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Research Article

INFLUENCE OF FIBER PARAMETERS ON MECHANICAL BEHAVIOR OF BANANA FIBER BASED EPOXY COMPOSITES

G.Devendhar Rao[1]., K.Srinivasa Reddy[1]., P.Raghavendra Rao[2] and P.Madusudana Rao[1]

[1]Department of Physics, JNTUHCEH, Kukatpally, Hyderabad, India
[2]Department of H & S, VNRVJIET, Bachupally, Hyderabad

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A B S T R A C T

In the quick Creating world, the worry to the ecological contamination and the counteractive action of non-renewable furthermore non biodegradable assets need pulled in analysts looking to create new eco-friendly materials what's more items dependent upon manageability standards. Last couple decades need seen composite materials constantly utilized predominantly to different requisitions. Fiber composites are hosting great deal of preferences and also requisitions which need aid bio degradable, prudent furthermore non-toxic. Hence, they are displace routine materials done aerospace, automotive, farming also development commercial enterprises. Common fibers for example, Abaca, sisal, jute, acacia, ramie, hemp, flax, bamboo Furthermore banana need aid favored by and large On commercial enterprises to settling on composites utilizing epoxy and polystyrene tar. The over ground parts similar to pseudo-stem and peduncle would the significant hotspot about fiber. In the present experiment, banana fiber fortified epoxy composites are arranged and the mechanical properties about these composites are assessed. The composite samples with different fiber volume fractions were prepared by using the hand lay-up process and apply pressure at room temperature. The samples were subjected to the mechanical testing such as tensile, flexural and impact loading.

INTRODUCTION

The common fibers are renewable, non-abrasive, bio-degradable, have a great calorific value, show phenomenal mechanical properties furthermore might make incinerated for vitality recuperation need low thickness furthermore need aid modest.This good environmental friendly feature makes the materials very popular in engineering markets such as the automotive and construction industry [1, 2]. The incorporation of natural fibers with glass fiber improve the tensile and flexural strength and these composites can be used for medium strength applications [3]. At present the banana fiber is a waste product of banana cultivation, therefore without any additional cost these fibers can be obtained for industrial purposes [4]. Pothan *et al* [5] studied the dynamic mechanical behavior of banana fiber reinforced polyester composites and found that the volume fraction of the fiber has great influence on the mechanical properties of the composites. The maximum strength is observed for composites with 40% fiber loading, which is chosen as the critical fiber loading. Idicula *et al.* [6] investigated the mechanical properties of short banana/sisal fiber reinforced with random orientation mixed hybrid polyester composites. The results shows that, the fiber/matrix adhesion and stress transfer was found to be good in composite with relative volume fraction of banana and sisal 3:1, which shown the highest tensile strength and flexural modulus. The chemically treated banana fibers reinforced composites exhibited superior mechanical properties than untreated fiber reinforced composites [7-12]. The improvement in the properties was found mainly due to the better packing of the cellulose chains, after the dissolution of lignin, which is the cementing material [12]. Sathasivam *et al*. [13] prepared the banana trunk fibers and polyvinyl alcohol blended composite films and examined their physical characteristics. They found that the increase in the fiber content improved the physical characteristics and decreased the degree of swelling when compared to unblended films. They suggested that these films can be used as an alternate replacing material for food packaging materials. Biswal *et al*. [14] examined the mechanical and morphological properties of polypropylene modified banana fiber nano-composites and observed that the improved mechanical properties by treating the mercerized banana fibers with NaOH solution. Vasishth *et*

Corresponding author:* **G.Devendhar Rao
Department of Physics, JNTUHCEH, Kukatpally, Hyderabad, India

al. [15] studied the Rheological Properties of viscosity of Industrial Lubricants.

Properties of banana fiber

Figure.1 Banana fiber

Banana fiber is a lingo-cellulosic fiber, which obtain from the pseudo-stem of banana plant. Banana fiber is a bast fiber with comparatively good mechanical properties. Banana fiber has good specific strength properties equivalent to those of conventional material, like glass fiber. This material has a lower density then glass fibers. The pseudo-stem is a cylindrical, clustered aggregation of leaf stalk bases. Banana fiber at is a waste product of banana farming and either not properly utilized or incompletely done so. Useful applications of such fibers would normalize the demand which would be reflected in a fall of the prices. Banana fibers have highly strength, light weight, smaller elongation, fire resistance quality, strong moisture inclusion quality, great potentialities and biodegradability. Banana fiber has documented for apparels and home furnishings. Banana fiber has great potentialities for paper making special require of handmade paper. Banana fiber is making products like filter paper, paper bags, greeting cards, lamp stands, pen stands, decorative papers, rope, mats and composite material etc. Banana fiber is used in currency notes in Germany and trial run in India also. Polypropylene reinforced with banana fiber is use by automobile companies for making under floor protection panels in luxurious cars like Mercedes. Banana fiber mostly used in manufacture handicrafts and home decorative. Composite material of banana fiber used in buildings boards and fire resistance boards. During the research it was found that paper made out of this fiber has long life of over 100 years as it is strongest of the long fibers over found other natural fibers, which can be folded 3,000 times.

Table 1 Production details of fibers, origin of banana fibers

Botanical name	Musa Ulugurensiswarb
Palnt origin	Leaf, bast
Production per metric ton	200

Table 2 Physical properties of the banana fibers

Dia(μm)	80-250
Length(mm)	1000-5000
Aspect Ratio(l/d)	150
Moisture content (%)	60

Table 3 Chemical composition of banana fibers

Cellulose (%) 60	65
Hemi cellulose (%) 6	19
Lignin (%) 5	10
Pectin (%) 3	5
Ash (%) 1	3
Extractives (%) 3	6

Table 4 Mechanical properties of banana fibers

Tensile Strength (Mpa)	529-914
Specific Tensile Strength(Mpa)	392-677
Young’s Modulus(Gpa)	27-32
Specific Young’s Modulus (Gpa)	20-24
Failure Strain (%)	1-3
Density (Kg/m3)	750-950

Preparation of composites

The banana fiber is obtained from banana plant, which has been collected from local sources. The extracted banana fiber were subsequently sun dried for eight hours then dried in oven for 24 hours at 105° C to remove free water present in the fiber. The dried fiber were subsequently cut into lengths of 5, 10, 15 mm. The epoxy resins and hardener are procured from Ciba Geigy India Ltd. The banana fiber based epoxy composite is fabricated using hand lay-up process. The moulds have been prepared with dimensions of 180×180×40 mm^3. The banana fiber of different length has been mixed with matrix mixture with their respective values by simple mechanical stirring and mixtures are slowly poured in different moulds, keeping the characterization standards and view on testing condition. The releasing agent has been use on mould sheet which give easy to composites removal from the mould after curing the composites. A sliding roller has been used to remove the trapped air from the uncured composite and mould has been closed at temperature 30° C duration 24 hour. The constant load of 50 kg is applied on the mould in which the mixture of the banana, epoxy resin and hardener has been poured. After curing, the specimen has been taken out from the mould. The composite material has been cut in suitable dimensions with help of zig saw for mechanical tests as per the ASTM standards. The designation and detail composition of composites is shown in Table 1.

Experimental Methods

Tensile testing

The machine comprises of a loading unit (or straining unit), control panel, Hydraulic system, pendulum dynamometer, load indicating system and load-elongation recording system. Tensile test is conducted by gripping the tests specimen between the upper and middle crosshead. Compression and Bending tests are conducted between the middle crosshead and the lower table.

Fig 2 UTM for tensile test

Fig 3 Showing the specimen before and after tensile test

Flexural Testing

Flexural tests are generally used to determine the flexural modulus or flexural strength of a material. A flexure test is more affordable than a tensile test and test results are slightly different. The material is laid horizontally over two points of contact (lower support span) and then a force is applied to the top of the material through either one or two points of contact (upper loading span) until the sample fails. The maximum recorded force is the flexural strength of that particular sample.These test methods cover the determination of flexural properties of unreinforced and reinforced plastics, including high-modulus composites and electrical insulating materials in the form of rectangular bars molded directly or cut from sheets, plates, or molded shapes. These test methods are generally applicable to both rigid and semi rigid materials. However flexural strength cannot be determined for those materials that do not break or that do not fail in the outer surface of the test specimen within the 5.0 % strain limit of these test methods. These test methods utilize a three-point loading system applied to a simply supported beam.

Fig 4 Showing the specimen before and after flexural test

Fig 5 Showing the apparatus and specimen during flexural test

Impact strength

The impact test is used to determine the behavior of material when subjected to high rates of loading usually in bending, tension or torsion. In the impact test, the impact strength i.e., resistance to shock loads and the toughness of material under dynamic load is determined. The principle employed in all impact testing procedures is that a material absorbs a certain amount of energy before it breaks or fractures. The quantity of energy thus absorbed is characteristic of the physical nature of the materials. If it is brittle it breaks more readily, i.e.., absorbs a lesser quantity of energy and if it is ductile, it needs more energy for fracture.

Fig 6 Specimen before impact test

Fig 7 Specimen after impact test

RESULTS AND DISCUSSIONS

The mechanical behavior of the banana fiber based epoxy composites depends on fiber parameters. The influence of fiber length and loading on tensile properties of composites is shown in Figures. It has been observed that the tensile strength of composites increases with increase in fiber length and loading.

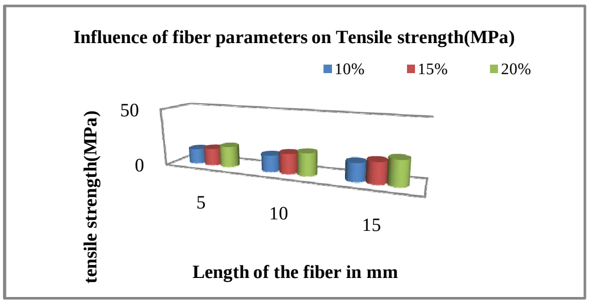

Fig 8 Influence of fiber parameters on tensile strength

Influence of Fiber Parameters on Flexural Strength

The influence of fiber length and loading on flexural strength of fabricated composites is shown in Figure. In figure it is show that when fiber length increases the flexural strength of the fabricated composites first increases up to 10 mm length and then decreases. When fiber loading increase then flexural strength increase up to fiber loading 15% then decreases. The maximum flexural strength is observed when fiber length is 10 mm and loading is 15%.

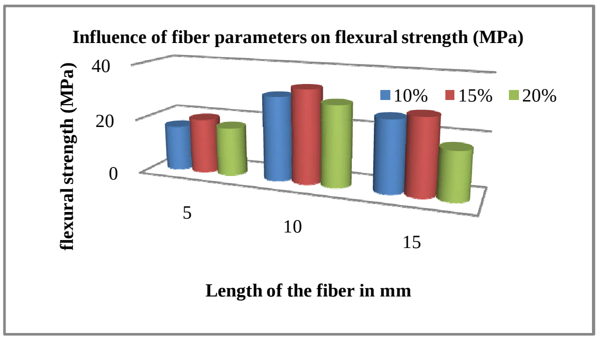

Fig 9 Influence of fiber parameters on flexural strength (MPa)

Influence of Fiber Parameter on Impact Strength

The test results for impact energy are shown in Figures .From the figure it is observed that the impact energy is increases with increase in fiber length. It also show that the impact energy increases with increases in fiber loading. The maximum impact energy absorbed by the material 15 mm length of fiber and 20% fiber content.

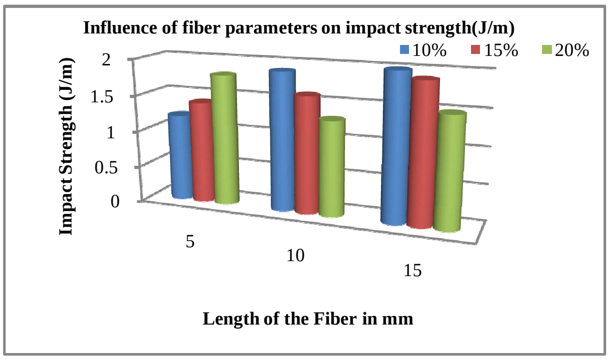

Figure 10 Influence of fiber parameters on impact strength(J/m)

CONCLUSIONS

This mechanical behavior of banana fiber based epoxy composites indicates to many conclusions. The fabrication of banana fiber based epoxy composites with different loading of fiber and different lengths of fiber are possible by hand lay-up process. From the current experiments results, it has been observed that fiber loading and length has major effect on the mechanical properties of the composites like as hardness, tensile strength, flexural strength. It has been observed that the better mechanical properties found for composites reinforced with 10 mm fiber length with 15% fiber loading.

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