REST Journal on Emerging trends in Modelling and Manufacturing
Vol: 6(4), 2020
REST Publisher
ISSN: 2455-4537

Website: www.restpublisher.com/journals/jemm

A Review on Kenaf Fiber Reinforced Polymeric Composite

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Abstract

The kenaf composite fabrication involved three types of polymers, which were polypropylene, polylactic acid, and epoxy. Through this process, the kenaf composite made of epoxy resin was the most promising composites materials as it exhibited excellent flexural strength at 180 MPa. The development of high-performance engineering products made from natural resources is increasing worldwide, due to renewable and environmental issues. Among the many different types of natural resources, kenaf plants have been extensively exploited over the past few years. Therefore, this paper presents an overview of the developments made in the area of kenaf fiber reinforced composites, in terms of their market, manufacturing methods, and overall properties. They kenaf composites are many type of testing in Impact test, Tensile test, Flexural Strength test.

1.Impact test

The results also showed that the optimal value to obtain the highest impact strength for kenaf bast and core fiber composites were 10%wt and 5%wt respectively. Results show that when bast was considered it gave maximum impact strength in kj/m2 at 10% which was above 30. Till 10% it keeps on increasing and then it decreased but when considered Core, it gave the maximum of 28 KJ/M2 on 5% itself. Till 5% it kept on increasing after which it decreased [2]. When compared to PP, vetiver–PP composites exhibited lower impact strength On the other hand impact strength decreased with increasing vetiver content. Both the notched and the unnotched Izod impact strengths were almost the same with the addition of compatibilizing agent. Charpy unnotched, and notched impact strength are 80 MPa, 3.5 GPa, 85 kJ/m2, and 12 kJ/m2, respectively. A high impact resistance level is maintained also at low temperatures where the matrix material becomes brittle. For the other matrix materials, similar reinforcing effects are observed, except for the impact behavior of HIPS, where the reinforcing fibers interfere with the impact modification of the matrix polymer. In contrast, the impact characteristics of PLA are drastically improved increasing the unnotched and notched Charpy strengths by 380% and 200%, respectively [3]. The impact test samples are prepared and tested according to the ASTM: D256-10. The charpy test was performed on five samples using pendulum impact tester. Charpy impact test was conducted to analyse the effect of woven fiber layering sequence on the energy absorption capability of the hybrid composites. The absorbed impact energy (Joule) is the total energy required to fracture the specimen. It is determined from the difference in potential energy before and after the test. The toughness of composite or impact strength (kJ/m2) was calculated by dividing the recorded absorbed impact energy with the cross-section area of the samples. The results from charpy impact test kenaf-Kevlar hybrid composites are clearly observed that hybrid composites have similar response in term of impact energy and toughness. Lower impact energy and impact toughness for sample A/k/A/k* where the kenaf surface was subjected to load, may be due to failure process including crack initiation and growth, fiber breakage and delamination in kenaf impacted surface. In 3-layer hybrid laminates, the sample with Kevlar at the middle opposed the impact load better than the sample with kenaf layer at the middle. The effect of chemical treatment was observed in sample k/ET. Treated sample (k/ET) has slightly lower impact energy absorption compared with the treated sample. No change observed in impact toughness compared to non-treated sample kenaf /epoxy (k/E) [8]. Thermoplastics when combined with short natural fibers less of impact strength is usually observed Strain of the composite also plays a major role in the impact strength. It is observable that strain is decreasing with increase of fiber loading. Hence, impact strength is also decreasing with increase of fiber loading. Impact strength deteriorated with increase in fiber loading. It can be said that 30% fiber loading is the optimum fiber loading, because it exhibited the best tensile strength, and it showed negligible decrease in impact strength compared to 20% fiber loading [10]. impact strength for TPNR–kenaf composite and PP/EPDM–kenaf fiber composite with and without MAPP. A slight increment can be seen for TPNR–KF composite. A drastic change however can be seen for PP/EPDM–KF composite where the impact strength improved by about 136% for treated composite as compared to unreinforced matrix. A strong interfacial adhesion between the matrix and the fibers will reduce polymer mobility and prevent fibers pull-outs from the matrix. Hence, the treated composite will have required more energy to failure due to good interaction between kenaf fiber and both matrix systems. kenaf fiber has greatly enhanced the impact strength for both types of composite [14].

2.Tensile test

Tensile tests were performed according to ASTM D 638 specification Tensile strength varies as its composition varies when kenaf is 10% tensile strength is 40Mpa when kenaf is 20% the strength is 41Mpa when kenaf is 30% the tensile strength is 45Mpa when kenaf is 40% the tensile strength is 47Mpa. Hybridization can improve the mechanical properties of natural fiber plastic composites. The results of the present study confirm that it is possible to enhance such properties by adding longer fibers (such as kenaf) to wood flour plastic composites. Both tensile modulus and tensile strength were improved when kenaf fibers were added to the wood flour/PP system [1]. Tensile tests were performed according ASTM D5083 specification in a nutshell, the composites reinforced with kenaf bast fibers are found to have higher tensile strength than kenaf core fiber composites. The results showed that the optimum fiber content to obtain the highest tensile strength and for both kenaf bast and core fiber composites were 20%wt. It also has been observed that the elongation at break for both composites decreased as the fiber content increased. It can be concluded, the higher cellulose content, the smaller fiber diameter and the longer fiber significantly increase the mechanical properties of the composite. Tensile strength of kenaf bast and core fiber reinforced unsaturated polyester composites for with 5% bast kenaf fiber tensile strength is 11Mpa, 10% bast kenaf fiber tensile strength is 15.32Mpa for 20% bast kenaf fiber tensile strength 19.8Mpa for 30% bast kenaf fiber tensile strength is 16Mpa and for 40% bast kenaf fiber the tensile strength is 9MPa. So from the data it is said that the tensile strength is maximum at 20%. For core kenaf fiber when the composition is at 5% core kenaf fiber the tensile strength is 10Mpa for 10% core kenaf fiber tensile strength is 11Mpa for 20% core kenaf fiber the tensile strength is 16Mpa for 30% core kenaf fiber the tensile strength is 7Mpa and for 40% core kenaf fiber the tensile strength is 1Mpa.The samples were prepared according to tensile test with dimension of (10 x 1.2 x 0.5) cm. Eight replicates were prepared for tensile testing with accordance to ASTM D3039 with cross head speed of 2mm/min and gauge length of 5cm using Gotech Testing Machine. Generally, the addition of kenaf fiber had improved the tensile properties of the composites. This is due to better stress transfer from matrix to the fillers. For 0% of MMT-UNT kenaf loading for 0%, 10%, 20%, 30% the tensile strength is 16Mpa, 15Mpa, 17Mpa, 24Mpa respectively. For 1% of MMT-UNT kenaf loading for 0%, 10%, 20%, 30% the tensile strength is 20, 28, 30, 32 (all are in Mpa). For 3% of MMT-UNT kenaf loading for 0%, 10%, 20%, 30% the tensile strength is 26, 32, 33, 38 (all are in Mpa). For 5% of MMT-UNT kenaf loading for 0%, 10%, 20%, 30% the tensile strength is 25, 35, 42, 43 (all are in Mpa). It appears that all types of composite show an increasing trend as the percentage of kenaf loading and MMT are increased. For composite without MMT, the result shows that the tensile strength increases as the kenaf fiber loading is increased. This0 clearly shows that the fibers which are in mat form are able to act as reinforcement in the composite [5]. A study on mechanical properties of soil buried kenaf fiber reinforced thermoplastic polyurethane (TPU) composites is presented in this paper. American standard ASTM: D638 type 'v' was used to carry out tensile testing for each specimen. weather, temperature, humidity, and degradation process significantly influenced the reduction in tensile strength of the composites. Tensile strength of soil buried kenaf reinforced TPU composites for 0, 20, 40, 60, 80 (all days) is 28, 19, 17.8, 20, 16 (all in Mpa). The specimen after 80 days of soil burial test showed the lowest tensile strength with a decrease of around 44% from _28.68 MPa (before soil burial test) to _16.14 MPa (after 80 days). The overall tensile strength for the specimens after soil burial test was decreased. The tensile strength for the specimen after 20 days was decreased around 35% from _28.68 MPa (before soil burial test) to _18.50 MPa (after 20 days). This result may indicate that the high moisture content in the specimen after being buried for the first 20 days influenced the strength of composites. The sample are cut according to standard tensile test; ASTM D638 Fiber perform structure effect on mechanical properties had been investigated woven structure of kenaf fiber [6]. Tensile tests were performed in accordance with the ASTM D638 standard (type V) for 100% PP. ASTM D3039 was used for the PP/kenaf composite. The processing parameters of PP/kenaf long fiber composite have been studied and optimized. The optimal processing parameters using our compression molding machine are a temperature of 230 _C and a barrel speed of 16 Hz. These processing parameters were found to influence the mechanical properties of the composite. Compression molding produced a great tensile strength in PP/kenaf composite of 35.1 MPa and that of pp is 31.5 Mpa [16]. Tensile tests were conducted according to ASTM D638. The results of mechanical testing showed that the properties of the interwoven hybrid composites are superior to the woven POM/kenaf composite due to balanced stress distribution in the matrix. The tensile strength of the interwoven hybrid composite when tested along kenaf fiber direction increased from 72 to 85 MPa due to increase in fiber content. Similarly, the tensile strength of the woven POM/kenaf composite increased from 67 to 75 MPa [18].

3.Scanning electron microscopy

SEM micrographs of typical fractured surfaces of tensile specimens of KF20. A long fractured kenaf fiber in the center of the image clearly indicates both the higher aspect ratio of kenaf fibers as compared with wood flour and the effectiveness of the compatibilizer. The image also shows the random distribution of fibers in the matrix [1]. In the fiber treatment process, the cleaned kenaf fibers were cut into an average length of 100 mm. Sodium hydroxide (NaOH) solution was prepared with a 6 wt% concentration. The selected fibers were immersed in NaOH aqueous solution for 24 h at room temperature. After treatment, the fibers were thoroughly washed with tap water until all traces of NaOH were removed from the fibers and then dried for 24 h in an oven at a temperature of 40 _C. The morphology of the untreated and treated fiber surfaces are presented. The SEM for untreated and treated Kenaf/epoxy composite with the treated sample having better mechanical interlocking and interfacial adhesion [4]. The SEM micrograph of the 80 days of soil buried composites shows a rougher surface with the presence of voids and holes. The presence of voids and holes could be due to the removal of cellulose by microorganism in the soil, the removal of other particles after moisture uptake or the fiber swelling after soil burial test [6]. The SEM image of tensile fractured surface of sample Kevlar/kenaf/Kevlar (A/k/A) and kenaf/Kevlar/kenaf (k/A/k) composites. It was observed that there is fiber pull-out, fiber-matrix incompatibility and matrix cracking and voids in the k/A/k sample, compared with A/k/A sample. Based on tensile strength data, it was observed that sample A/k/A has higher tensile strength. As during tensile testing, outer layers of composites consist of Kevlar fabric, absorbed the stress and distribute them in the 13 composites. The kenaf layers at the inside of composite exposed to the lower stress before failure [8]. SEM was carried out to study the fracture surface of mat kenaf composite and woven kenaf composite. SEM micrographs revealed a certain number of fiber breakage fracture surfaces of woven kenaf composite since the fiber pull out is not possible for tight woven fiber. Strong bonding between kenaf fiber and polyester matrix is proven through the adhesion of matrix which fully coated at the fiber surface. There are no significant different between fracture surface of mat composite and woven composite unless some fiber pullout in mat fracture sample. This could be caused by better drapability in woven composite structure reduce the ability of fiber to be pulled out [10]. The SEM image shows the APP2 particles before compounding. Even though the particles are in different size and shape, the lateral dimensions are ranging within few microns. During the preparation of effective flame retardant homogeneous composite with immiscible blends of PP/kenaf and APP, the form of the solid particles and the viscosity of the polymer play a major role with the presence of the compatibilizer [13]. SEM micrograph MAPP is derived from PP, thus it is compatible and reduced wetting with TPNR (PP-based). The chemical bonding facilitates efficient stress transfer between KF and TPNR leading in improving reinforcing effect. The same trend can be observed for flexural strength where the compatibilized composite always possess higher strength than the composite without MAPP. Compatibilized PP/EPDM–kenaf fiber composite shows highest flexural modulus approximately 39% higher than compatibilized TPNR– kenaf composite. Similar explanation can be offered to the flexural strength which is related to the effectiveness of the reinforcement as well as due to the good bonding between matrix and fiber. Thus, when the composite is subjected to load, the matrix will transfer the stress to the fiber and the fiber may act as load carrier [14].

4.Flexural Strength

Flexural test was performed according to ASTM D 790. Treated hybrid composites result in optimum flexural strength at fiber content of 15% treated hybrid (30TK:70TG), which is 40.2 (Mpa). The flexural strength for this system closes to the glass fiber composite treated with silane. However, at fiber ratio of 30TK:70TG, hybrid composite, gives the flexural strength that is almost the same with treated glass composite alone at the same fiber content (10%, 15%, and 20%). The flexural strength of hybrid composite with kenaf is obtained between the ranges of both fiber composite alone that is used for this research. Moreover, 10%, 15%, and 20% of untreated hybrid composite at fiber ratio of 30UTK:70UTG give optimum values of flexural module which are 2080 (MPa), 2470 (MPa), and 2320 (MPa). The result obtained indicates that the optimum combination for untreated hybrid composite is at ratio 30UTK:70UTG at 15% fiber content.[21] The flexural tests were performed according to ASTM D790-10 ,Graph explains us about the research that the flexural strength in kenaf is 77.66(Mpa) then when we add glass to it we will get 115.71(Mpa),which is maximum and with 0.5 cnt's we will get 97.15(Mpa) and if it acts with 1.0 cnt's we will get 91.91(Mpa) which is minimum.[22] Flexural tests were performed according to ASTMD638, D790 The composite material of flexural strength will be 112(MPa) with long PET/polyoxymethyl, which will be maximum for short PET/polyoxymethyl is 83(Mpa) for kenaf long its 70(mpa) and for kenaf short its 65(Mpa), which will be Minimum.[23] Flexural tests were performed according to standard ASTM, Comparison of flexural strength of Kenaf composites to other natural fiber composites. The specific module in the kenaf material, it gives the density or E modulus of kenaf as 55 (gram per cubic meter) which is maximum among the rest of the properties Ex. (Hemp or coil) in the graph. [24] Flexural tests were performed according to ASTM D 790-03 Experiments were conducted to characterize the surfaces of treated and untreated fibers and to investigate water absorption in natural fiber composites. Natural fiber composites absorb more water than glass fiber composites. Alkali treatment removes lignin and hemi cellulose from the surface of natural fibers. ESEM indicated that the silane treatment coated the fibers. Glass fiber composites had a modulus than untreated and treated most natural fiber composites with the exception of silane treated kenaf. Trends in hemp and kenaf treated composites are dissimilar. Kenaf generally performed better in mechanical testing than hemp Flexural modulus for treated and untreated composite or fiber composite, Kenaf modulus (GPA) gives the flexural modulus (Gpa) of kenaf mw as the maximum in the given graph where as we observe that hemp silcane mw has the minimum flexural modulus(Gpa). [26] Flexural tests were performed according to ASTM Standard D3039, on comparison of the flexural strength(Mpa) of kenaf / Polypropylene composites to other natural fiber composites, we get the flexural strength(Mpa) of flax/Polypropylene as maximum, which is in between 70-80(Mpa), and flexural strength(Mpa) of sisal/polypropylene as minimum, which will be 20-30(Mpa) [27]. Flexural tests were performed according to standard ASTM, Kenaf/PLA biodegradable composites were fabricated using kenaf fiber bundles and an emulsion type biodegradable resin. The following results were obtained follows: Unidirectional biodegradable composites fabricated using an emulsiontype PLA resin and kenaf fibers at a fiber content of 70% have high tensile and flexural strengths of 223 MPa and254 MPa, respectively, as kenaf /PLA composites biodegrade, tensile strength and weight decrease 91% and 38%, respectively, after composting for four weeks. The biodegradability of the composites was confirmed. [28] Flexural tests were performed according to ASTM D790-07 Flexural properties of treated and untreated kenaf composites\ NaOH-The flexural properties of the NaOH composite are highly influenced by the kenaf fiber surface characteristics. NaOH treatment highly enhanced the interfacial adhesion of the fiber with the matrix leading to better flexural properties compared to the untreated fibers. Thirty-six percentage increment in the flexural strength of the epoxy composite achieved when treated kenaf fibers were used as reinforcement compared to the untreated fibers, which showed only 20%.[29] Flexural tests were performed according to standard ASTM ,The flexural properties of the kenaf-filled poly-propylene show -over those of the unfilled Poly-propylene, but significantly higher than that of the 40%-CaCO3-filled or 40%-talc-filled Poly-propylene, the flexural modulus of the kenaf system was remarkably high-in the same range as that of the stiffest system, mica-filled Polypropylene.[30] Flexural tests were performed according to ASTM 790-90 High fiber Low matrix composites- The plasticization technique allows the processing of highly filled composites using melt blending technology. Highly filled 85 percent kenaf fiber poly propylene composites show some interesting results. Their flexural properties exceed those of typical, commercially available formaldehyde-based wood composites. [31] Flexural tests were performed according to standard ASTM, Wear Rate of Natural Fiber Long kenaf Composite - The results were plotted as Mass loss against distance. For both materials, straight lines were obtained for all load cases. The gradient of the line increases with load. This suggests that for higher load, the mass loss increases significantly with distance. However, for low load, the mass loss barely increases over distance. [32].

5.Conclusion

The highest impact strength for kenaf bast and core fiber composites were compared to PP, vetiver–PP composites exhibited lower impact strength On the other hand impact strength decreased with increasing vetiver content. Both the notched and the unnotched Izod impact strengths were almost the same with the addition of compatibilizing agent. Charpy unnotched, and notched impact strength are 80 MPa, 3.5 GPa, 85 kJ/m2, and 12 kJ/m2, respectively impact test. Tensile tests were conducted according to ASTM D638 the tensile strength of the interwoven hybrid composite when tested along kenaf fiber direction increased from 72 to 85 MPa due to increase in fiber content. Flexural test was performance according to Moreover, 10%, 15%, and 20% of untreated hybrid composite at fiber ratio of 30UTK:70UTG give optimum values of flexural module which are 2080 (MPa), 2470 (MPa), and 2320 (MPa).

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