Natural fibre composites-A Review

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Abstract: Composite materials are playing a major role in engineering applications. They are used in automobiles, marine, aerospace, sports and various other fields. Nowadays, reinforcing is done with natural fiber in place of synthetic fiber. Natural fibers are cheap and abundantly available. They are nontoxic and can be treated chemically in order to enhance the mechanical properties. Such composite materials are ‘Go by Green” and a lot of research is focused on such natural fiber based composites. A few of such research works are reviewed in this paper.

Keywords: Natural fiber, Composites, Banana, Jute.

1.0 Review on natural fiber composite

Nowadays, a natural fiber composite materials are replacing conventional materials because of their properties like high Strength to Weight ratio, high specific strength, high density and their bio degradability. This Section reviews some of the research carried out using natural fibers as reinforcement to fabricate composites. It reviews effect of mechanical behavior of composites while using various resins and fibers.

2.0 Review on sisal fiber

Maya Jacob et al. [1] considered two natural fibers namely sisal fiber and oil palm fiber along with natural rubber composite. They studied the mechanical property of natural rubber composite when it was reinforced with sisal and palm fibers. The composite was fabricated using two row mill. Two different types of composites were made, one using untreated fiber and another with treated fiber. The tensile and tear strength were calculated by using Universal testing machine and tearing strength tester. They concluded that addition of sisal and oil palm fibre to the natural rubber composite gives high tensile and tear strength. They also found that the mechanical properties were improved much when compared to rubber composite was reinforced with chemically treated fibers than untreated fibers. Leandro Josêda Silva et al. [2] studied the addition and the effect of silica micro particles on polymeric composites. In this complex process, most of the mechanical properties were improved. They also concluded that the addition of maleic anhydride and silica nanoparticles improved the flexural strength and elastic modulus.
2.1 Epoxy hybrid composites

Yuvaraj et al. [3] analysed Flexural and water absorption behaviour of epoxy hybrid composites. Epoxy is used as a resin and hand layup methods were used to make up the composites. 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 content in composites. This results in better mechanical properties for glass fiber-sisal fiber construction than dispersed construction. Yuvaraj et al. [4] investigated Mechanical behaviour of Sisal epoxy Hybrid composites. It seems that the fiber is fabricated by hand layup process. It shows that the breaking load during double shear test, hardness, inter delamination tests are increased. The results prove that the composite having equal ratio of glass and sisal have improved mechanical properties than composite having minimum sisal fibre percentage.

2.2 Twisted fiber composites

Vijaya Ramnath et al. [5] investigated twisted Natural Fiber Hybrid Composite on its mechanical behaviour and Fabrication is done by using Vacuum assisted compression moulding technique. To enhance the strength and stiffness of laminates two fibres are sandwiched between the layers of glass fibres. For the improvement of mechanical properties fibres are also alkalized. It shows that due to the presence of twisted fibres there is a significant improvement in its mechanical properties.

3.0 Review on banana fiber

Amira et al. [6] studied the effects of fiber configuration on mechanical properties of banana fiber. Four types of banana fibers were considered in this process and they are unreinforced PP, PP/Raw banana fiber, PP/Banana yarn and PP/Banana mat. The process used in preparation of composite was compression molding method. Tensile test, flexural test and other microstructural analysis were carried out. It was observed that the fiber produces high mechanical strength, and also banana composites high tensile and flexural strength compared to other fibres. It can be seen that the banana fiber yarn provides the best mechanical properties in PP composite. William Jordana et al. [7] proved that properties of Banana fibers reinforced polymer composites were improved by treating the fibres chemically. The two treatments were carried out such as Peroxide treatment and Permanganate treatment. For peroxide treatment, dicumyl peroxide was used and for permanganate treatment potassium permanganate was used. Then mechanical testing was done followed by computation of Single fiber results. Both treatments increased their interfacial bonding of banana pseudo stem to LPDE matrix. Flexural properties and tensile properties indicated that there was an increase in strength and stiffness with increased fiber volume fraction. Benitez et al. [8] showed that in order to improve the adherence property of banana fiber to plastic matrices, fibers must be treated chemically or physically. The two chemicals namely, Sodium hydroxide and Maleic anhydride were used to treat the fibres at different temperatures and pressures. The leaves from inside and outside part of the pseudo-stem of not being exposed to environment were used. The fibres were subjected to injection moulding process after the treatment. FTIR analysis has been done to check whether there are any changes in fiber surface due to different chemical treatments. FTIR results seem to prove that banana fiber is similar to pure cellulose. It was shown that canary banana tree has higher tensile strength and elastic modulus than other types of fibers.
3.1 Treatment of banana fiber

Ramesh et al. [9] used different fiber volume fractions and used hand layup process by applying pressure at room temperature for fabricating banana fiber reinforced composites. The processed samples were subjected to different tests like tensile, flexural and impact tests and various results were studied. In order to analyse the structure of fractured surfaces; Scanning Electron Microscope was used to study the crack analysis. Different materials including catalyst methyl ethyl ketone peroxide and acetone thinner were used. After the SEM analysis, crack formation in matrix layer is clearly observed.

3.2 Mechanical and thermal characteristics of Banana fiber

Satish et al. [10] studied Banana-Kenaf Hybrid Epoxy Composites in terms of their mechanical and thermal characteristics in effect of fiber orientation and stacking sequence. Here the composite is prepared using Hand Layup process with different fiber orientations and volume fractions. It seems that fibres produce better properties when they are arranged at 45 degree inclinations than the other orientations. It was also seen that when the thickness increases compressive strength also increases. Manickavasagam et al. [11] evaluated Abaca and Flax reinforced polymer composites for double shear and hardness in automotive applications. Hand layup method is used for the production of composite. It is found that Ultimate strength and hardness of abaca is greater than that of flax composites. Vijaya Ramnath et al. [12] experimented Mechanical properties of Banana Jute Hybrid Composite. Hand LayUp method is used for the Fabrication of composite. Tensile test, Flexural test, delamination test are carried out. To know fracture direction, matrix structure, fiber orientation failure morphology tests is done using Scanning Electron Microscope. It shows that when compared to mono composites, hybrid composites have better mechanical properties.

3.3 Dynamic mechanical analysis

Laly Pothan et al. [13] carried out dynamic mechanical analysis of banana fiber reinforced polyester composites. This was carried out with reference to effect of temperature and pressure. The dynamic properties included the intrinsic properties, morphology and the nature of interface. Important materials included methyl ethyl ketone peroxide and cobalt naphthenate. These dynamic properties were depending mostly on volume fraction of the fiber. The dynamic analysis showed that incorporation of fiber is decreased and is below the glass transition temperature. Sapuan et al. [14] studied the mechanical properties of three different geometries of woven banana fibres were prepared and mechanical properties of those geometries were studied. The mould was prepared and the process was carried out in either compression or injection moulding process. When analyzed statistically using ANOVA, it showed that insignificant results were obtained in three samples which confirmed that under different tests composites provided a stable mechanical behaviour. These positive results in banana fibres was more useful for people near village sites as they use this banana fibres for producing household utilities. Pothan et al. [15] considered the polarity parameters of a chemically modified banana fiber reinforced polyester composites, in order to improve adhesion and there was a need of chemical modification in fibres. These modifications had been analyzed to investigate the interfacial properties. These were investigated by solvatochromy and zeta potential measurements. Here, cellulose fibers and silanes were used. It was shown that composites having better modulus and low damping can be used as a substitute for building material, which can be developed from banana fibers.
3.4 Mechanical properties of intra-layer abaca fiber

Vijaya Ramnath et al. [16] determined Mechanical properties of intra-layer Abaca-jute-glass fibre reinforced composites. The composites are manufactured and varied in three different orientations and proportions. It is observed that for determining the mechanical properties of composite fiber orientation plays a vital role. samples having higher abaca content exhibited better properties when compared to other samples. Vijaya Ramnath et al. [17] tested Manila Fibber Reinforced Composite is for its tensile properties. Glass fibres are used to provide rigidity and strength to composites. Hand layup method is used for production of composites. Fiber matrix interfacial bonding determines the strength of composites. Homogeneous distribution of fibres results in uniform tensile properties in the samples. Rajesh et al. [18] studied the free vibration behavior of banana fibers. Hydrophilic nature plays a very important role in natural fiber where it produces poor adhesion between fiber-matrix. The fibres were pre-treated to produce good results. This chemical treatment increased the free vibrational properties of composites. In this work, short and random fibers were used. When investigated for damping factor and frequency, it was found that 50% composite had maximum natural frequency, it was because of the stiffness and modulus were increased by the chemical treatment. Venkateshwaran et al. [19] studied the water absorption behavior of natural fiber based composites. First of all, weight percentage and fiber length were determined. Fracture behavior was studied by Morphological analysis using Scanning Electron Microscope. The samples were prepared in mold machine. Due to the poor interfacial bonding between matrix and fiber there was a marginal increase in mechanical properties. By chemical treatment, interfacial bonding was improved. Bhoopalan et al. [20] studied the thermal properties of banana fiber reinforced epoxy composites. The composites were prepared by molding technique by preparing them in different weight ratios. Tensile, flexural and water absorption tests were carried out. There was an increase in thermal properties and considerable decrease in moisture absorption property. There was a marginal increase in mechanical property which was due to interfacial bonding between fiber and matrix.

4.0 CONCLUSION

In this paper, the natural fibre composite properties are reviewed on Banana and jute based hybrid composite. It is found that the natural fiber composites possess higher properties as compared to traditional one. Also it is concluded that natural fiber composites can be used as replacement material for automotive, construction, marine and domestic applications.

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