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"Safety Analysis and Performance Assessment of Banana Fiber Reinforced Polymer Composites"

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Abstract

Now a days the environmental pollution increases in this technology world and everyone is looking to concentrate on the materials that satisfy the environment. We have to prevent the non-renewable and non-biodegradable resources. The natural fibers can provide more advantages than the synthetic reinforcement materials. On comparison with synthetic reinforcement materials, the banana fiber composites are low cost, low density, non toxicity, comparable strength, minimum waste disposal problems. In this experiment, banana fiber reinforced polymer composite is prepared and to improve mechanical properties of these composites they are investigated and evaluated. The samples of composite with different amount of fiber portions were prepared by using hand lay–up process and the pressure will be applied at room temperature. The banana fiber reinforced samples were subjected to the mechanical testing process such as tensile, flexural and impact test. They are used in integrated parts of automobiles. The applications of banana fiber composite on automobiles are reduction of parts, low manufacturing and tooling cost, better integration of parts into other components of automobiles.

1. Introduction

The natural fibers are taken from natural resources. They are renewable and bio-degradable. They are inexpensive and have low density. They are used in automobile and construction industry. There are three types of natural fiber, they are Plant fiber, Animal fiber and Mineral fiber. The banana fiber is one of the plant fibers. It provides cool to the material. The banana fiber reduces the overall resource consumption and it can be used as green technology to rural areas. At present banana fiber is waste product of banana cultivation. Without any additional cost the banana fibers can be used for the industrial purposes. Banana fiber is extracted from banana tree and it is used to make a composite material. Banana fibers are obtained after the fruit is harvested and fall in the group of bast fibers.

Composite material is made from two or more constituent materials with difference in physical or chemical properties. When combined to produce a material with characteristics different from individual components. The banana fiber reinforced composite has an good mechanical properties. The chemically treated banana fiber reinforced composite has superior mechanical properties than the untreated fiber reinforced composites. It is due to good connection of cellulose chains, after the dissolution of lignin, which is a complex organic polymer deposited in the cell wall of many plants, making them rigidity and woody.

Thinner is a organic compound and it is colorless, volatile and flammable liquid. It is used to remove the impurities on the banana fiber.

Epoxy resins are reacted to form thermoset polymers possessing a high degree of chemical and solvent resistance, outstanding adhesion to wide range of substrates, a low range of shrinkage cure, impact resistance, flexibility and good electrical properties. The applications of epoxy resins are Very high tensile, compressive, flexural strengths, Remarkable resistance to corrosion and Excellent chemical resistance.

Hardener is the chemical substances which is used to react with epoxy resin to harden it. In some mixtures a hardener is used simply to increase the binding of the mixture once it sets. A hardener can be either a reactant or a catalyst in the chemical reaction that occurs during the mixing process.

Methyl Ethyl Ketone Peroxide (MEKP) is one of the catalysts which is used to make a chemical reaction happen more quickly. It is an organic peroxide and it is high explosive than acetone peroxide. MEKP is a colorless, oily liquid whereas acetone peroxide is a white powder .

2. Literature Review

1] The fibers from the natural sources provide indisputable advantages over synthetic reinforcement materials such as low cost, low density, non-toxicity, comparable strength, and minimum waste disposal problems. In the present experiment, banana fiber reinforced epoxy composites are prepared and the mechanical properties of these composites are evaluated. ***2]*** The properties of banana fiber reinforced polymeric composites by treating the fibers. Many lignocellulosic fibers are well characterized in terms of composition and mechanical properties. All of these fibers will contain a combination of cellulose, hemicellulose, and lignin, although their relative amounts vary greatly between different species of plants. ***3]*** The mechanical properties of phenol formaldehyde composites reinforced with banana fibers and glass fibers. Composites were fabricated using banana fiber and glass fiber with varying fiber length and fiber loading. The analysis of tensile, flexural and impact properties of these composites revealed that the optimum length of fiber required for banana fiber and glass fiber are different in phenol formaldehyde resole matrix.***4]*** The banana fibers reinforced low-density polyethylene / poly (*J*-Caprolactone) composites. Polymeric composites structures are used extensively in various applications such as missiles, aircrafts, submarines and automobiles due to its high strength–low weight ratio. Its vast applications in industries have emphasized the development of new efficient numerical techniques for the analysis of composites.***5]*** The degradation of polycaprolactone in banana fibers reinforced thermoplastics composites. Banana fibers, a waste product of banana cultivation, are an abundantly available renewable resources, which may be used as a reinforcement of thermosets as well as thermoplastics. Their use for reinforcement of polyester resins and resol type phenol formaldehyde resins was investigated in the past.***6]*** The dynamic mechanical analysis of banana fiber reinforced polyester composites. The dynamic mechanical analysis of banana fiber reinforced polyester composites was carried out with special reference to the effect of fiber loading, frequency and temperature. The intrinsic properties of the components, morphology of the system and the nature of interface between the phases determine the dynamic mechanical properties of the composite.***7]*** The dynamic mechanical analysis of randomly oriented intimately mixed short banana/sisal hybrid fiber reinforced polyester composites. The dynamic and static mechanical properties of randomly oriented intimately mixed short banana/sisal hybrid fiber reinforced polyester composites were determined. Dynamic properties such as the storage modulus (E0), damping behavior and staticmechanical properties such as tensile, flexural and impact properties were investigated as a function of total fiber volume fraction and the relative volume fraction of the two fibres.***8]*** The effect of fiber surface treatments on the fiber–matrix interaction in banana fiber reinforced polyester composites. Banana fiber, the cellulosic fibers obtained from the pseudo-stem of banana plant (*Musa sepientum*) is a bast fiber with relatively good mechanical properties. The fiber surface was modified chemically to bring about improved interfacial interaction between the fiber and the polyester matrix.***9]*** The effect of mercerized banana fiber on the Mechanical and morphological characteristics of organically modified fiber-reinforced polypropylene nanocomposites. Banana plants are widely distributed in tropical countries and have been a waste product of banana cultivation. The fibers can be used for various industrial purposes without any further investment in banana fiber extraction and retting.***10]*** The polarity parameters on the mechanical properties of composites from polypropylene fiber and short banana fiber. Natural fiber/thermoplastic composites attract much attention because of the recyclability and ecofriendly nature of the composite products. But natural fibers and thermoplastic matrices often have a surface chemistry that is incompatible for perfect bonding.***11]*** The Temperature Dependence of Thermo-Mechanical Properties of Banana Fiber-Reinforced Polyester Composites. Natural fibers are available in abundance in nature and can be used to reinforced polymers. ***12]*** The morphological, physical, and thermal properties of chemically treated banana fiber. The thermophysical properties of banana/sisal hybrid fiber reinforced composites as a function of fiber surface modification and fiber volume was analyzed. The result showed that thermal conductivity of alkali-treated fiber composite is higher than the untreated fiber composite.***13]*** The physio-mechanical and degradation properties of banana fiber/LDPE composites, effect of acrylic monomer and starch. Banana fiber-reinforced low density polyethylene (LDPE) based unidirectional composites (40% fiber by weight) were manufactured by compression molding. Banana fibers were treated with 2-ethylhexyl acrylate (EHA) mixed with methanol (MeOH) under UV radiation.***14]*** The mechanical properties and thermal properties of jute and banana fiber reinforced epoxy hybrid composites. To improve the mechanical properties, jute fiber was hybridized with banana fiber. The jute and banana fibers were prepared with various weight and then incorporated into the epoxy matrix by moulding technique to form composites. The tensile, flexural, impact, thermal and water absorption tests were carried out using hybrid composite samples.***15]*** The Treatment of banana fiber for use in the reinforcement of polymeric matrices. The substances in present in all types of natural fiber, including the focus of this study, namely fiber from the Canary banana tree.

3. Experimental Procedure

3.1 Materials

The materials used in this experiment for composite are banana fibers, epoxy resin, hardener, methyl ethyl ketone peroxide as catalyst and acetone thinner. The banana fibers are extracted from the banana tree trunk. The epoxy resin, hardener and methyl ethyl ketone peroxide and acetone thinner are purchased from dealers in Coimbatore district, Tamilnadu, India

3.2 Extraction of banana fiber

The banana tree is used to fabricate the trunk from its body. Thus the banana fiber is extracted from banana tree trunk. Further, banana fiber is extracted by using banana fiber extractor machine. The extractor machine can produce 15kg to 19kg within 8 hrs. The banana fiber will be kept under sun for the drying process for 48 hrs after the extraction of banana fiber. After the extraction the process for fiber material will undergone.

3.3 Process of banana fiber

The banana fiber will be cleaned by using acetone thinner which can remove the impurities on the fiber. The fiber is cutted at a dimensions of 250x250 mm.

3.4 Mixture of chemicals

A plastic mug vessel is taken to pour the epoxy resin and hardener. They are mixed at the ratio of 10:1 for example, take 100g of epoxy resin and 10g of hardener. Then stir the mixture thoroughly. The mixtures of banana fiber, epoxy resin, hardener and methyl ethyl ketone peroxide are given below

Table 1: Tabulation of mixtures in g

S.NO	FIBER (g)	EPOXY RESIN (g)	HARDENER (g)	CATALYST (MEKP in g)
1	35	130	20	-
2	40	200	30	-
3	45	100	5	10
4	50	115	-	5
5	55	150	15	-

Table 2: Tabulation of mixtures in percentage

S.NO	FIBER (%)	RESIN MIXTURE (%)
1	30	70
2	40	60
3	50	50
4	60	40
5	70	30

3.5 Preparation of composite material

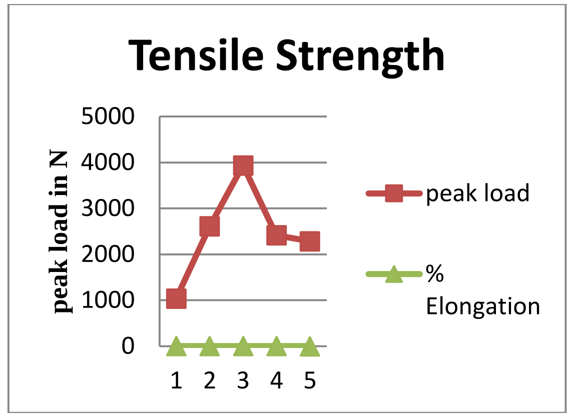
The process of preparation is done by using hand lay-up process. The fibers of banana were cut according to required length. OHP sheet is placed on the base metal plate. This sheet is used to control the reaction of base metal with resin mixture. The resin mixture is applied on the surface of OHP sheet using brush. Then place the banana fiber on resin coated OHP sheet. Once again the resin is pour on the surface of fiber. By using the brush the resin is used to pass over the surfaces of banana fiber. OHP is placed on the head part of fiber. The epoxy resin applied is distributed to the entire surface by means of a roller and the air gaps formed between fiber during fabrication are removed by gently squeezing. These materials are taken to compression machine (UTM) for compression process. This compression process is done for tight bonding of the composite material. Thus the mechanical properties of composite materials were improved. The waste part of composite materials were removed. Then the composite material is cut down to 150x150 mm. The same process will be repeated for other four samples. The other four samples are in different volume fractions. This composite material will undergo tensile, impact and flexural tests. The average values of the tests were taken into account for detailed analysis of the composite material.

4. Mechanical Testing

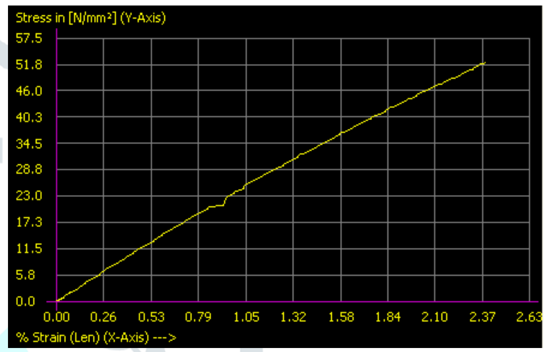
4.1 Tensile strength

The specimen prepared is shaped into required dimension using a hand cutter and the edges are polished using an salt paper. It is prepared according to the ASTM D3039 standard. The dimensions, gauge length and cross head speeds are chosen according to the ASTM D3039 standard. The tensile test is performed on the Universal Testing Machine (UTM).

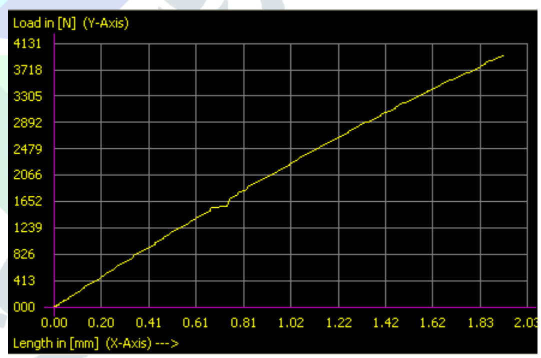
The process involves placing the test sample in the UTM and applying tension to it until the fracture of the material. Then the force is recorded as a function of the increase in gauge length. During the application of tension, the elongation of the gauge section is recorded against the applied force. There are five different types of samples taken for tensile test. The dimension for cutting tensile test is 150x25 mm.



Graph 1: Peak load in N vs length in mm



Graph 2: (spec 4) Stress vs Strain

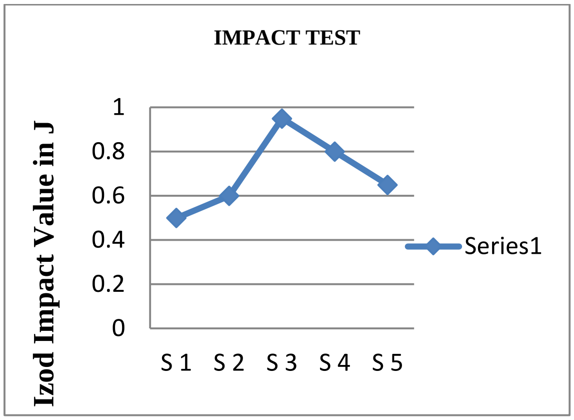


Graph 3: (spec 4) Load in N vs Length in mm

4.2 Impact test

The impact test specimens are prepared according to the required dimension following the ASTM D256 standard. During the testing process, the specimen must be loaded in the testing machine and allows the pendulum until it fractures or breaks.

Using the impact test, the energy needed to break the material can be measured easily and can be used to measure the toughness of the material and the yield strength. The effect of strain rate on fracture and ductility of the material can be analyzed by using the impact test. The dimension for cutting impact test is 65x13 mm.

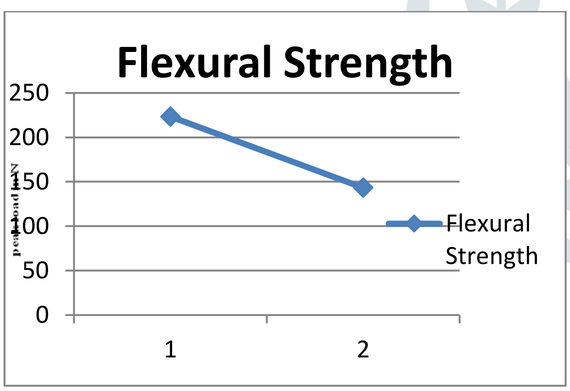


Graph 4: Impact value in J vs Specimen in g

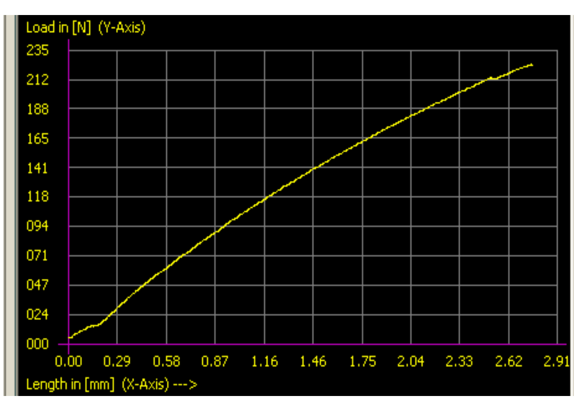
4.3 Flexural strength

The flexural specimens are prepared as per the ASTM D790 standards and the test has been carried out using the same UTM. This test is the most common flexural test and used in this experiment for checking the bending strength of the composite materials.

The testing process involves placing the test specimen in the UTM and applying force to it until it fractures and breaks. The dimension for cutting flexural test is 125x13 mm.



Graph 5: Peak load in N vs Specimen in kg



Graph 6: Load in N vs Length in mm

5. Result and conclusion

The samples are tested in their corresponding testing machines and the tensile, flexural and impact properties are determined. The sample graphs generated with respect to load for banana fiber is presented below.

The results indicated that the banana fibers exhibited excellent mechanical properties and the maximum values obtained are as tensile strength, as flexural strength and as impact strength.

Sample. No	Impact test	Tensile strength	Flexural test
4	0.95 J	52.464 MPa	143.232 MPa

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