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**Research Article**

# FABRICATION AND INVESTIGATION OF BANANA FIBER AND JUTE FIBER REINFOERCED COMPOSITE MATERIAL

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**ABSTRACT**

In the current scenario Automobile industry focuses on enhancing the strength and reducing the weight of body parts. The fuel efficiency and emission regulation of two wheelers are two important issues in these days. The best way to increase the fuel efficiency without sacrificing safety is to employ fiber reinforced composite materials used for the two wheeler. In this study two wheeler mudguard which is used to protect the mud and rain water placed on front and rear wheel is considered for investigations. Mudguard is the one of the part having more weight and in my work, the existing steel/ABS plastic mudguard replace with composite mudguard. The fabrication of composite material is made up of Epoxy resin with banana and jute reinforced polymer is carried out and weight of the mudguard will reduce. In this work, fabrication of Banana and jute fiber composite material is completed and its mechanical properties like hardness, tensile strength etc., are calculated and analyzed. Experimental testings are conducted before and after curing with four different sample ratios. The maximum values are obtained for the sample ratios (40:60, 50:50)

**Key words:-** Composite materials, Banana and jute fibers, Epoxy resin

## 1. INTRODUCTION

Composites are materials made by combining two or more constituent materials with significantly different physical or chemical properties. They're engineered to enhance specific characteristics like strength, durability, or conductivity. Common types include fiber-reinforced polymers (like carbon fiber), metal matrix composites, and ceramic matrix composites. They find extensive applications in aerospace, automotive, construction, and sports industries, among others due to lightweight nature and tailored properties.

Composite materials have come to be known as the emerging materials of this century. Although it is not clear, man understood the fact that mud bricks made sturdier houses if lined with straw and used them to make buildings that lasted long. Ancient pharaohs made their slaves use bricks with the straw to enhance the structural integrity of their buildings, some of which testify to the wisdom of the dead civilization even today. Contemporary composites result from research and innovation from the past few decades and have progressed from glass fiber for automobile bodies to particulate composites for aerospace and a range other applications. Ironically, despite the growing familiarity of composite materials and their ever-increasing range of applications, the term defines a clear definition. Loose terms like " materials composed of two or more distinctively identifiable constituents" are used to describe glass composites like timber, organic materials, like tissue surrounding the skeletal system, soil

aggregates, minerals and rock. As they are biodegradable and their strength is more and equal to that of the plastics many applications like in transportation industry composites are preferred and used. Composite materials, are engineering or glassy occurring materials with significantly different physical or chemical properties which remain separate and distinct at the macroscopic or microscopic scale within the finished structure. They are solids that are composed of two or more materials. Usually, the result of embedding fibers, particles, or layers of one material in a matrix of another material, composites are designed to exploit the best properties of both components to produce a material in a matrix of another material, composites are designed to exploit the best properties of both components to produce a material that surpasses the performance of the individual parts. A composite material consists of two or more physically and / or chemically distinct, suitably arranged or distributed phases, with an interface separating.

The attraction in utilizing natural fiber, for example, distinctive wood fiber and plant fiber as support in plastics has expanded drastically throughout last few years. Concerning the ecological viewpoints if natural fibers might be extremely intriguing. Natural fibers have numerous points of interest contrasted with glass fiber, for instance they have low thickness, and they are biodegradable and recyclable. Also they are renewable crude materials and have generally great strength and stiffness.

Natural fibers are classified on the basis of the origin of source, into three types

1. Plant Fibers
2. Mineral Fibers
3. Animal Fibers

1. **Plant fibers:** Plant fibers are usually consists of cellulose: examples cotton, jute, bamboo, flax, ramie, hemp, coir and sisal. Cellulose fibers are used in various applications.
2. **Mineral Fiber:** Mineral fibers are those which are get from minerals. These are naturally happening fiber or somewhat changed fiber. It has different classifications they are taking after Asbestos is the main characterically happening mineral fiber.
3. **Animal Fibers:** Animal fiber by and large comprises of proteins; cases, silk, alpaca, mohair, downy. Animal hair are the strands got from creatures e.g. Sheep's downy, goat hair, horse hair, alpaca hair, and so forth.

Table 1.1 Composition of few commonly used natural fibers

| Fiber | Cellulose | Hemicellulose (Wt%) | Lignin(Wt%) | Pectin(Wt%) | Moisture(%) | Waxes |
|---|---|---|---|---|---|---|
| Cotton | 85-90 | 5.7 | - | 0-1 | 7.85-8.5 | 0.6 |
| Bamboo | 60.8 | 0.5 | 32 | - | - | - |
| Jute | 61.1-71.5 | 13.6-20.4 | 12-13 | 0.2 | 12.5-13.7 | 0.5 |
| Kenaf | 45-47 | 21.5 | 8-13 | 3-5 | - | - |
| Sisal | 66-78 | 10-14 | 10-14 | 10 | 10-22 | 2 |
| Banana | 63-64 | 19 | 5 | - | 10-12 | - |
| Ramie | 68.6-76.2 | 13.1-16.7 | 0.6-0.7 | 1.9 | 7.5-17 | 0.3 |

**Literature review:**

- Merlini et al. [6] have studied the effect surfacetreatment on the chemical properties of banana fiber and reported that treated banana fiber give higher shear interfacial stress and tensile strength when compared with the untreated fiber
- Dhiebet al. [7] have studied about the surface and sub-surface degradation of unidirectional carbon fiberand have given many conclusion such as under sliding in demineralized water, the most simple degradation was detected on sliding in anti-parallel direction.
- Shankar et al. [8] have studied and reported that the ultimate tensile strength value maximum at 15% and then decreases with increasing in fiber starting from 15% to 20%. They also reported that the flexural strength value decreasing from 5% to 10% (87.31 MPa) and after that the value increased from fiber

## 2. Experimental methodology

### 2.1 Materials

The epoxy resin employed in the present study is LY556 and the hardener is HY95. Epoxy LY556/Hardener HY951 (Room temperature cure type): LY556 resin is a bi- functional epoxy resin ie., Diglycidyl Ether of Bisphenol-A (DGEBA) and HY951is an aliphaticprimary amine, viz., Triethylene Tetramine – TETA. Mixing ratio is10:1 w/w. Epoxy adhesives are a major part of the class of adhe- sives called “structural adhesives” or “engineering adhesives” (which also includes polyurethane, acrylic, cyanoacrylate, and other chemistries.) These high performance adhesives are used in the construction of aircraft, automobiles, bicycles, golf clubs, skis, snow boards, and other applications where high strengthbonds are required. Epoxy adhesives can be developed that meet almost any application. In general, epoxy adhesives cured with heat will be more heat- and chemical-resistant than when cured at room temperature. Table 1 presents the properties of epoxy and hardener.

### 2.2.Jute Fiber

Jute fiber as shown in Fig.1 is the mostly used and least expensive as all fibers. Jute fiber also known as the “golden fiber” is a natural fiber obtained from the bark of the jute plant. Here’s brief overview

1. **Natural fiber:** just is a long, soft, and shiny vegetable fiber that can be spun into coarse, strong threads.
2. **Versatility:** Jute fibers are versatile and find applications in various industries such as textiles, packaging, construction and agriculture.
3. **Biodegradable and Eco-friendly:** Like banana fiber, jute is biodegradable and environmentally friendly, making it a preferred choicefor sustainable packaging and textiles.
4. **Strength and Breathability:** Jute fibers are known for their strength, breathability, and insulation properties, making them suitable for a widerange of applications in both consumer and industrial sectors

Table 1
Properties of Epoxy LY556 And Hardener HY951

| **Properties** | **Epoxy LY556** | **Hardener HY951** |
|---|---|---|
| Visual appearance | Medium viscosity, colorless clear liquid. | Brownish yellow color liquid |
| Viscosity at room temperature | 9000-12000 Mpa | 500-1000 Mpa |
| Density at room temperature | 1.13-1.16 gm/cc | 0.946 gm/cc |

Fig. Jute Fiber

**2.2 Banana Fiber:**

Traditionally, Banana has been the leading material for agricultural twine (binder twine and baler twine) because of its strength, durability, ability to stretch,affinity for certain dyestuffs, and resistance to deterioration in saltwater, Apart from ropes, twines, and general cordage, Banana is used in low-cost and specialty paper, dartboards, buffing cloth, filters, mattresses, carpets, handicrafts, wire rope cores, and Macrame, Banana has been utilized as an envi- ronmentally friendly strengthening agent to replace asbestos and fiber glass in composite materials in various uses including the automobile industry. Banana Fiber as shown in Fig. 2 is extracted by a process known as decortications, where leaves are crushed and beaten by a rotating wheel set with blunt knives, so that only fibers remain.. The fiber is then dried, brushed and baled for export. Superior quality sisal is found in East Africa. Proper drying is important as fiber quality depends largely on moisturecontent. Artificial dryness has been found to result in generally better grades of fiber than sun drying, but is not feasible in the developing countries where sisal is produced. In the drier climate of north-east Brazil, sisal is mainly grown by smallholders and the fiber is extracted by teams using portable raspadors which donot use water. Fiber is subsequently cleaned by brushing. Dry fibers are machine combed and sorted into various grades, largely on the basis of the previous in-fieldseparation of leaves into size groups.

Here are some key points about banana fiber

1) **Renewable Resource:** Banana fiber is considered an eco- friendly material as it is made from the stalks of the banana plant, which are renewable and abundant
2) **Strength and Durability:** Despite being lightweight, banana fiber is knownfor its strength and durability, making it suitable for various applications suchas textiles, handicrafts, and paper.
3) **Uses:** Banana fiber finds applications in a wide range of products including clothing, accessories, home furnishings, and industrial products.
4) **Biodegradable:** Banana fiber is biodegradable, meaning it can decompose naturally, reducing environmental impact compared to synthetic fibers.

Fig. Banana Fiber

**3. Fabrication of Composite**

The methods of preparation of specimen is shown in is explained as follows:

- Mould prepared by using plywood
- As per volume fraction of fiber, fibers are weighed.
- Epoxy and hardener are mixed properly in the ratio of 10:1 at room temperature.

- A release agent is applied on the mould and dries it for few minutes.
- Short fiber and epoxy mixture are mixed properly at room temperature.
- The fiber and epoxy mixture is poured uniformly on to the mould and excessamount of epoxy mixture was removed and leveling is done by using roller
- The mould is closed and the composite material was pressed uniformly for 24 hfor curing at room temperature,
- Once the composites are dried, it is separated from the mould.
- The test specimen are cut according to the ASTM Standard

### 3.2 Hand Lay-up Process:

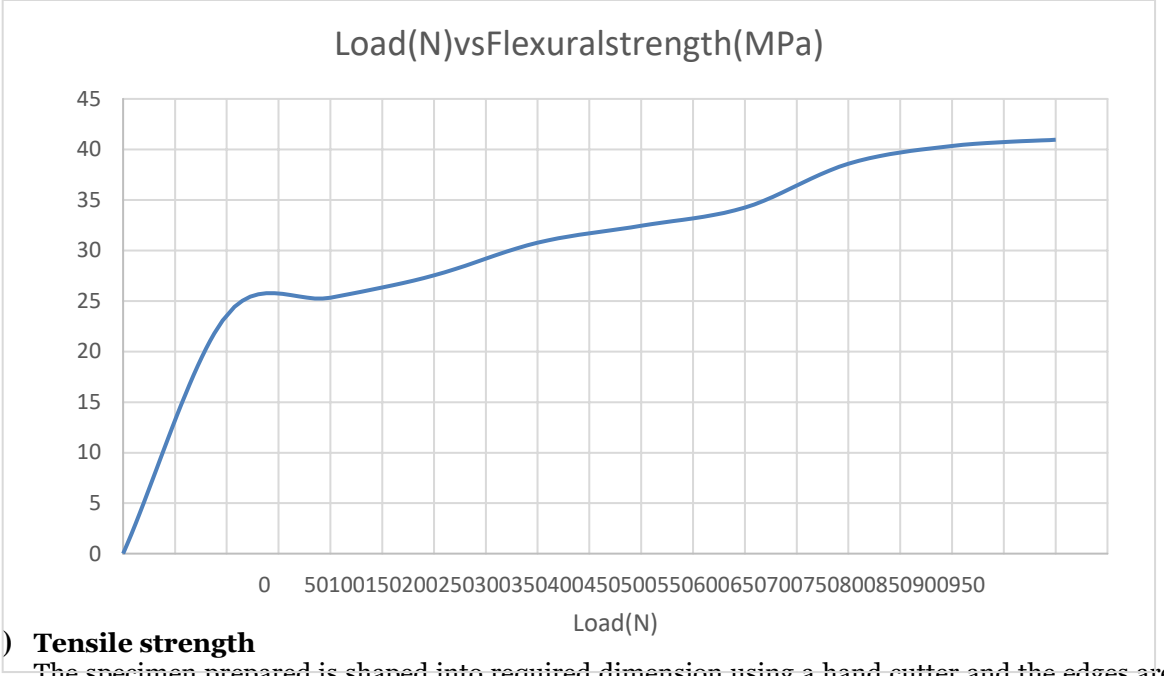
Hand lay-up is a simple method for composite production. A mold must be used for hand lay-up parts unless the composite is to be joined directly to another structure. The mold can be as sim- ple as a flat sheet or have infinite curves and edges. For some shapes, molds must be joined in sections so they can be taken apart for part removal after curing. Before lay-up, the mold is prepared with a release agent to insure that the part will not adhere to the mold.Reinforcement fibers can be cut and laid in the mold. It isup to the designerto organize the type, amount and direction ofthe fibers being used. Resin mustthen be catalyzed and added to the fibers. A brush, roller or squeegee can be used to impregnate the fibers with the resin. The lay-up technician is responsible for controlling the amount of resin and the quality of saturation. The basic process of hand lay-up. Other fabrication processes such as vacuumbagging, vacuum resin transfer molding and compression molding can be usedwith hand lay-up to improve the quality of the finished part or save time. Compression molding may follow the first steps of hand lay-up, but normally the process will be much more complicated. The mold for a compression- molded part must be design for proper routing of excess resin. A male and female mold will be necessary. They can both be solid molds or a bladder moldcan be used to compress into the other mold. Once fabrication techniques havebeen organized, the production pro- cess can begin. First the molds must be prepared with a release agent. Then fibers must be cut and placed on the surface of oneor both of the molds. Catalyzed resin must be impregnated into the fibers with excess. The two molds are then joined and adequatepressure canbe applied by air or mechanical force. If the mold is set up properly, the desiredamount of resin will disperse through- out the fibers and out through the properexit channels

## 4. Result and discussion

### 1) Flexural strength:

The flexural specimens are prepared as per the ASTM standards and the test has been carried out using the UTM machine. The 3- point flexural 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.

| S.No | Sample details | Force (N) | Flexural Strength (Mpa) | |
|---|---|---|---|---|
| | | | Before curing | After curing |
| 1 | Sample- 35:65 | 560 | 40.60 | 35.22 |
| 2 | Sample- 40:60 | 900 | 40.96 | 35.96 |
| 3 | Sample- 45:55 | 420 | 28.33 | 25.62 |
| 4 | Sample – 50:50 | 520 | 32.22 | 30.32 |

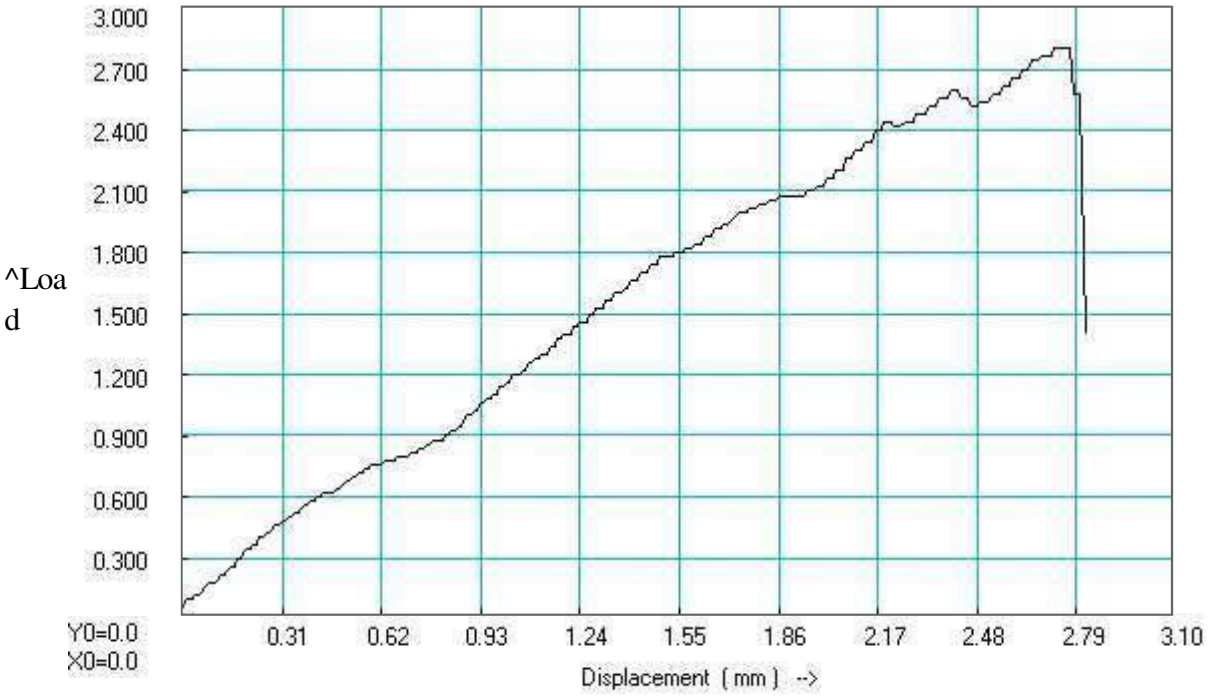



**1) Tensile strength**

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

| S.No | Sample Details | Tensile strength (MPa) | | Elongation (%) |
|---|---|---|---|---|
| | | Before curing | After curing | |
| 1 | Sample- 35:45 | 12.69 | 14.22 | 6.00 |
| 2 | Sample- 40:60 | 12.78 | 14.88 | 6.30 |
| 3 | Sample- 45:55 | 9.09 | 15.02 | 12.65 |
| 4 | Sample- 50:50 | 14.22 | 16.33 | 7.05 |

**Graph : Load ( kN ) Vs Displacement ( mm )**



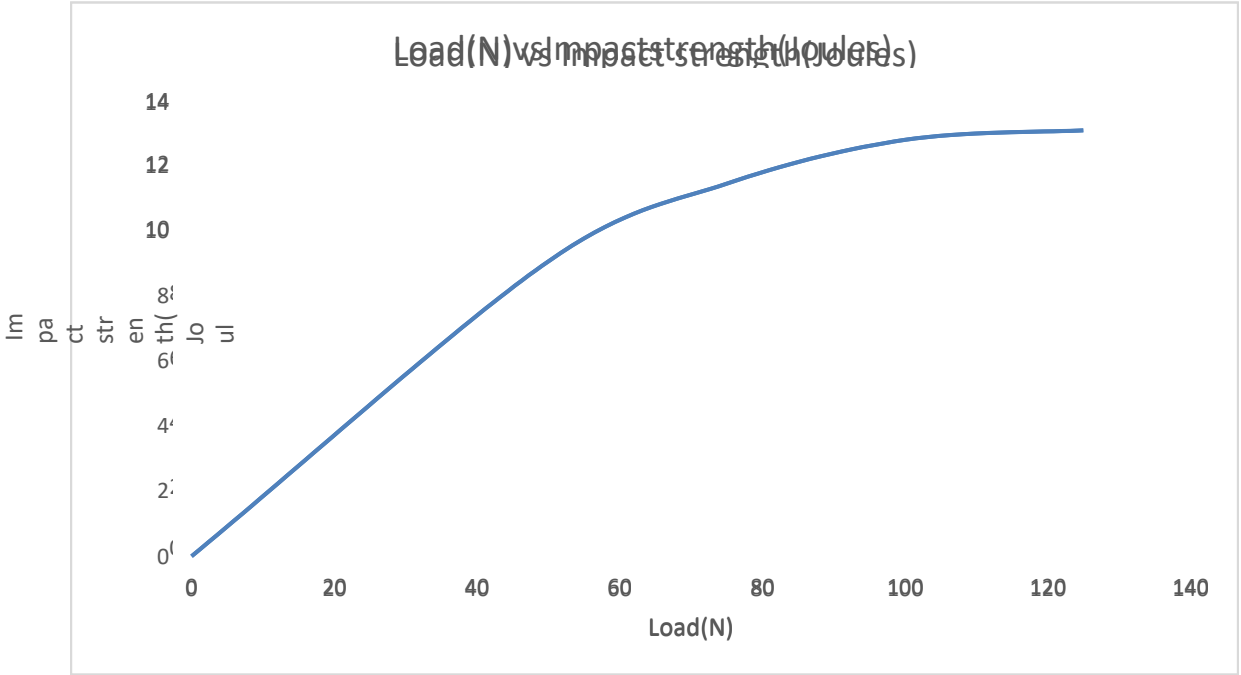
### 2) Hardness

| S.No | SAMPLE DETAILS | HARDNESS (Shore D) | Average |
|---|---|---|---|
| 1 | Sample- 35:65 | 70,73,71 | 71.33 |
| 2 | Sample-40:60 | 73,75,75 | 74.33 |
| 3 | Sample-45:55 | 77,80,75 | 77.33 |
| 4 | Sample-50:50 | 80,78,81 | 79.66 |

### 3) Impact test

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

| S.No | Sample Details | Force (N) | Impact strength (Joules) | |
|---|---|---|---|---|
| | | | Before curing | After curing |
| 1 | Sample- 35:65 | 100 | 10.43 | 8.22 |
| 2 | Sample- 40:60 | 125 | 13.11 | 10.52 |
| 3 | Sample- 45:55 | 150 | 12.82 | 11.20 |
| 4 | Sample- 50:50 | 175 | 11.50 | 11.95 |



## 5. Conclusion

This experimental examination of mechanical behavior of banana and Jute fiber based on epoxy composites indicates to the many conclusions

- The fabrication of banana and jute fiber based epoxy composites with different loading (Ratios) of fiber is possible by hand lay-up process
- It has been observed that the better mechanical properties found for composites reinforced with sample ratios of (50:50, 40:60).
- From the testings it was found that the flexural strength and impact strength were decreased gradually after curing

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