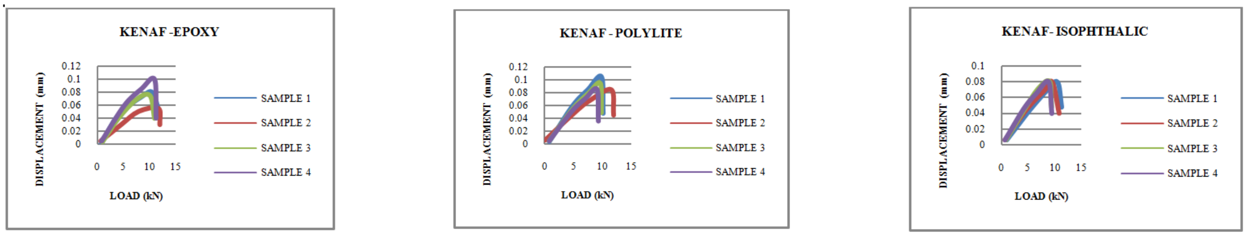

Figure.11.Displacement vs Flexural Tensile Load for (a) Kenaf/Epoxy Composite (b) Kenaf/Polylite Composite (c) Kenaf/Isophthalic Composites

Table.2.Comparison of Results of Tested Sample

Mechanical Properties	Sample	Epoxy (Mpa)	Isophthalic (MPa)	Polylite (MPa)
Tensile Strength	1	37	59	50
	2	35	56	56
	3	43	52	50
	4	46	54	44
Flexural Strength	1	64.70	89.27	93.17
	2	63.19	85.56	75.79
	3	69.44	79.27	86.54
	4	84.34	75.57	82.06

Impact Testing: The impact test specimens were prepared according to ASTM D256. The energy absorbed by the material can be found by comparing the differences in the height of the hammer before and after the fracture. The Impact Strength of Epoxy, Polylite and Isophthalic resins are shown in Table.3.

Table.3. Impact test results

Mechanical Properties	Sample	Epoxy (J)	Isophthalic (J)	Polylite (J)
Tensile Strength	1	2	1.8	2.5
	2	2.2	2	2.6
	3	1.9	2.1	2.7
	4	2.1	1.9	2.6

Shore D Hardness: The two most common durometer scales used are Type A and D. Type A scale is for soft polymer materials and Type D scale is for harder ones. Hardness is the material's resistance to permanent indentation. The shore D hardness of Epoxy, Polylite and Isophthalic resins are 82, 80 and 81 respectively.

Shear Lap Testing: Shear Lap Testing is a test used to measure the shear strength properties of material. The induced strain is recorded at constant interval for the applied load to determine the stress-strain curve for each confining stress. The results of the tests on each specimen are plotted along the graph confining stress along x-axis and the peak (or residual) stress on the y-axis as shown in fig. 12.

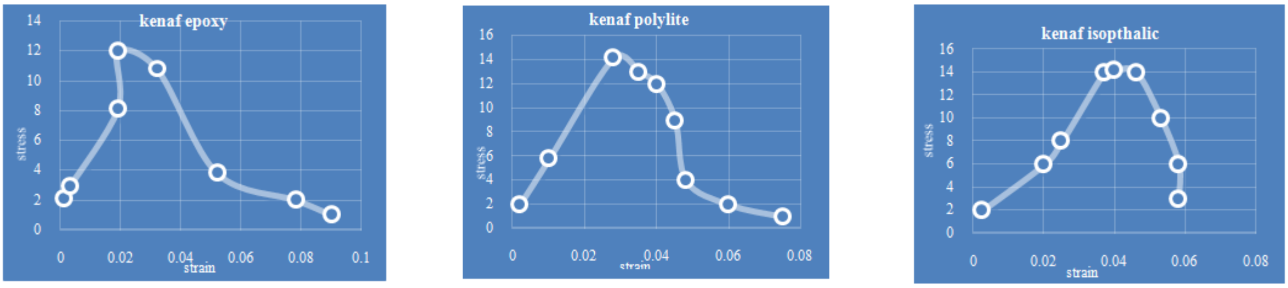

Figure.12.Stress vs. Strain for Shear Lap Testing of (a) Kenaf-Epoxy(b) Kenaf-Polylite (c) Kenaf-Isophthalic

4. CONCLUSION

From the graph below fig.13 the tensile and flexural strength of Epoxy, Polylite and Isophthalic resins are compared. It shows that "Isophthalic" resin based laminate fabricated by Hand Layup method possess a tensile strength of 59MPa than that of Epoxy 46MPa and Polylite 56MPa. The Flexural Strength of Epoxy, Polylite and Isophthalic resins are 84.34Mpa, 86.54MPa and 89.27MPa respectively. It shows that Isophthalic resin-based composite also possesses better flexural strength. From the above results shown in Table.2 infers that Kenaf/Isophthalic composite possess better mechanical property comparing to other and also the bidirectional mat shown the better results.

Fig.13.Comparison of Epoxy, Isophthalic and Polylite Resins (a) Tensile Strength (b) Flexural Strength

REFERENCES

Akil, HMl MF, Omar AAM, Mazuki SZAM, Safiee ZA, Mohd Ishak and Abu Bakar A, Kenaf fiber reinforced composites, A review, Materials & Design, 32(8), 2011, 4107-4121.

Chen Y, Chiparus O, Sun L, Negulescu I, Parikh D.V and Calamari T.A, Natural fibers for automotive nonwoven composites, Journal of Industrial Textiles, 35(1), 2005, 47-62.

Cheon, Seong Sik and Tae Seong Lim, Impact energy absorption characteristics of glass fiber hybrid composites, Composite Structures, 46(3), 1999, 267-278.

Jeyanthi S and Janci Rani J, Improving mechanical properties by kenaf natural long fiber reinforced composite for automotive structures, Journal of Applied Science and Engineering, 15(3), 2012, 275-280.

Khalina, Abdan, Edi Syams Zainudin, Abdul Rahman Mohd Faizal H, Jalaluddin A. H, Umar and W. N. W. N. Syuhada, Development of biocomposite wall cladding from kenaf fibre by extrusion molding process, In Key Engineering Materials, 471, 2011, 239-244.

Kumar K.K, Babu P.R and Reddy K.R.N, Evaluation of flexural and tensile properties of short kenaf fiber reinforced green composites, International Journal of Advanced Mechanical Engineering, 4, 2014, 371-80.

Mohanty A.K, Misra M and Hinrichsen G, Biofibres, biodegradable polymers and biocomposites, an overview, Macromolecular materials and Engineering, 276(1), 2000, 1-24.

Rajasekaran T and Vigneshkumar S, Comparative study on the mechanical testing of fiber reinforced polymer composites, Journal of Chemical and Pharmaceutical Sciences, 9, 2016, 657-660.

Taib, Mohammad, Mohamad Nurul Azman, Mohd Ariff Jamaludin, and Masitah Abu Kassim, Flexural properties of bio-composite made from hydrothermally treated kenaf (Hibiscus cannabinus) fibres, In Advanced Materials Research, 535, 2012, 2409-2412.