# ASSESSMENT OF MECHANICAL PROPERTIES OF BANANA AND BASALT FIBER REINFORCED EPOXY COMPOSITES

**E. Deepak naidu[1], D. Eswara naga sai pavan[2], G. Seshu durga bhavani[3], CH. Sai kumar[4], K. Bhanu prakash[5], CH. Siva nagaraju[6]**

*[1]Professor Department of Mechanical Engineering DMSSVH College of Engineering, Machilipatnam, Andhra Pradesh, India.*
*[2] B.Tech Student Department of Mechanical Engineering DMSSVH College of Engineering, Machilipatnam, Andhra Pradesh, India.*

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**Abstract –**

Using natural fiber-reinforced composites is highly useful because the strength toughness recyclability non pollution and low cost of those composites resulting are more than those of the unreinforced plastics. This present work evaluated the effect of fiber orientation on mechanical properties of banana and basalt fiber epoxy composites. This present work deal with the fabrication of composite materials by using banana fiber, basalt fiber, are mixed with epoxy resin and evaluation of mechanical behaviour of fabricated composite laminates. On this work banana and basalt fiber is used as reinforcement and epoxy is used as matrix. Four samples of different orientations banana and basalt fiber reinforced laminates prepared by hand lay-up approach. Each laminate consist of 5 layers in the sequence of banana/basalt/banana/basalt/banana and investigated their mechanical properties like tensile strength and flexural strength. The result shows that for which the better mechanical behaviours were found in the composite laminate.

***Key Words***: banana fiber, basalt fiber, epoxy and hardener and mechanical properties.

## 1. INTRODUCTION

The usage of composites material in engineering field is increasing day by day. A composites fabric a system composed of a combination of two or greater constituents. It includes a phase that is matrix and fiber. The fibers may be polymers inclusive of banana and basalt. Matrix will be epoxy resign. Fiber reinforced composites provide varied advantages in various applications. Today fiber composites are used in various programs inclusive of cars, plane, area motors, offshore structures, container sand piping, wearing goods, electronics and home equipment much work is done within the application of natural fiber as reinforcement in polymer composites. In India, banana is abundantly cultivated. Banana fiber can be received without problems from the plants which are rendered as waste after the fruits have ripened. So banana fiber may be explored as a ability reinforcement. Thermo set resin commonly used in engineering applications is epoxy. Epoxy has higher mechanical properties but it is expensive.

### Literature survey

1. M. Sumaila,I. Ambekar has investigated on the effect of fiber on the physical and mechanical properties of composites. From the experimental study it was noted that the fiber length influence the tensile and flexural properties.The maximum tensile strength and modulus and percentage of elongation..

2. N. Vijay Kumar evaluated the properties of glass fiber reinforced hybrid fiber polymer composites. He found that the composites material made of banana –glass (50%) has better mechanical properties with tensile elongation of 157.14% composed to pure matrix. He determine the mechanical properties of different composite material i.e.,

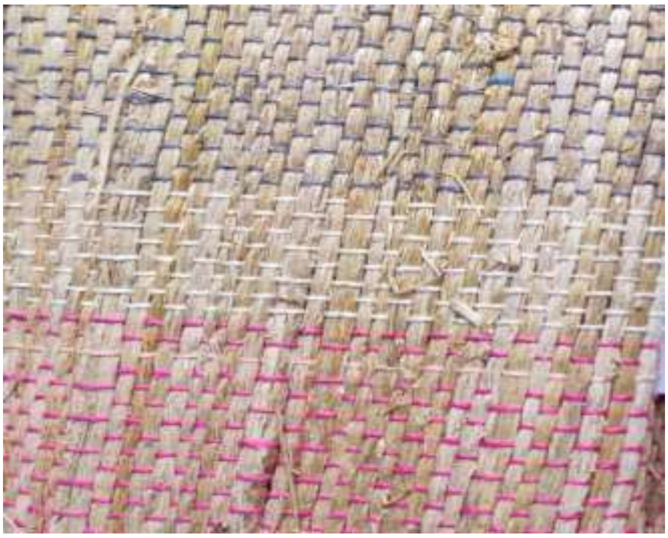
- pure epoxy composites
- banana with epoxy composites
- glass with epoxy composites
- banana-glass composites(50-50)
- banana –glass composites (100-100)

## 2. Experimental Details

### 2.1Materials

### A) Banana

Banana is a natural fiber traditionally used in making twine and rope. Banana is fully biodegradable and highly renewable resource Banana fiber is exceptionally durable and a low maintenance with minimal wear and tear strength. The banana fiber is collected from banana plant. The extracted banana fibers were dried for 24 hours at room temperature to remove free water present. The chemical composition of banana consists of cellulose (60-70%), hemi cellulose (15-20%), lignin (5-10%). The density of banana fiber is 1.35gm/cm^3.



**The fig represents the schematic diagram of banana fiber**

**Product description**

Fibre type: banana fiber

Colour: grey

Mat size: 300GSM

Pattern: unidirectional

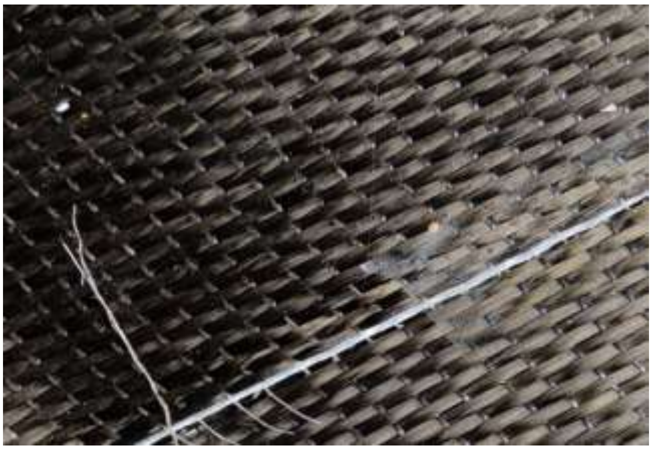
Purchased from: VRUSHKA ENTERPRISES, Chennai, India

**Properties**

- The chemical composition of banana fiber is cellulose, hemicelluloses, and lignin.
- It is highly strong fiber
- It has smaller elongation
- It is light weight
- It is average fineness is 2400 N-m

### B) Basalt

It is a material made from extremely fine fibers of basalt. Banana is a igneous rock formed as a result of lava cooling at the surface of the planet. It is drawn into continuous fiber by rock melt drawing at about 1500 degrees centigrade. It consists of 45-50% of $SIO_2$ and at least 65% of rock in the form of plagioclase. Basalt fiber is similar to fiber glass that has better physic mechanical properties. The density of basalt fiber is 3gm/cm3.



**The fig represents the schematic diagram of basalt fiber**

**Product description:**

Fibre type: basalt fiber

Colour: grey to black

Mat size: 400GSM

Pattern: unidirectional

Purchased from: ARROW TEXTILES LTD, Mumbai, India.

**Properties**

- High tensile strength (breaking strength)
- Low elongation at peak
- High elastic modulus
- Low thermal conductivity
- high sound absorption coefficient

**C) Epoxy**

Epoxy is the common thermo set resin used to make composite materials. Epoxy resin will perform good at elevated temperatures up to 121 degrees centigrade. Epoxy has the superior electrical properties and has the resistance to corrosive liquids and environment. Epoxy and hardener used in the composite are LY-556, HY-951. The HY-951 has good mechanical strength and has the resistance chemical degradation. The epoxy and hardener are mixed in the ratio of 10:1.


**The fig represents the schematic diagram of epoxy and hardener**

**Product description**

Form: liquid

Purchased from: Sri composite industry, Hyderabad.

Properties of epoxy resin LY-556

Visual appearance: clear, pale yellow liquid

Density at room temperature: 1.25gm/cm^3

Viscosity at room temperature: 10,000-12,000mpas

**Properties of hardener HY-951**

Density: 0.95gm/cm^3

Drying temperature: normal room temperature.

Water solubility: soluble

### 2.2 Composition

The composition of both the banana and basalt fiber are given below:

| S. no | Samples | Layer-1 Banana | Layer-2 Basalt | Layer-3 Banana | Layer-4 Basalt | Layer-5 Banana |
|---|---|---|---|---|---|---|
| 1 | S1 | 180° | 0° | 0° | 0° | 180° |
| 2 | S2 | -30° | +30° | 0° | -30° | +30° |
| 3 | S3 | -45° | +45° | 0° | -45° | +45° |
| 4 | S4 | -60° | +60° | 0° | -60° | +60° |

### 2.3 Hand Lay Up Method

Hand lay out method is used to manufacturing of composites. In this method first place the clear film of with a required dimensions [200*200*6] on the desk. Then add the mixture of epoxy and hardener in the ratio of 10:1 is coated on the clear film with the help of brush. Then the unidirectional banana fibre [200*200] is placed on the film at 30°as a primary layer. Then the epoxy is coated on the banana fibre. Now basalt fiber at 30° is placed over the banana fiber and epoxy is coated over the basalt fiber. Next banana fiber at 0° is placed above the basalt fiber again epoxy is coated over the banana fiber. Now basalt fiber at 30° is placed over the banana fiber and also epoxy is applied over it. So finally composite is prepared by adding banana fiber at 30° and epoxy is applied above it. This whole process is continued for 180°, 45° and 60°. Roller is used to increase the uniformity of surface and eliminate air bubbles. The curing time of 24 hours at a room temperature. The composition of fibre in the composite is 25-30% and the remaining composition of epoxy and hardener is 65-75%.

### 2.4 Specimen Preparation

After of completion of sample preparation with the banana and basalt fibers, a plate with the dimension of 200*200*6 mm is received. The 4 plates are made in different orientations. The desired shape is taken from the laminate plate with the help of cutting device. The specimens are taken as according to the dimension.

| S no | Test | Standards | Dimensions |
|---|---|---|---|
| 1. | Tensile test | ASTM 3039 | 200*15*6 mm |
| 2. | flexural test | ASTMD790 | 100*15*6 mm |

## 3. Testing

### 3.1 Tensile Test

Tensile test specimen is prepared according to the standard ASTM 3039 standard. According to the standard the dimensions of the specimen used are 200*15*6 C-MM. The specimen was fixed in between fixed grip and moving grip of universal testing machine. Three samples are tested for each orientation of the composite to find the average tensile strength and modulus. The tensile strength and tensile modulus were found in table below:

**Before Testing After Testing**

**Banana and Basalt Composites for Tensile Test**

| S no | sample name | weight % of fibre | average load(N) | Elongation (mm) | Tensile strength($N/mm^2$) | Tensile modulus($N/mm^2$) |
|---|---|---|---|---|---|---|
| 1 | S1 | 26.4 | 13266 | 0.0131 | 154.824 | 19321.77 |
| 2 | S2 | 26.4 | 58130 | 0.011 | 668.608 | 363650.1 |
| 3 | S3 | 26.4 | 18566 | 0.0181 | 247.318 | 14326.8 |
| 4 | S4 | 26.4 | 26866 | 0.00811 | 286.331 | 38327.5 |

Tensile strength and tensile modulus are found in the graph below:

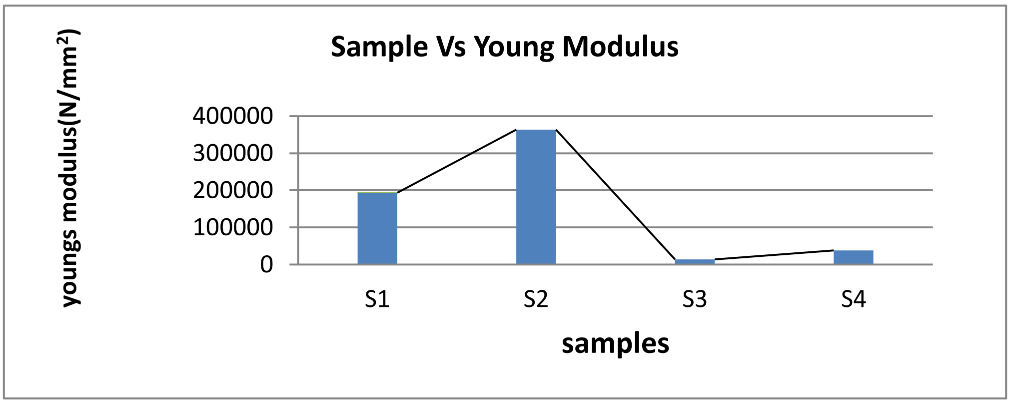



**Figure: 1 The fig represents the sample vs. young's modulus**

In this figure the young's modulus of S1 value is (19321.77) $N/mm^2$, S2 value is (363650.1) $N/mm^2$, S3 value is (14326.8) $N/mm^2$, S4 price is (38327.5) $N/mm^2$. It is located in this figure the highest value of young's modulus is S2 at 30°. And the lowest value of the young's modulus is S3 at 45°.Sample S2 is higher than the sample S1.

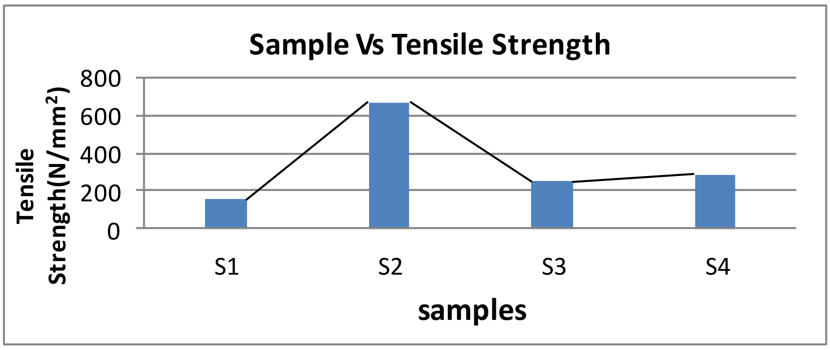



**Figure: 2 The fig represents the sample Vs Tensile Strength**

In this figure the Tensile strength of S1 value is (154.824) N/mm$^2$, S2 value is (668.608) N/mm$^2$, S3 value is (247.318) N/mm$^2$ and S4 value is (286,331) N/mm$^2$. It is located in this figure the highest value of Tensile strength is S2 at 30°. And the lowest value of the Tensile strength is S1 at 180°.sample S2 is higher than the sample S4.

### 3.2 Flexural Test

Flexural test is also known as bending test. Flexural test specimen is prepared according to ASTMD790 standard. According to the ASTM-D790 standard the dimensions of the specimen used are 100*15*6mm. The specimen was fixed in the grip of universal testing machine. Three and average flexural modulus samples are tested for each orientation of the composite to find the average flexural strength.

**Before Testing After Testing**

**Banana and Basalt Composites for Flexural Test**

| S.NO | Sample name | weight % of fiber | average load(N) | Flexural strength(N/mm$^2$) | Flexural modulus(N/mm$^2$) |
|---|---|---|---|---|---|
| 1 | S1 | 26.4 | 2316.66 | 687.23 | 65125.163 |
| 2 | S2 | 26.4 | 4616.96 | 1210.3 | 95440.02 |
| 3 | S3 | 26.4 | 3233.37 | 1048.86 | 109052.32 |
| 4 | S4 | 26.4 | 5400 | 1620.26 | 101186.85 |

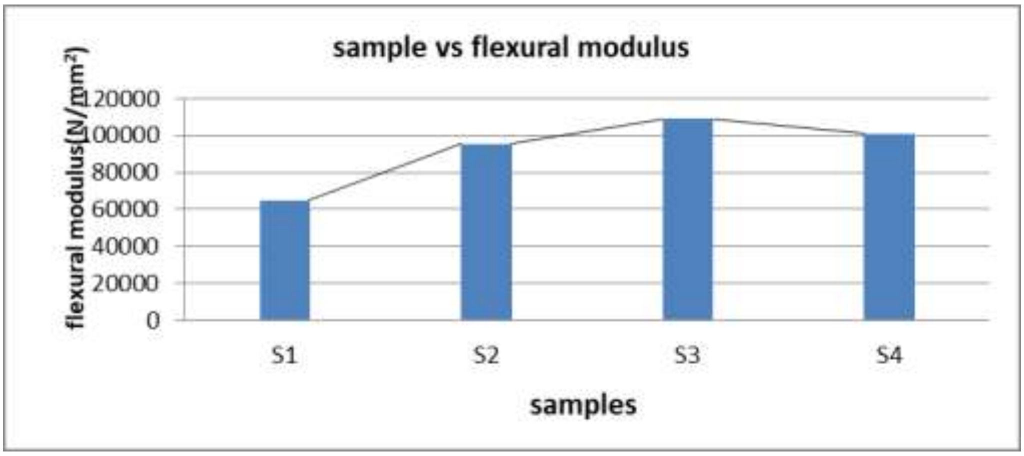



**Figure: 3 The fig represents the sample Vs flexural modulus**

In this figure the flexural modulus of S1 value is (65125.163) $N/mm^2$, S2 value is (95440.02) $N/mm^2$, S3 value is (109053.32) $N/mm^2$, S4 value is (101186.85) $N/mm^2$. It is located on this figure the highest value of flexural modulus is S3 at 45°. And the lowest value of the flexural modulus is S1 at 180°.sample S3 is higher than the sample S4.

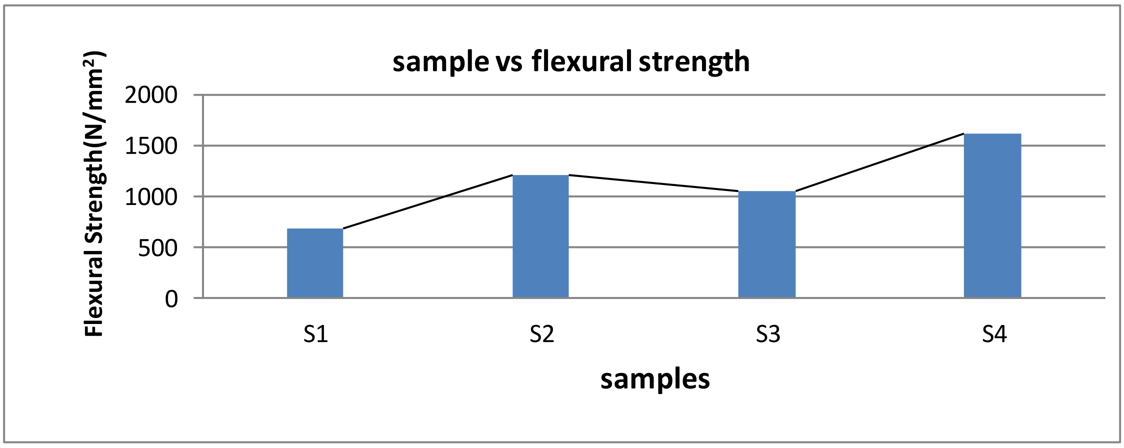



**Figure: 4 The fig represents the sample Vs flexural strength**

In this figure the flexural strength of S1 value is (687.23) $N/mm^2$, S2 value is (1210.3) $N/mm^2$, S3 value is (1048.86) $N/mm^2$ and S4 value is (1620.26) $N/mm^2$. It is located in this figure the highest value of flexural strength is S4 at 60°. And the lowest value of the flexural strength is S1 at 180°.Sample S4 is higher than the sample S2

**4. CONCLUSIONS**

Thus the mechanical behaviour of banana and basalt fiber composite have been studied and the results of tensile and flexural testing shows the following

- It is observed that the sample S2 has the highest value of tensile strength at 30° orientation.
- It is also observed that the sample S4 has the highest value of flexural strength at 60° orientation.
- It is observed that the sample S1 has the lowest value of tensile strength at 0° orientation.

And finally It is observed that the sample S1 has the lowest value of flexural strength at 0° orientation.

**REFERENCES**

[1] M. Sumaila, I. Ambekar, et.al, "Effect Of fiber length on the physical & mechanical properties of random oriented, nonwoven short banana",Volume-02, march2013

**[2]** N. Vijay Kumar, B. Sai Krishna , N. Sai Chandra , ¨Evaluation of properties of glass-banana –fiber reinforced hybrid fiber polymer composites¨

[3] Satishpujari, A. Ramakrishna et.al, "Comparison of Jute and Banana Fiber composites", International journal of Current engineering& Technology, Feb 2014.

[4] S.Raghavendra, Lingaraju,et.al," Mechanical properties of short Banana fiber reinforced natural rubber composites", The International Journal ofinnovative research in science ,Engineering and technology, Volume-2, Issue-05 may 2013.

[5] M.Sakthivel S. Ramesh, et.al, "Mechanical properties of natural fiber (Banana, Coir, Sisal) polymer composite Volume-1, Issue-1, July2013.

[6] N. Anupama sai priya et.al, "Experimental testing of polymer reinforced with coconut coir fiber composite", Volume 4, issue 12 Dec 2014. Composites",

[7] Syed AltanfHussai,"n, et.al, ", Mechanical properties of green coconut fiber reinforced polymer composite," Vol.3, 11 Nov2011.

[8] Y.Indraj, et.al, "Development& study of properties of natural fiber reinforced polyester composite",,October 2014.

[9] Ashwani Kumar, et.al,"Development of Glass /Banana fiber reinforced Epoxy composite", , Volume3, Nov – Dec 2013.

[10] V P. Shashi Shankar,et.al, "Mechanical performance and Analysis of Banana fiber reinforced epoxy composite", Industrial science.

[11] Sim, J., Park, C., & Moon, D. Y, "Characteristics of basalt fiber as a strengthening material for concrete structures", Composites Part B: Engineering, 36(6-7), 504-512.

[12] B. Vijaya Ramnath, S. Junaid Kokan, R. Niranjan Raja, R. Sathyanarayanan, C. Elanchezhian, A. Rajendra Prasad, V.M. Manickavasagam "Evaluation of mechanical properties of abaca–jute–glass fibre reinforced epoxy composite" material and design 51 (2013) 357-366

[13] V.S. Srinivasan , S. Rajendra Boopathy, D. Sangeetha, B. Vijaya Ramnath"Evaluation of mechanical and thermal properties of banana–flax based natural fibre composite" material and design 60 (2014) 620-627

[14] B. Vijaya Ramnath , V.M. Manickavasagam, C. Elanchezhian, C. Vinodh Krishna, S. Karthik, K. Saravanan "Determination of mechanical properties of intra-layer abaca– jute–glass fiber reinforced composite" material and design 60(2014) 643-652

[15] Schloesser, Th.; Knothe, J, "Vehicle parts reinforeced with natural fibers", Kunstst-Plast Europe 1997, 87 (9), 25

[16] P. Sathish,R. Kesavan. Vijaya Ramnath,C. Vishal, "Effect of Fiber Orientation and Stacking Sequence on Mechanical and Thermal Characteristics of Banana-Kenaf Hybrid Epoxy Composite", Silicon, DOI 10.1007/s12633-015-9314-7.

## BIOGRAPHIES

E.DEEPAK NAIDU M.Tech
Professor of Mechanical Department

D.ESWARA NAGA SAI PAVAN
(B.Tech Student)

G.SESHU DURGA BHAVANI
(B.Tech Student)

CH.SAI KUMAR(B.Tech student)

K.BHANU PRAKASH, (B.Tech student)

CH.SIVA NAGA RAJU, (B.Tech student)