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Analysis and Fabrication of Mechanical Properties of Banana and Sisal Hybrid Composites

M.Gokul¹, S.Samraj², A.Samidurai³, A.Thirupathi⁴

Assistant Professor, Department of Mechanical Engineering, Muthayammal Engineering College, Rasipuram, Tamil

Nadu, India¹

U.G. Student, Department of Mechanical Engineering, Muthayammal Engineering College, Rasipuram, Tamil Nadu,

India^{2,3,4}

ABSTRACT: The focus of the project is the development of the natural fibres composites primarily to explore value application avenues. The development of the natural fibre composites in India is based on the two pronged strategy of preventing depletion of the forest resources as well as good economic returns for natural fibres. Banana and Sisal based composites have been developed substitutes for ply wood and medium density fibre boards. In this project natural fibre composites were fabricated, by combining materials of Banana and Sisal in chopped from hand lay method. Epoxy resin was used as matrix material. The NFR composite were made in different fibre volume fraction such as12.5% of Banana and 12.5% Sisal. The mechanical properties of these samples were investigated according to the ASTM standards. From the result it was observed that the 12.5% of Banana and 12.5% of sisal fibre reinforcement showed the highest flexural strength among the other fibre volume fraction.

KEYWORDS: Natural fiber, Banana fibre, Sisal fibre, Epoxy Resin.

I. INTRODUCTION

The advantage of composite materials over conventional materials stem large from their higher specific strength, stiffness and fatigue characteristics, which enables structural design to be more versatile. By definition, composite materials consist of two or more constituents with physically separable phases. However, only when the composite phase materials have notably different physical properties it is recognized as being a composite material.

Composites are materials that comprise strong load carrying material (known as reinforcement) imbedded in sweaker material (known as matrix). Reinforcement provides strength and rigidity, helping to support structural load. The matrix or binder (organic or inorganic) maintains the position and orientation of the reinforcement. Significantly, constituents of the composites retain their individual, physical and chemical properties; yet together they produce a combination of qualities which individual constituents would be incapable of producing alone.

The reinforcement may be platelets, particles or fiber and are usually added to improve mechanical properties such as stiffness, strength and toughness of the matrix material. Long fibers that are oriented in the direction of loading offer the most efficient load transfer. This is because the stress transfer zone extends only over a small part of the fibermatrix interface and perturbation effects at fiber ends may be neglected. In other words, the ineffective fiber length is small. Popular fibers available as continuous filaments for use in high performance composites are glass, carbon and aramid fibers.

The matrix material can be metallic, polymeric or can even be ceramic. When the matrix is a polymer, the composite is called polymer matrix composite. Fiber reinforced polymer (FRP) composite are the most common advanced composites. These composites consist of a polymer matrix reinforced with thin diameter fibers. The reasons why they are the most common composite include low cost, high strength, and simple manufacturing processes.



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Vol. 4, Special Issue 6, May 2015

There are many polymer resin system used as matrices in FRP composites. They can be classified as thermoplastic (polyethylene, polypropylene, nylon, etc) and thermoset (epoxies, polyesters, vinyl ester, etc) polymer. Thermoplastic polymer can be repeatedly softened and formed by increasing the temperature or hardened by decreasing the temperature, while the thermoset polymers are insoluble and infusible after cure.

As far as reinforcement is concerned fibers occupy the largest weight fraction in a FRP composite and it share its major portion of the load that act on the composite structure. There inforcing fibers can be oriented during fabrication there by giving sample opportunity to the designer to tailor down the properties in specific direction.

The major fibers in use today are glass, carbon and aramid. Recently research on engineering interest have been shifting from traditional synthetic fiber composite to lignocellulose natural fiber composite due to their advantages like high strength to weight ratio, non-carcinogenic and biodegradability. The term natural fiber covers a broad range of vegetables, animal and mineral fibers. Availability of natural fibers and easy of manufacturing is tempting researcher to try locally available inexpensive natural fibers as reinforcement material in polymer matrix.

The other advantages associated with natural fibers are nonabrasive nature, low energy consumption, biodegradability, light weight and low cost. Careful selection of reinforcement type enables finished product characteristics to be tailored to almost any specific engineering requirement. Whilst the use of composites will be a clear choice in many instances, material selection in others will depend on factors such as working lifetime requirements, number of items to be produced (run length), complexity of product shape, possible savings in assembly costs and on the experience & skills the designer in tapping the optimum potential of composites. In some instances, best results may be achieved through the use of composites in conjunction with traditional materials. **Bio composite**



Classification of Natural/Bio-fibers

II. PROBLEM IDENTIFICATION IN OTHER MATERIALS

The existing system work had made by using single natural fiber, various mechanical test was carried out. But mechanical properties not much enough .To rectify this problem, work have made on the hybrid fiber using procedures should be follow

1. To fabricate a suitable alternative material for wood products and plastic products this is an economically viable alternative and should be easy to fabricate.

Fig. 1



(An ISO 3297: 2007 Certified Organization)

Vol. 4, Special Issue 6, May 2015

- 2. The banana is very good in compressive properties. But we need of composite materials as good in all mechanical properties such as, tensile strength, Flexural strength etc.
- 3. Sisal is good in tensile, flexural strength but moderate of compressive strength etc. So we use the hybrid fiber (Sisal & banana) with epoxy, it is good in flexural strength and also tensile strength.
- 4. To fabricate hybrid fiber epoxy reinforced composite with various volume fraction.
- 5. To evaluate the mechanical properties such as tensile strength, flexural strength, impact strength.

Raw Material Selection

The natural fibers selected for the making of composites are

- Sisal fiber
- ➢ Banana fiber

The Resin selected for the making of composites are

- Epoxy resin
- Sisal fiber



Fig 2 Sisal fiber

Sisal is a natural fiber (Scientific name is Agave sisalana) of Agavaceae (Agave) family yields a stiff fiber traditionally used in making twine and rope. Sisal is fully biodegradable and highly renewable resource of energy. Sisal fiber is exceptionally durable and a low maintenance with minimal wear and tear. Sisal fiber is extracted by a process known as decortication, where leaves are crushed and beaten by a rotating wheel set with blunt knives, so that only fibers will remain.

Banana fiber



Fig 3 Banana Fiber

The stress –strain curve for banana fiber is determined. Properties such as the initial modulus(YM),ultimate tensile strength(UTS) and percentage elongation are evaluated as a function of fiber diameter, test length and speed of testing. It is found that YM,UTS and % elongation show little variation in their values for fibers of diameter ranging from 50 to 250 μ m. The UTS and breaking strain are found to decrease with an increase in the test length while both breaking strength and breaking strain remain constant with the increase of speed of testing from 0.5 to 100 x10⁻³m and thereafter they both decrease.

These observed properties are explained on the basis of the internal structure of the fiber, namely, the number of cells, spiral angle and the number of defects. Scanning electron microscopic (SEM) studies of the fractured surfaces of the fibers indicate that the failure is due to pull-out of microfibrils accompanied by tearing of cell walls; the tendency for fiber pull-out seems to decrease with increasing speed of testing.



(An ISO 3297: 2007 Certified Organization)

Vol. 4, Special Issue 6, May 2015

5.3 Epoxy resin

Epoxy Resin EP -306, Hardener EH – 758 is used to fabricate the composite.

Epoxy resins are polyether resins containing more than one epoxy group capable of being converted into the thermoset form. These resins, on curing, do not create volatile products in spite of the presence of a volatile solvent. The epoxies may be named as oxides, such as ethylene oxides (epoxy ethane), or 1,2 epoxide. The epoxy group also known as oxirane contains an oxygen atom bonded with two carbon atoms, which in their turn are bound by separate bonds.

(Scheme I)



The simplest epoxy resin is prepared by the reaction of bisphenol A (BPA) (80-05-7) with epichlorohydrine (ECH) (106-89-8)

(Scheme II)



The value of n varies from 0 to 25. This determines the end-use applications of the resin.

The Advantages of Epoxy Resin versus Polyester



Fig 4 Comparative Tensile Strength of Resins



Fig 4 Comparative Stiffness of Resins



(An ISO 3297: 2007 Certified Organization) Vol. 4, Special Issue 6, May 2015

Fabrication of Hybrid Composite



Fig 5Compression Moulding Machine

Compression moulding is a method of moulding in which the moulding material, generally preheated, is first placed in an open, heated mould cavity. The mould is closed as shown in figure 6.1 with a top force or plug member, pressure is applied to force the material into contact with all mould areas, while heat and pressure are maintained until the moulding material has cured.

The process employs thermosetting resins in a partially cured stage, either in the form of granules, putty-like masses, or preforms. Compression moulding is a high-volume, high-pressure method suitable for moulding complex, high-strength fiberglass reinforcements. Advanced composite thermoplastics can also be compression moulded with unidirectional tapes, woven fabrics, randomly oriented fiber mat or chopped strand. The advantage of compression moulding is its ability to mould large, fairly intricate parts.

Also, it is one of the lowest cost moulding methods compared with other methods such as transfer moulding and injection moulding; moreover it wastes relatively little material, giving it an advantage when working with expensive compounds. However, compression moulding often provides poor product consistency and difficulty in controlling flashing, and it is not suitable for some types of parts. Fewer knit lines are produced and a smaller amount of fiber-length degradation is noticeable when compared to injection moulding.

Compression-moulding is also suitable for ultra-large basic shape production in sizes beyond the capacity of extrusion techniques. Materials that are typically manufactured through compression moulding include: Polyester fiberglass resin systems (SMC/BMC), Torlon, Vessel, Poly phenylene sulfide) (PPS), and many grades of PEEK.

Compression moulding was first developed to manufacture composite parts for metal replacement applications compression moulding is typically used to make larger flat or moderately curved parts. This method of moulding is greatly used in manufacturing automotive parts such as hoods, fenders, scoops, spoilers, as well as smaller more intricate parts.

The material to be moulded is positioned in the mould cavity and the heated platens are closed by a hydraulic ram. Bulk moulding compound (BMC) or sheet moulding compound (SMC), are conformed to the mould form by the applied pressure and heated until the curing reaction occurs. SMC feed material usually is cut to conform to the surface area of the mould. The mould is then cooled and the part removed.

Materials may be loaded into the mould either in the form of pellets or sheet, or the mould may be loaded from a plasticizing extruder. Materials are heated above their melting points, formed and cooled. The more evenly the feed material is distributed over the mould surface, the less flow orientation occurs during the compression stage.



(An ISO 3297: 2007 Certified Organization)

Vol. 4, Special Issue 6, May 2015

Thermoplastic matrices are commonplace in mass production industries. One significant example are automotive applications where the leading technologies are long fiber reinforced thermoplastics (LFT) and glass fiber mat reinforced thermoplastics (GMT).

In compression moulding there are six important considerations that an engineer should bear in mind

- Determining the proper amount of material.
- Determining the minimum amount of energy required to heat the material.
- Determining the minimum time required to heat the material.
- Determining the appropriate heating technique.
- Predicting the required force, to ensure that shot attains the proper shape.
- Designing the mould for rapid cooling after the material has been compressed into the mould.

Experimental Result And Discussion

This chapter deals with testing result of composite material the various test performed in mechanical testing are

- i) Tensile test result
- ii) Flexural test result
- iii) Impact test result

Tensile Test Result

Tensile test is done by applying tensile load on the body using Schimadzu AGI universal testing machine. The test is conducted for the hybrid composite material of length 30mm and volume fraction of Sisal & Banana 60:40(treated) &70:30(untreated). Tensile strength result of Sisal & Banana Hybrid composite.

Flexural Test result

Flexural is also known as bending test .It is done by applying a point load at the center of the composite. It's also carried out using universal testing machine. The Test is conducted for hybrid composite material of Sisal & Banana epoxy composite.

III. CONCLUSION

- ▶ The tensile strength is 17.486 N/mm² for 12.5% Banana and 12.5% Sisal fiber epoxy composite.
- ▶ The flexural strength is 57.176 MPa for 12.5% Banana and 12.5% Sisal fiber epoxy composite.
- > The impact strength is 0.4 J for 12.5% Banana and 12.5% Sisal fiber epoxy composite.
- From the experimental study it can be is suggested that the 25% Banana Sisal fibers and 75% epoxy resin composite materials can withstand the higher loads when compared to the other combinations and used as an alternate materials for conventional fiber reinforced polymer composites.
- Future work of our project will deals with the analysis of properties of the composite with change of continuous and woven fiber changes in the resin.

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(An ISO 3297: 2007 Certified Organization)

Vol. 4, Special Issue 6, May 2015

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