EVALUATION OF MECHANICAL PROPERTIES OF KENAF BASED HYBRID COMPOSITE FOR AUTOMOTIVE COMPONENTS REPLACEMENT

C. Elanchezhian, B. Vijaya Ramnath, Kaosik R., Nellaiappan T. K., Santhosh Kumar K., Kavirajan P. and Sughan M. U.
Department of Mechanical Engineering, Sri Sairam Engineering College, Chennai, Tamil Nadu, India
E-Mail: elanchezhian.mech@sairam.edu.in

ABSTRACT

Tremendous growth of science and technology over the past few decades demands a new and hybrid material to meet variety of purposes. Composite materials are one among those new emerging engineering material which plays a major role in auto motive parts. Thus our project is based on valuating the mechanical properties and behavior of kenaf, banana, and neem fibres as hybrid composites which in case proposed for automotive components. These three were the dispersed phase and the epoxyresinas the matrix phase. We chose kenaf as the main reinforcement material as it does have promising properties on impact and tensile which are the most important while considering automotive components. The samples were made by using hand layup technique which is the conventional way of producing hybrid composites. Three samples were made. The first sample was made with kenaf fibre/ GFRP, another was with kenaf and banana fibres and the third was with kenaf and neem fibres. Thus the mechanical properties and behaviors of these samples were identified by Tensile, Impact, Flexural and Hardness tests and these properties were compared with existing automotive component properties.

Keywords: natural fibers, kenaf, neem, banana fibers.

1. INTRODUCTION

There are some materials that can be used as a replacement for glass. These materials include abaca, banana, neem, Jute, Ramie, pineapple leaf, and kenaf. Certain materials have some interesting features such as low density, high toughness, comparable specific strength properties, reduction in tool wear, ease of separation, decreased energy of fabrication. Kenaf, abaca, flax are considered as bast fibre composites and sisal is known as leaf fibre. The same flexural strength is shown by the bast fibres in comparison with glass fibres. These fibres can be used as an alternative to traditional materials as they have many attractive properties. The Natural fibres are biodegradable, renewable and are also abundantly available. These fibres mainly consist of cellulose, lignin and pectin. These characteristics of natural fibres vary with their types. These variations are based on the growing and harvesting methods the natural reinforced composite fibres are strong, non-hazardous, low weight. So, it can be used as an alternative material which can be used for buildings, shipping, automobiles, etc. Even though the natural fibres have several advantages, they carry some restrictions such as pitiable resistance to moisture especially absorption and low strength compared to synthetic fibre such as glass [1]. Kenaf fibreis obtained from stems of plants called genus Hibiscus, from Malvaceae family and H. cannibinus species. Kenaf fibre requires only less amount of water for growth as it has growing period of 150 to 180 days with average yield of 1700kg/ha [2]. The Asian countries are mostly exposed to areas with high moisture. In old enperiods, moisture was absorbed by all types of natural fibres, on exposure to humid atmosphere. Itisdue to the hydrophilic character of the fibre and hence it is very responsive to water, resulting in variation its properties. The moisture polymer chains of composites material consist of micro gaps which holds up the moisture inside it [3]. The other methods are capillary transportation in to the gaps and interfacial flaws between polymer and fibres. The properties of Kenaf fibre reinforced composite shows the highest reduction rate in tensile modulus when immersed in sea water, than fibres dipped in distilled water and in rain water at room temperature [4].Theoretically, the reduction pattern shows better ductile properties due to the constraint in the movementofpolymermolecules,aftertheimmersionprocess. Themobilityofthe deformed polymer molecules are constrained by the reinforcing fibres introduction, and the tensile modulus is also increased but decreases the visco elastic lag between the stress and the strain. For immersed kenaf fibrere in forced composite the reduced value of tensile modulus, may be due to the scratched matrix, decreased bond strength, between matrix and fibre[5].The water molecule when enter sin to the polymer, the plasticization and hydrolysis of the matrix will break the bonding and also chemical combinations. Hence the interfacial bonding strength reduces resulting in a lower tensile modulus[6].Kenaf fibres are cultivated more in areassuchasIndia,Thailand,andBangladesh,partsofAfrica,andsoutheastEurope.The fibreis used extensively in paper, coarse cloth, twine and rope. But, to be used as an alternative reinforcement for polymers there is demand for this fibre [7]. Also, kenaf fibre is getting more popular in Malaysia and became the best fibre for applications which included the automobile industries. As Malaysiais

VOL. 10, NO. 13, JULY 2015 ISSN 1819-6608
ARPN Journal of Engineering and Applied Sciences

planning to decrease the usage of non-degradable products, kenaf is the one best [8]. The properties of jute - abaca and jute-banana glass fibre reinforced epoxy composite shows that banana hybrid composite has better tensile modulus.[9, 10].A number of methods have been applied to get improved inter-laminar bonding effect[11-12]and consequently to acquire superior quality of mechanical or hydrophobic properties[13-14]. To get better mechanical properties of the natural fibres including hemp, jute and neem a variety of chemical treatments have been used by many researchers [15- 19].Hemp, sisal and jute fibres were treated with various concentrations of NaOH and found out that 7% was the most favorable concentration for cleaning the bundle surfaces of fibres and maintaining a high index of crystal inity [16]. Properties such as flexur almodulus, flexural strength, strength modul us and impact strength can be improved by alkalizing the kenaf fibres [17, 18]. Banana-flax hybrid composites shows better mechanical and thermal properties when compared to abaca flax composites [20, 21 and 22].

2. MATERIALS

We preferred Natural fiber materials for composite fabrication as it is bio-degradable and eco-friendly and it has specific properties which could be used in automotive component replacements such as carhood and mudguard.

a) Kenaf fibre

The cultivation of kenaf fibres in India and also in Asian countries are increasing because of its usage in automotives. The major constituents of kenaf are cellulose (44_67wt. %), hemicelluloses (20.9wt. %), lignin (7.5-14wt. %), and pectin (2-6wt. %). We preferred Kenaf fibre as the base fibre for the hybrid composites inceith as promising Impact and tensile strength which makes it applicable in various components in automotive industries.

b) Neem fibre

The Neem fibre has high potential as are inforcing fibre in polymer composites. Neem treeisa common home and office house tree that can reach an altitude of 10-25 meters. Various Physical properties of Neem tree fibreare Reddish brown, durable wood, easy to work and a pest resistant. Their versatility is based on the following desirable material properties such as very good mechanical properties, mainly tensile modulus, thermal, acoustic and low abrasive nature.

c) Banana fibre

Banana fibres are obtained from the stem of banana plant called as Musasapientu. Banana fibre when mixed with glass shows better properties for producing low cost composite materials. The tensile strength of the fibre reinforced polymers can be increased by hybridizing at 19% fraction of reinforcement.

d) Resin

For the fabrication of the composite, Epoxy resin (ARALDITE LY 556) and hardener (HY 951) is used in this work. The resin and hardener mixture is taken in the ratio of 10:1 which provides the adequate interfacial bonding between fibers.

3. FABRICATION PROCEDURE

Initially, the glass fibre is cutin to a number of plies of size 300 x 300 mm. In the to pand botto mayer of the laminate glass, fibre is placed. The fibre strands are rolled to increase the surface smoothness and it also pretreated to minimize the absorption of moisture and to raise the surface properties. Epoxy resin is applied uniformly between each layer of the fibres which act as adhesives. Natural fibre weighing around 20-35 grams is spreading the resin applied glass fibre. The curing time of 5-6 hours is provided forth eloped bottom structures to achieve better strength. The resin and hardener mixture is applied and rolled for each layer and the resin is dried within 10 to 25 min and thereby avoiding drying of epoxy resin. After that a curing time of 4-7 hours is provided for the top and bottom layers to achieve good strength. The required composite materials can be obtained by applying a load (10-20 kg) for a period of 11 – 16 hours. In Kenaf-glass composite, Kenaf-neem-glass composite and Kenaf-banana-glass composites the plies are aligned in the array of intermediate glass fibres and natural fibres which constitutes totally of 7 plies. For example, inkenaf-neem-glass composite it consists of 1 ply of kenaf, 4 plies of glass and 2 plies of neem are aligned.

4. TESTING PROCEDURE

a) Tensile test

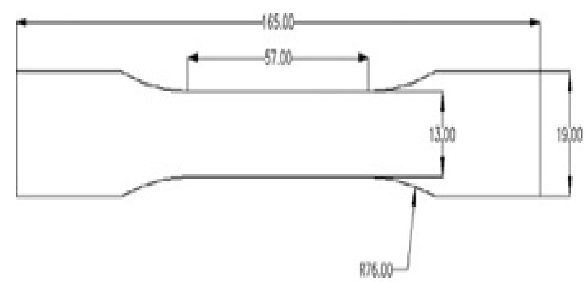

Figure-1. Tensile test specimen [ASTM: D638].

The tensile test is done by subjecting the composite specimen to cutting process as per ASTM: D638 standard as shown in fig 1. The testing uses universal testing machine (UTM) to determine the tensile strength. Three composite specimens with different fiber orientation are tested. The specimen is placed in the gripper of UTM and load is applied until the specimen breaks. Break load, ultimate tensile strengths and displacements are recorded and Stress Vs strain graph is generated.

VOL. 10, NO. 13, JULY 2015 ISSN 1819-6608
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b) Flexural test

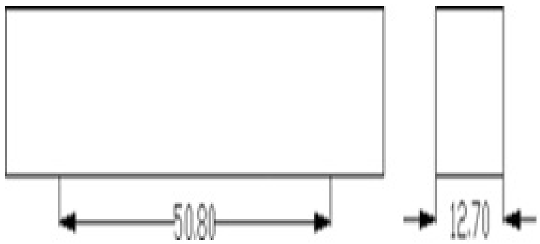

Figure-2. Flexuraltest specimen [ASTM: D790].

The values for the modulus of elasticity in bending, flexural stress, and flexural strain can be obtained by the flexural test. The Flexural test is done in a three point flexural setup as per ASTM: D790 standard and schematic diagram of the test specimen is shown Figure-2. Sampleispositionedontwo support in gainsaid loading is made from the to pata constant rate. The loading is continued until the sample fails. Hence the maximum stress in the outer most fibre is called as the flexural strength.

c) Impact test

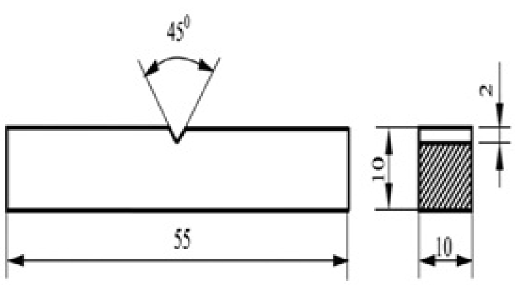

Figure-3. Impact test specimen [ASTM: D256].

The total energy absorbed by a specimen during fracture is found by the Charpy Impact test. The test is done accordingtoASTM:D256 standard as shown in the figure 3.This test is done by arranging a notch and pendulum is allowed to drop over it to create an impact on it.To evaluate the relative toughness or impact toughness of materials, this is one of the commonly used methods.

d) Hardness test

Shore D hardness test determines the hardness of composite specimen based on indentation hardness of a material. Hardness is defined as the resistance offered by the material to permanent indentation. Shore D hardness is also called as Shore Durometer. The test is done by cutting the natural composites specimen as per ASTM: D2240.

5. RESULTS

a) Tensile test

The tensile tests are conducted asper ASTM: D638 and ithas been found that the three layered kenaf sample showshighest tensile strength other than the2 samples.

Table-1. Tensile modulus of samples.

Sample	Break load (kN)	Maximum Displacement (mm)	% Elongation	Tensile Strength (MPa)	Tensile Modulus (MPa)
Kenaf+Kenaf+Kenaf	6.12	5.75	11.5	63.63	555.30
Banana+Kenaf+Banana	7.38	6.05	12.1	55.47	458.43
Neem+Kenaf+Neem	7.17	5.875	11.75	57.62	490.38

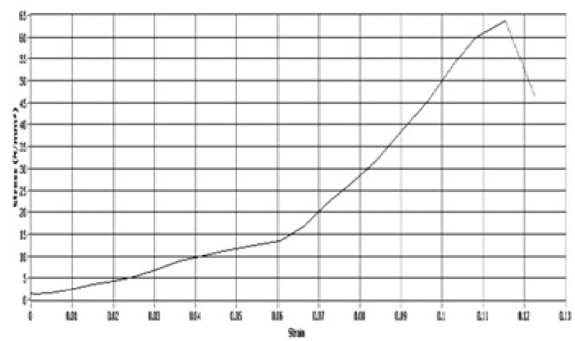

Figure-4. Stress- Strain graph of Kenaf+Kenaf+Kenaf sample.

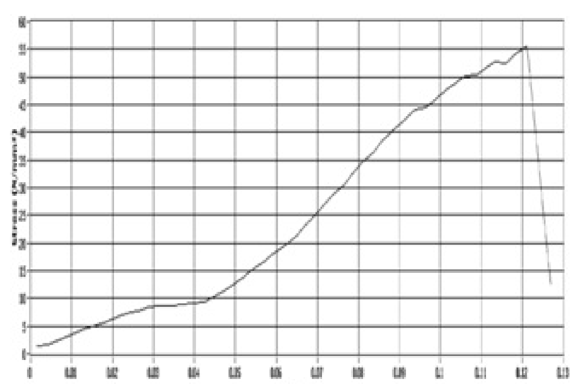

Figure-5. Stress - Strain graph of Banana+Kenaf+Banana.

VOL. 10, NO. 13, JULY 2015 ISSN 1819-6608
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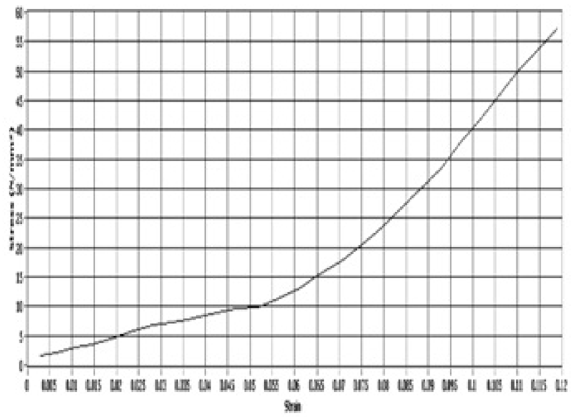

Figure-6. Stress - Strain graph of Neem+Kenaf+Neem.

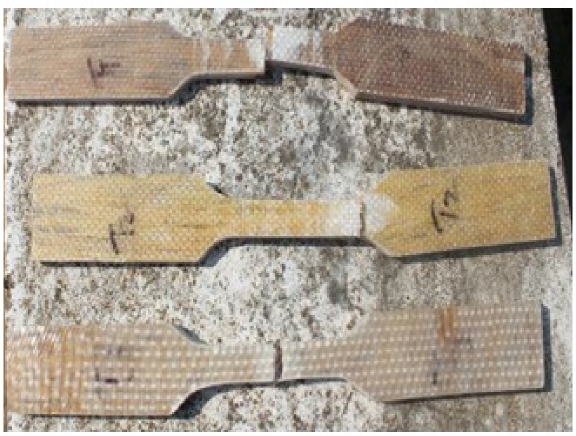

Figure-7. Tensile tested specimens.

b) Impact test

In impact test the Kenaf-banana based composite shows maximum impact energy and this ensures maximum of up to 12J of energy which was conducted using charpy impact test based on ASTM: D256.

Table-2. Impact energy of specimens.

Sample	Impact energy(J)		
Kenaf+Kenaf+Kenaf	4	4	4
Banana+Kenaf+Banana	4	12	6
Neem+Kenaf+Neem	10	8	8

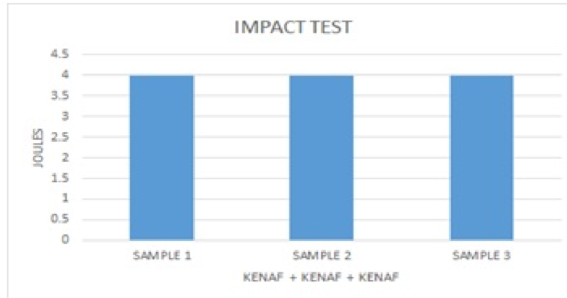

Figure-8. impact graph specimen-1.

Figure-9. Impact graph specimen-2.

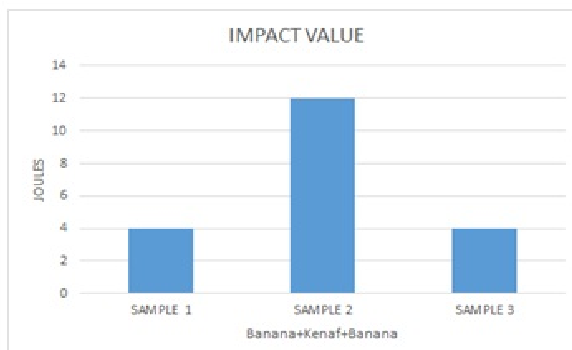

Figure-10. Impact graph for specimen-3.

Figure-11. Impact tested specimens.

c) Flexural test

Table-3. Flexural strength of specimen.

Sample	Break load (kN)	Maximum Displacement (mm)	% Elongation	Flexural Strength (MPa)	Flexural Modulus (MPa)
Kenaf+Kenaf+Kenaf	1.67	3.75	3.75	167.28	4460.8
Banana+Kenaf+Banana	1.87	5.1	5.1	187.32	3280
Neem+Kenaf+Neem	2.20	8.75	8.75	220.37	1191.77

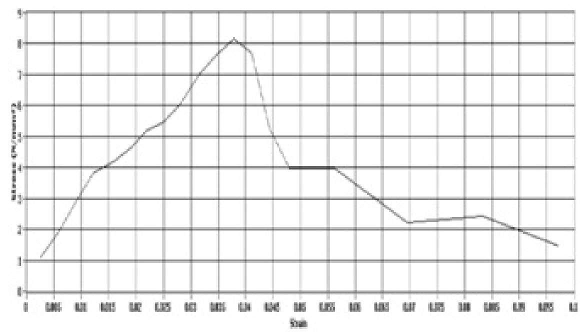

Figure-12. Stress - Strain graph of Kenaf+Kenaf+Kenaf.

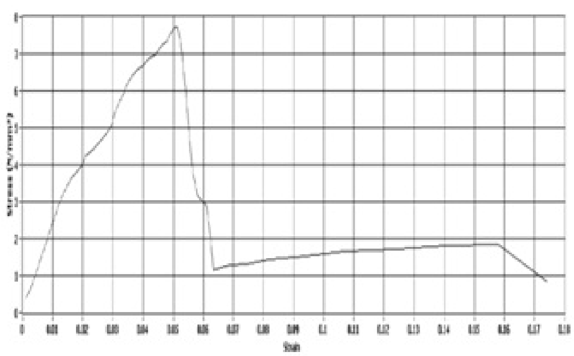

Figure-13. Stress Strain graph of Banana+Kenaf+Banana.

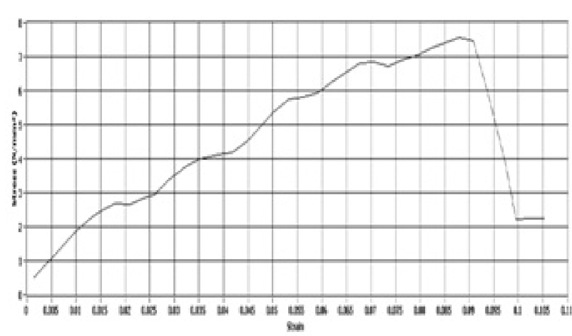

Figure-14. Stress Strain graph of Neem+Kenaf+Neem.

Figure-15. Flexural tested specimens.

d) Hardness test

Table-4. Hardness values of specimens.

Sample	Hardness		
Kenaf+Kenaf+Kenaf	72	73	73
Banana+Kenaf+Banana	70	72	75
Neem+Kenaf+Neem	75	73	74

6. CONCLUSIONS

The kenaf based composite fabricated, shows high flexural strength and hardness and it can be used in automotive components such as car hood and mud guard. The composite thickness is high as we used handlayup technique for fabrication. Smaller thickness would fullfil the application in wide components in automotive field which can be achieved through compression moulding technique. Kenaf – kenaf hybrid composite shows high tensile strength in comparison kenaf-neem hybrid composite shows high flexural strength, hardness and impact energy.

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