



Development and Characterisation of Banana and E-Glass Fiber Reinforced With Isophthalic Resin Based Composites

A.K. Arun Raja, K. Arun Vasantha Geethan, G. Tamilarasan, S.J. Shanoffer, S. Rathish

Abstract : *Natural fibers can have different advantages over synthetic reinforcing fibers as they are renewable. Thus the natural fibers have been used to reinforce materials in many composites structures. Among the various fibers banana fibers are used because of its light weight properties and it is locally available in all over India and Tamilnadu. Banana fibers obtained from the stem of the plant and it is a ligno cellulosic under exploited bast fibers, where E-glass being a synthetic fiber so the properties of Banana fabric reinforced composite has been compared with E-glass fabric based composites. Here the banana fabric mat is being separately treated with the caustic soda (NaOH) solution in water by the process of mercerization, both the fabric mat reinforced in isophthalic resin and filler chalk powder by 2% weight added, in order to compare their properties under various experiments such as TENSILE, HARDNESS, IMPACT, SEM and the FIRE RETENTION TEST.*

Keywords: *Banana fiber, E-glass fiber, Isophthalic, Mercerization*

I. INTRODUCTION

Now a days the use of natural fibers as reinforcement in composite materials are widely used as an alternative for many applications. The engineers and scientists get lured to these fibers because of their reasonably good mechanical properties, sustainable and decomposable characteristics [1]. Their high strength and low cost also add them in the list of favourites. The principle motive for natural fibre reinforced composites is to enhance the mechanical behavior such as tensile and impact strength economically [2]. These features hold them superior than the traditional artificial composites. Natural fibers may have average mechanical properties but if treated properly with other chemicals and materials, they can

perform the same job as the artificial fibers. The study conducted by Ku H and Wang H on natural fiber reinforced composite shows that the tensile load bearing function are observed to be enhancing to maximum level with the fiber content [3]. The study conducted by Mohanty AK [4] shows that the benefit of reprocessability make them ideal for reinforcement of thermoplastics and thermosets. In today's world there is a huge demand for ecofriendly, pollution free and renewable products and natural fibers meet the above required criteria in the field of science. They have even stretched their hands in the fields of automobile, construction, aerospace and furnitures [5]. Due to the growing global energy crisis and ecological risks lately, the natural fiber reinforced composites have drawn greater research attention. Several studies even prove that prime properties can be achieved by merging natural and synthetic fibers in the same matrix. Natural fibers are obtained from plants, animals and certain minerals. Banana fiber is one of the largely obtained natural fiber in India. It looks similar to bamboo and ramie fiber and has relatively good mechanical properties due to the high amount of cellulose. Until last decade the use of banana was only limited, but due to the increase in environmental awareness it has been recognised for its good qualities. The durability of the polyester composites has increased vitally when banana is added to them [6]. It has gained importance in polymer composite materials and is being used in various fields such as papermaking, furnitures, food packaging, building interiors and in some electronic components. Experiments in the past convey that banana laminates appear to have finer work on the flexural strength and can hold out upto 192 Mpa [7]. Several degradation studies conclude that there is an increase in surface roughness when treated with alkali solution. The properties of banana fiber reinforced composite is analysed and compared with the e-glass fiber reinforced composite in this work. This work is done to clarify whether banana fiber comes par with the performance of e-glass fibre in addition to its low cost and lightweight.

II. EXPERIMENTAL

A. Materials used

1) Banana fabric

Banana plant is the largest herbaceous flowering plant. It is typically available in abundance in tropical and subtropical region.

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Pseudo stem is the main source of the plant from which large amount of fiber can be obtained. Thus the chemical composition of banana fiber is cellulose (63-64%) , hemicelluloses (19%) , and lignin (5%) and the density of banana fiber is 1350 kg/m³.

2) E-glass fabric

Glass fiber is formed when thin strands of silica based glass are extruded into many fibers with small diameters suitable for textile processing. The major ingredients are silica sand, limestone and soda ash , where silica sand used as glass former and soda ash and limestone used to lower the melting temperature. Glass fibers are used as reinforcements of polymers in many fields such as aerospace , automobile etc....

3) Hardener and catalyst

MEKP DDM-9 Methyl Ethyl Ketone Peroxide Hardener catalyst is used.

4) Isophthalic resin

High strength Isophthalic resin is a low-viscosity polyester resin with good heat and chemical resistance. It is used in mold making because of its extreme durability. Polyester can withstand a temperature upto 80 °C. They show resistance to weathering and ageing.

B. Composite Preparation

Composite material were fabricated by using mercerization treatment and hand lay-up process. In mercerization process the banana fabric matte is treated with the caustic soda (NAOH) at ambient temperature and after dried for 24 hours ,it helps to improve the strength and gives better smoothness to fabric matte. In hand lay-up process the reinforced banana fabric and E-glass fabric matte are treated separately with the isophthalic resin and the filler chalk powder and the catalyst and the hardener at room temperture. The mixture is applied to the fabric matte till its reaches the desired thickness and then they are dried for 2 hours. The weight ratio of fabric: Resin: Filler -20:78:2. The following photos show how the fabrication of both fibres was done.



Fig.1. Mercerization process



Fig.2. Banana fabric composite



Fig.3. E-glass Fabric Composite

III. TEST

Experimental procedures are performed as through the ASTM standards. Mechanical tests such as Tensile, Flexural, Impact are performed as per the ASTM D-638, ASTM D-790, ASTM D-256 standards. Rate of burning and SEM are performed as per the ASTM D-635, ASTM F1372 Standards.

A. Tensile test

A tensile test, otherwise called a strain test, is one of the most principal and regular sorts of mechanical testing. An elastic test applies tractable (pulling) power to a material and measures the example's reaction to the pressure. utilizing the malleable or pressure test technique, includes applying an ever-expanding burden to a test up to the point of disappointment. The cycle makes a pressure/strain bend indicating how the material responds all through the pliable test. Along these lines the ductile test is performed through the widespread testing machine.



Fig.4.Universal testing machine

B. Flexural test

Flexural testing estimates the power needed to twist a light emission material and decides the protection from flexing or solidness of a material.

Flex modulus is demonstrative of how much the material can flex before lasting twisting. Flexural quality estimates a paver's capacity to oppose breaking when weight is applied. The outcome assists with finding out the items application appropriateness and life span just as the end client's wellbeing.



Fig.5.Flexural testing machine

C. Impact test

The Charpy impact test, otherwise called the Charpy V-score test decides the measure of vitality consumed by a material during break. This ingested vitality is a proportion of a given material's sturdiness and goes about as a device to consider temperature-subordinate weak flexible progress. It is to decide if the material is fragile or bendable in nature. It's an electronic test that estimates memory, ability to focus, visual and verbal critical thinking. Effect has two essential uses: before the beginning of a movement, a gauge test is led to quantify the competitor's exhibition pattern.



Fig.6. Impact testing machine

D. Rate of burning

This test strategy was created for polymeric materials utilized for parts in gadgets and apparatuses. After expulsion of the fire, the test example is watched for time and degree of consuming. A normal consuming rate is accounted for a material on the off chance that it consumes to the 100 mm mark from the touched off end.

E. SEM

Scanning Electron Microscopy (SEM) is a test cycle that filters an example with an electron shaft to deliver an amplified picture for investigation. The technique is otherwise called SEM examination and SEM microscopy, and is utilized viably in microanalysis and disappointment investigation of strong inorganic materials. SEM investigation, gives high-goal imaging helpful to assessing different materials for surface cracks, blemishes, contaminants or erosion.



Fig.7. SEM testing machine

IV. RESULT AND DISCUSSION

The results are obtained from the average of the following tests. Minimum of five test samples are used for the testing. The average test results obtained are tabulated and graphical representation are provided. Consider the test sample,

- A as Banana fabric
- B as E-glass fabric

A. Mechanical properties

Mechanical properties such as tensile, flexural and impact values are tabulated. It could be seen that E-glass fiber has greater mechanical properties than Banana fiber .

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| SPECIMEN | TENSILE STRENGTH | FLEXURAL LOAD | IMPACT VALUES |
|----------|------------------|---------------|---------------|
| UNITS | Mpa | Mpa | Joules |
| A | 44.5 | 430 | 2 |
| B | 65.28 | 220 | 12 |

Table 1: Mechanical properties readings

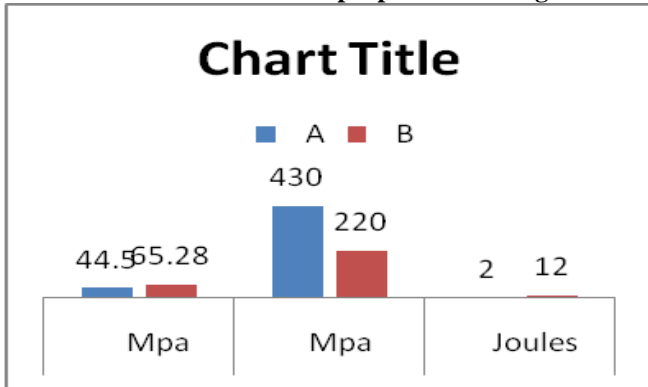


Fig.8. Comparison of mechanical properties

B. Rate of Burning

In rate of burning test, As far as pace of consuming it is high in banana fiber followed by E-glass by little edge which influences the application and utilization of the material. Two samples were tested in each test.

Table 2: Rate of burning readings

| SPECIMEN | RATE OF BURNING |
|----------|-----------------|
| UNITS | (mm/min) |
| A | 22.9 |
| B | 20.84 |

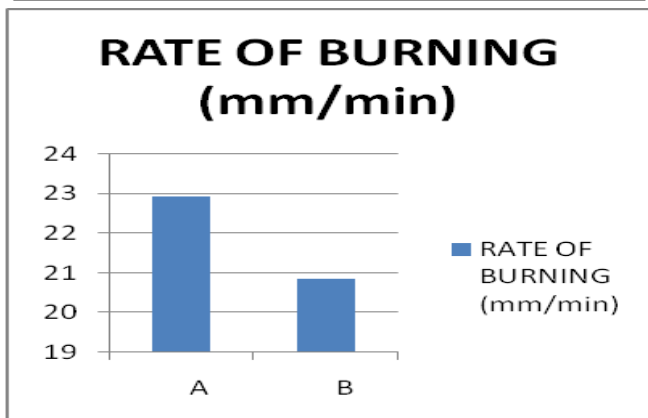


Fig.9. Comparisons of specimens based on Rate of burning

C. SEM

Fig.10 and Fig.11 is the SEM perspective on banana fiber composite example after the ductile examinations. This picture uncovers that the Banana fiber has improved the mechanical property. From the picture we can say that the dispersion of cross breed pitch is overwhelmed the fiber impact. Thus, the outcomes think about shows that the Banana fiber shows better outcome in this examination

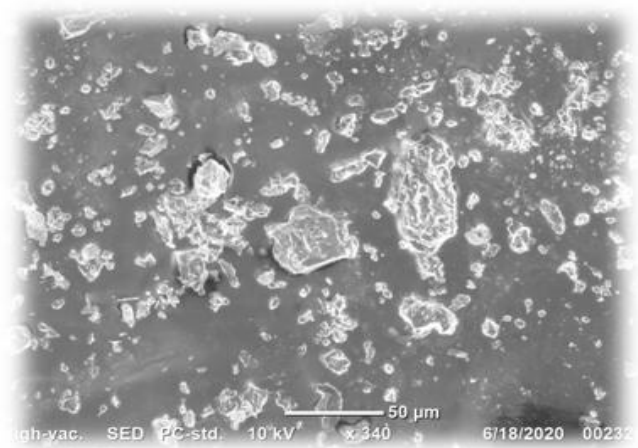


Fig.10. SEM Image of Banana Fiber

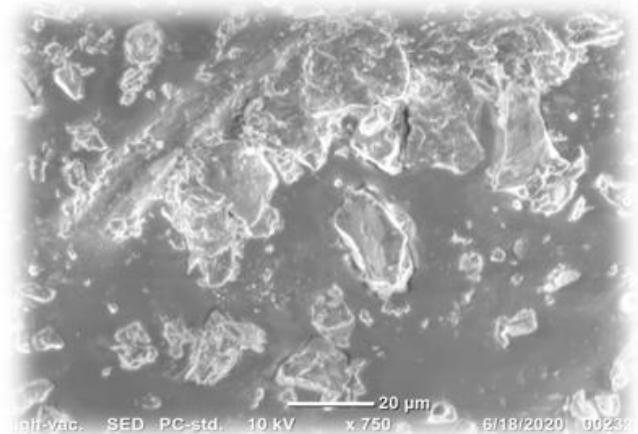


Fig.11. SEM Image of Banana Fiber

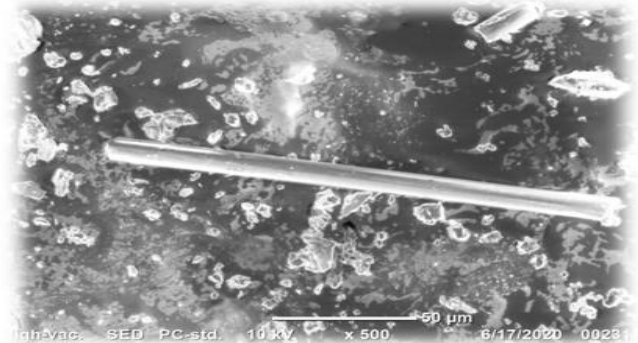


Fig.12. SEM Image of E-Glass Fiber

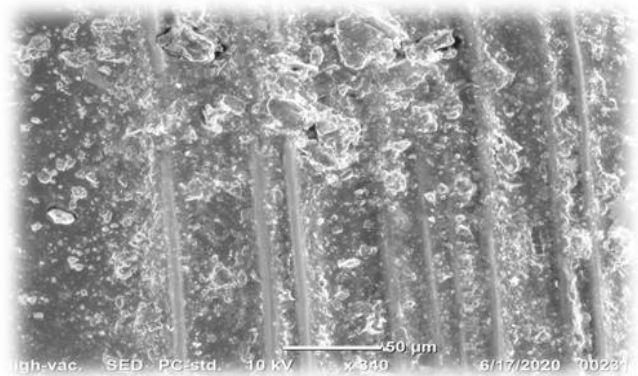


Fig.13. SEM Image of E-Glass Fiber

SEM pictures of E-Glass fiber composite examples are appeared in Fig.12 and Fig.13. Fig.12 shows the SEM of E-Glass composite after tractable test and it uncover that the courses of action of fiber isn't thick, and voids are available in it, so mechanical properties yield poor in this classification.

V. CONCLUSION

In light of the examination of test outcomes and test tests, the accompanying ends can be drawn

- This undertaking presents the manufacture of mixture composite utilizing banana and E-glass fiber strengthened polymer composite by hand layup strategy.
- From the tests The accompanying end are drawn. Since the overlays are relieved utilizing hand layup strategy is extremely straightforward and less expense
- From the tensile test it is discovered that, the greatest rigidity was unadulterated E-glass layer and least is unadulterated banana
- From the flexural test, it shows that the Banana has highest flexural strength and the E-glass has lowest flexural strength
- It is found from the impact test that, quality of E-glass is the most noteworthy (12joules) and Banana (2joules) has the least effect quality.
- Ductile properties show constructive outcome. Break conduct of tractable disappointment tests were examined from checking electron micrographs (SEM).
- In pace of consuming, pace of devouring it is high in banana fiber followed by E-glass by little edge.

In future different other normal fortifying material could be utilized to blend in with banana fiber to shape a superior mixture composite which has a superior mechanical property and is Ecologically cordial than E-glass fiber and just as financially savvy.

REFERENCES

1. M. R. Sanjay, G. R. Arpitha, L. Laxmana Naik, K. Gopalakrishna, B. Yogesha, "Studies on Mechanical Properties of Banana/E-Glass Fabrics Reinforced Polyester Hybrid Composites".
2. P. Divya Vani, P. Prasanna, "Experimental Investigation of Mechanical Properties of Banana and Glass Fiber Reinforced Epoxy Based Hybrid Composites with Filler Materials".
3. H. Ku, H. Wang, N. Pattarachaiyakop, M. Trada, "A review on the tensile properties of natural fiber reinforced polymer composites".
4. Mohanty AK, Drazl LT, Misra M, "Engineered natural fiber reinforced polypropylene composites: influence of surface modifications and novel powder impregnation processing". J Adhes Sci Technol 2002; 16(8):999-1015.
5. Yegireddy Haribabu., "Study of Mechanical Properties of Banana and E-Glass Fiber Composite".
6. V.P. Arthanarieswaran, A. Kumaravel, M. Kathirselvam., "Evaluation of mechanical properties of banana and sisal fiber reinforced epoxy composites: Influence of glass fiber hybridization".
7. Saurab Dhakala, Keerthi Gowda B Sb, "An Experimental Study on Mechanical properties of BananaPolyester Composite".
8. SK Khasim Sharif , Shankarlinga B. Shikkeri , K. Rajanikanth , "Mechanical characterization of Jute/Banana/Epoxy reinforced laminateComposite".
9. R.D. HEMANTH, M. SENTHIL KUMAR, AJITH GOPINATH & L. NATRAYAN, "Evaluation of mechanical properties of e-glass and coconut fiber reinforced with polyester and epoxy resin matrices".
10. Samrat Mukhopadhyay S, Raul Fangueiro R, Yusuf A,Senturk Ulku, "Banana fibers- variability and fracture behavior". J Eng Fiber Fabric 2008; 3:1-7.

11. Sureshkumar Perumal Singaraj, Kavati Phene Aaron, Krishnaraj Kaliappa, Karthikeyan Kattaiya & Mohan Ranganathan, " Investigations on Structural, Mechanical and Thermal Properties of Banana Fabrics for Use in Leather Goods Applications.

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