REVIEW ON NATURAL FIBER COMPOSITES

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Abstract. In recent years more research is carried out on natural fiber composites due to their low weight and reusable property and improved mechanical characteristics. The natural fiber based composites are economical and can be fabricated easily in places fibers are abundantly available. Such composites are recyclable and are nontoxic in nature. They are replacing rapidly synthetic fiber based composites in various engineering applications.. This paper just reviews the recent works carried out on natural fiber based composites.

1.0 Review on natural fiber composites
A composite material made from two or more constituent materials with significantly different physical or chemical properties that when combined produces a material with characteristics different from individual component.

2.0 Reviews on kenaf fiber

Majid Niaz Akhtara et al. [1] studied two different types of fibers such as chemically treated kenaf fiber and untreated kenaf fibers. Polypropylene was reinforced with treated and untreated kenaf fibers. 10%, 20%,30%,40%,50% weight of kenaf composites were prepared during fabrication. The process used for fabrication of kenaf/pp reinforced composite was Injection molding process. Testing includes X-ray diffraction, Differential scanning calorimetric, Thermo gravimetric analysis, Fourier transform infrared spectroscopy, Scanning electron microscopy. It is found that chemically treated kenaf/pp composites with 40% wt loading showed the improved mechanical properties(tensile strength, flexural strength) when compared to untreated kenaf/pp reinforced composite and other loadings such as 10% , 20 % , 30 %, 50% wt of kenaf/pp reinforced composite. In testing process, it was found that under 50% wt loading burning of kenaf fibers occurred and there was no proper mixing of kenaf and polypropylene.

Neng Sri Suhartya et al. [2] studied two different reinforcements such as primary and secondary were made. Here, recycled polypropylene (RPP) was used as a matrix, Divinyl benzene (DVB) as a cross linker, PP-g-AA as a bonding agent as a primary reinforcement. Whenever these materials were bonded together, it was found that the tensile strength and flexural strength percentage was increased gradually. Clay or Kenaf fiber was used as secondary reinforcement. When 20% kenaf fiber was added as a secondary reinforcement to the RPP/DVB/PP-g-AA/hall composite it was found that tensile strength was once again improved gradually approximately to 20% and flexural strength was increased by 30% and impact toughness by 28%. Synthesis process was carried by mixing RPP/DVB/PP-g-AA/hall composite with boiled Xylene solvent, mechanical stirrer and nitrogen gas for 1 hour. Tensile testing and flexural testing were carried out using universal testing machine and Izod impact test.
machine. It was found that addition of kenaf fiber with RPP/DVB/PP-g-AA/hall composite increased the tensile, flexural strength and impact toughness.

2.1 Hybrid composites Vijaya Ramnath et al. [3] dealt the paper on Hybrid Composites consisting of Flax and Abaca and Glass fiber Reinforce Polymer in which Flax and Abaca is a matrix GFRP is a reinforcement. Among other fibers Flax proved to have improved Mechanical properties when combined with glass. It is found that Abaca+Flax+GFRP found to have improved Flexural properties and mechanical properties. Satish et al. [4] studied the Properties of Hybrid composites varying the mechanical properties and thermal properties when orientation of fibers. Here Banana Kenaf reinforced with GFRP is studied. Reinforcement agent is epoxy resin and hardener. Fabrication is done using Hand layup method. It was found that fibers having 45degree orientation produced higher mechanical and thermal properties. SEM is used to analyses internal structure.

2.1.1 Composites and polymers Vijaya Ramnath et al. [5] deals with selection of fibers play a major role in day to day implementation. Epoxy resin is used as a matrix and manila as a reinforcing agent which is placed between glass fibers. Manila is placed alternatively by using Hand layup technique. The bonding between fiber and glass plays a major role on tensile strength. It is performed in three samples and average is noted down. Mohamed Hafiz Zemra et al. [6] used Kenaf fiber was used as reinforcement and unsaturated polyester resin was used as a matrix. The process used for fabrication is thermoset pultrusion process in which Kenaf fiber was first impregnated on unsaturated polyester resin. Then the Kenaf fiber impregnated with resin was pulled out at particular speed from steel die pulling machine. Thus the fiber pulled was cured at a temperature of 120°. Then, Pultruded kenaf fiber reinforced composite was parted into different sizes of 1400,2200,3300. Compression and flexural properties were studied. Compression and flexural strength were increased with the decrease in Tex number and it was found that tensile strength increased with increase in tex number.

2.1.2 Properties of natural fiber in Acoustics Lima et al. [7] used Kenaf fiber is used to absorb the sound energy. When the amount of fiber is more in the specimen, the absorption coefficient also increases according to it. It was tested using Natural incidence sound absorption where the specimen was fitted to the one end of the impedance tube and random incidence sound absorption where kenaf fibers were made into sheets of size 0.43m*0.43m. In natural incidence sound absorption method, the fiber was made into required thickness and diameter by hot compression method. In random incidence sound absorption the sheets were placed in the frame by providing the air gaps of three distances 10mm, 20mm, 30mm. It was found that there was an increase in absorption coefficient whenever there was a increase in thickness and bulk density. It was found that when the air gap was increased, the absorption was increased at lower frequencies.

2.1.3 Short fibers and long fibers Reza Mahjoub et al. [8] studied the influence of short fibers and long fibers as reinforcements. Polyethylene and polypropylene were used as matrix. Kenaf fiber was used as a reinforcement and maleic anhydride polyethylene (MAPE) and maleic anhydride polypropylene e(MAPP) were used as coupling agents. When short fibers were treated with different alkaline composition such as 2%, 3%, 6% and 9% of NaOH, it was found that tensile strength and modulus of elasticity increased at 6% NaOH alkaline treatment when compared with untreated kenaf fiber. When alkaline treated kenaf fiber was bonded with MAPP, it was found that composite can able to withstand the higher loads (impact loads) when compared with Kenaf fiber reinforced with MAPE.
Shifeng Zhang et al. [9] chopped Kenaf into total of 100 gms in 50mm length. Kenaf fiber was treated with NaOH solution (5%-10%). This retted fiber was treated with ALCL3 solution which involved heating to a particular temperature, cooling process and drying for more than 2 hours. Fabrication process was carried out by forming the bond between treated and untreated kenaf fibers with unsaturated polyester and t-BP catalyst using Vacuum Assisted Resin Transfer Molding (VARTM). It was found that thickness swelling percentage varied with time. Tensile test was carried out using Universal testing machine. Mechanical properties like modulus of rigidity and modulus of elasticity were tested as per standards. Such properties increased by certain percentage when aluminium was added by (2-4%). Hence Treated kenaf fibers can replace the glass fibers in automotive applications.

2.1.4. Natural fiber composites in construction  Mohd Suhard Meona et al. [10] used Natural fibers in construction of buildings where the concrete was wrapped up with Kenaf fiber reinforced polymers. Glass fiber reinforced polymer had higher tensile strength compared to the KFRP and has high modulus of rigidity and ductility. Initially kenaf was chemically treated and the polyester resin was reinforced with kenaf fiber. Improvements on Kenaf fibers could be made by increasing the amount of fibers and thickness and amount of wrappings in the concrete. Axial load was applied on the concrete wrapping. Testing on unwrapped samples, samples wrapped with GFRP and samples wrapped with KFRP were made and improvements were studied. Researches started to focus on hybrid composites.

2.1.5. Study of Mechanical and Thermal properties of natural fiber composites

Jamal Mirbagheri et al. [11] used hybrid composite consisted of wood flour/ kenaf fiber reinforced with polypropylene matrix. Bonding agents such as maleic anhydride and cumylin peroxide were used. There were two reinforcement and the ratio was carried out as fixed ratio which is reinforcement1 and reinforcement 2. The process carried out for fabrication of sample was injection molding process. Tensile test was carried out by using Universal testing machine as per standards. Rule of mixtures equation was used to find out the elastic modulus of composites. They identified that addition of kenaf fiber to wood flour/pp matrix composite increased the property of tensile strength and tensile modulus. Edynoor bin osman et al. [12] studied about morphological and electrical properties of Composites that are used in electrical fields. Kenaf fiber was treated with (5-10%) of NaOH solution. Indium/zinc solution was prepared by dissolving zinc acetate dehydrate in ethanol and stirred mechanically for number of hours and then finally Indium solution was added to the mixture. Indium/zinc oxide solution was coated over the layer of kenaf fiber. The process carried out was dip coating method. After that annealing process was carried out at 150-200°. Scanning Electron Microscope was used for testing process in order to ensure whether the indium/zinc oxide solution was properly coated entirely. Electrical conductivity of this composite is entirely high and it is used in textile industries, and for electrostatic coating protection. Dunne et al. [13] discussed about Material characterization of natural fiber based Composites are environmental friendly. Some of them include Kenaf and Sisal in which kenaf is chosen because it has been used in automotive applications and used in industries. Sisal is chosen because it has been used in making coir’s and twines. Hybrid composite was fabricated by using kenaf/sisal as the reinforcement and Acrylonitrile Butadiene Styrene matrix (ABS) immersed in acetone solution which acted a bonding agent. The bonding was so strong that it increased the mechanical properties such as tensile strength and elastic modulus. Testing such as tensile testing, air flow resistivity, and impact strength with different densities were measured. There was an increase in tensile strength, impact strength and found automotive applications.
Srinivasan et al. [14] discussed about increasing mechanical and thermal properties based on types of fibers such as banana and flax reinforced with glassfiber. Epoxy resin of particular quantity such as certain percent increases the property. Hand layup is used to fabricate the fibers reinforced with epoxy resin glass fiber. It is found that thermal stability has been increased. Testing such as SEM is used. Chaithanyan et al. [15] investigated about tensile behaviour of Fibers such as Sisal is mixed with vinyl ester resin which is fabricated using hand layup method. GFRP is used with particular weight is used in this process. Different composition of Fiber and resin is mixed and different results are generated. Testing is carried out using universal testing machine. As a result it is found that it has high specific strength, good stiffness and light weight. Vijaya Ramnath et al. [16] investigated about the mechanical behaviour of Twisted Natural Fiber Hybrid Composite and Fabrication is done by using Vacuum assisted Compression moulding technique. For the improvement of mechanical properties fibres are also alkalized. To enhance the strength and stiffness of laminates two fibres are sandwiched between the layers of glass fibres. It shows that due to the presence of twisted fibres there is an significant improvement in its mechanical properties.

3.0 A Review on sisal fiber

Felipe dos santos et al. [17] Studied about the sisal fibre when it was mixed to the cementitious composite along with Ethylene Vinyl Acetate (EVA) and piassava fibre was mixed to cementitious composite along with EVA and then the mechanical properties of both were compared. Workability, tensile strength and compression test were made. Specimens were prepared by adding required % of EVA and fibre (sisal or piassava) to the cementitious material. Fibers were cut into the required length. The tensile strength was tested using a Universal servo controlled machine. Compressive strength was tested using hydraulic press. Workability was tested in a flow table device. The sisal fiber reinforcement in light weight cementitious composite with EVA was more efficient than piassava fiber. Fláviode Andrade Silva et al. [18] studied the fatigue behaviour of sisal fiber when it was used as reinforcement to cementitious material. The composite was fabricated using the molding process. The sisal fiber was cut into the required length and then the fiber is mixed to the cementitious material. Fatigue test was carried out and the micro structural investigation was done. The composite did not undergo fatigue when the composite was subjected to maximum stress. Ashishkumre et al. [19] fabricated a composite by using sisal as reinforcement and epoxy as matrix. The fabrication of composite was done using hand layup method. Tensile test was done using Universal testing machine. Flexural test was also done using Universal testing machine. Impact test was done using impact machine. They found that by the addition of glass to sisal fibre-epoxy polymer composite, the mechanical property increased. Tensile strength of epoxy remained same by the reinforcement of sisal but the tensile modulus, flexural and impact properties increased.

Mohan et al. [20] studied the chemical treatment of sisal fibre. The composite (sisal-pp composite) was fabricated using the extrusion method. The three types of specimen were made, one was made using the untreated sisal fibre and second one was using chemically (Na OH) treated sisal fiber and the third one was using chemically-clay (Na OH-clay) treated sisal fiber. Moisture absorption testing for the three specimens was conducted. Fibre pullout test for all the three specimens were done as per the standards. Tensile test was conducted in universal testing machine. The researchers found that the chemically treated sisal fibre had greater thermal, physical and mechanical properties than the untreated sisal fibre. Whereas the chemically-clay treated sisal fibre had much greater thermal,
physical and mechanical properties than chemically treated sisal fiber. Easwar Prasad et al. [21] tested the Impact strength of both treated (4-10% Na OH) and untreated sisal polyester composites. Sisal fibres were cut into 10mm length. 2mm, 3mm, 4mm, 5mm and 6mm thick specimens with fiber volume of 10% ,15%, 20%, 25% and 30%. The process used for making specimen was manually operated hot compression moulding. Izod impact strength of each specimen was tested according to ASTM standard D-256. After the testing it was found that the impact strength of both treated and untreated sisal fibre embedded polyester matrix composite increase with increase in thickness and volume fraction of the fibre. Yuvaraj et al. [22] investigated flexural and water absorption behaviour of epoxy hybrid composites in which Epoxy is used as a resin and hand layup method was used to make up the composites. This results in improved mechanical properties for glass fiber- sisal fiber construction than dispersed construction. It seems that there is a slight increase in flexural property of composites with increase in fibre loading and also there is an decrease in water absorption property with increase in glass fibre composition in composites. Yuvaraj et al. [23] studied mechanical behaviour of Sisal epoxy Hybrid composites which shows that the breaking load of double shear test, hardness, inter delamination tests are increased It seems that the fiber is fabricated by hand layup process. The results prove that the composite having equal proportion of glass and sisal enhanced the mechanical properties when compared with composite having minimum sisal fibre proportion.

4.0 Conclusion
In this paper the review has been done based purely on natural fiber composite such as Kenaf and sisal. It is observed that fibers may enhance the physical and mechanical properties by chemical treatment. It shall certainly be applied in various fields such as automotive, construction and for domestic applications.

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