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# **Analysis of Mechanical Properties of Jute & Banana Fibre Reinforced Vinyl Ester Composites**

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**ABSTRACT:**Composites are materials that comprise strong load carrying material (known as reinforcement) imbedded in weaker 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. Selection of raw material (Jute, Banana) this is mostly good in all properties and easily available. After selection of raw material, fabrication is done by simple hand layup process. Testing carried out as per ASTM (D3039M-93, D790M-86and D256) standard.

## **I. INTRODUCTION**

### **OVERVIEW OF COMPOSITES**

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 weaker 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.

Particulate Composites consist of a matrix reinforced by a dispersed phase in form of particles.

- i) Composites with random orientation of particles.
- ii) Composites with preferred orientation of particles.

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**Broadly, composite materials can be classified into three groups on the basis of matrix material. They are:**

- i) Metal Matrix Composite(MMC)
- ii) Ceramic Matrix Composite(CMC)
- iii) Polymer Matrix Composites(PMC)

## Metal Matrix Composites

Metal Matrix Composites have many advantages over monolithic metals like higher specific modulus, higher specific strength, better nozzle (in rocket, space shuttle), housings, tubing, cables, heat exchangers, structural members etc. A metal matrix composite (MMC) is composite properties at elevated temperatures, and lower coefficient of thermal expansion.

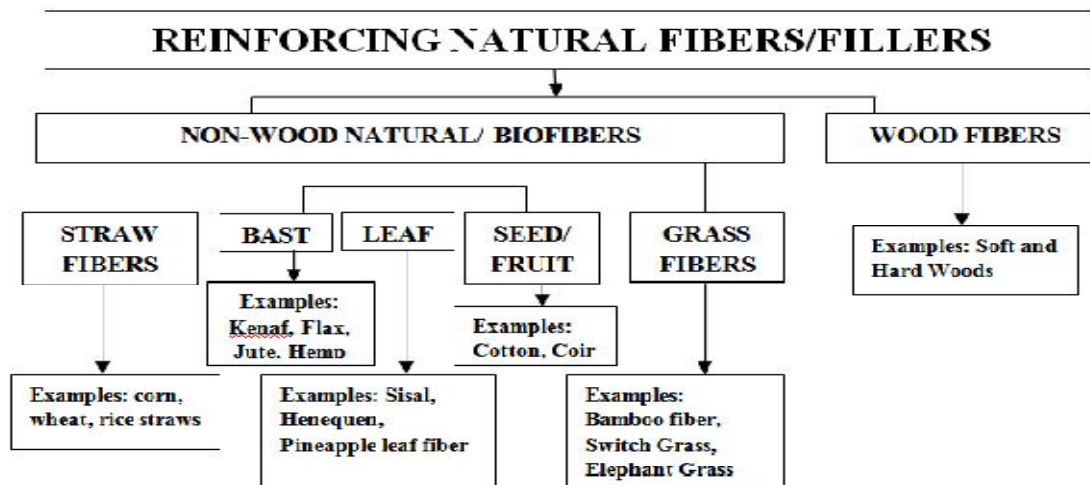
## Ceramic Matrix Composites

Ceramic matrix composites have ceramic matrix such as alumina, calcium, alumina silicate reinforced by silicon carbide. The advantages of CMC include high strength, hardness, high service temperature limits for ceramics, chemical inertness and low density. Naturally resistant to high temperature, ceramic materials have a tendency to become brittle and to fracture. Composites successfully made with ceramic matrices are reinforced with silicon carbide fibers. These composites offer the same high temperature tolerance of super alloys but without such a high density. The brittle nature of ceramics makes composite fabrication difficult.

## Polymer Matrix Composites

The most common advanced composites are polymer matrix composites. These composites consist of a polymer thermoplastic or thermosetting reinforced by fiber (natural carbon or boron). These materials can be fashioned into a variety of shapes and sizes. They provide great strength and stiffness along with resistance to corrosion. The reason for these being most common is their low cost, high strength and simple manufacturing principles. Due to the low density of the constituents the polymer composites often show excellent specific properties.

## Classification of Natural/Bio-fibers



## Advantages

Tensile strength of composites is four to six times greater than that of steel or aluminium (depending on the reinforcements), improved torsion stiffness and compressive properties, higher fatigue endurance limit (up to 60% of ultimate tensile strength), 30% - 40% lighter for example any particular aluminium structures designed to the same functional requirements.

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## Application of natural fiber composite

Building and construction industry: panels for partition and false ceiling, partition boards, wall, floor, window and floor frames, roof tiles, mobile pre-fabricated buildings which can be used in times of natural calamities such as floods, cyclone, earthquakes, Storage devices: post boxes, grain storage silos, bio gas containers etc, Furniture: chair, table, shower, bath units, etc.

## Reason for the Application of Natural Fiber

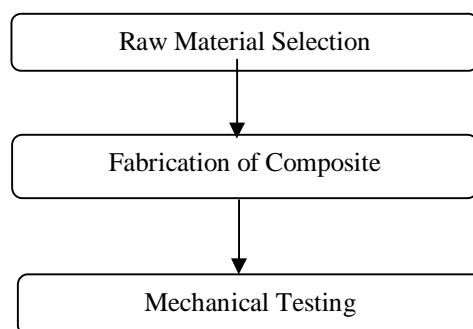
Low density: which may lead to a weight reduction of 10 to 30%  
Acceptable mechanical properties, good acoustic properties  
Favorable processing properties, for instance low wear on tools, etc  
Price advantage both for the fibers and the applied technologies

## 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. To fabricate a suitable alternative material for wood products and plastic products this is an economically viable alternative and should be easy to fabricate. 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. Jute is good in tensile, flexural strength but moderate of compressive strength etc. So we use the hybrid fiber (Jute & banana) with vinyl ester, it is good in flexural strength and also tensile strength. To fabricate hybrid fiber vinyl reinforced composite with various volume fraction. To evaluate the mechanical properties such as tensile strength, flexural strength, impact strength.

## METHODOLOGY

Selection of raw material (Jute, Banana) this is mostly good in all properties and easily available. After selection of raw material, fabrication is done by simple hand layup process. Testing carried out as per ASTM (D3039M-93, D790M-86 and D256) standard. By using statistical package optimal fiber parameter will found out. Methodology used in the present work shown in fig



## RAW MATERIAL SELECTION

The natural fibers selected for the making of composites are

- Jute
- Banana fiber

The Resin selected for the making of composites are

- Vinyl Ester resin

## Jute fiber

Jute is a fiber which yields a stiff fiber traditionally used in making twine and rope. Jute is fully biodegradable and highly renewable resource of energy. Jute fiber is exceptionally durable and a low maintenance with minimal wear

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and tear. Jute 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.

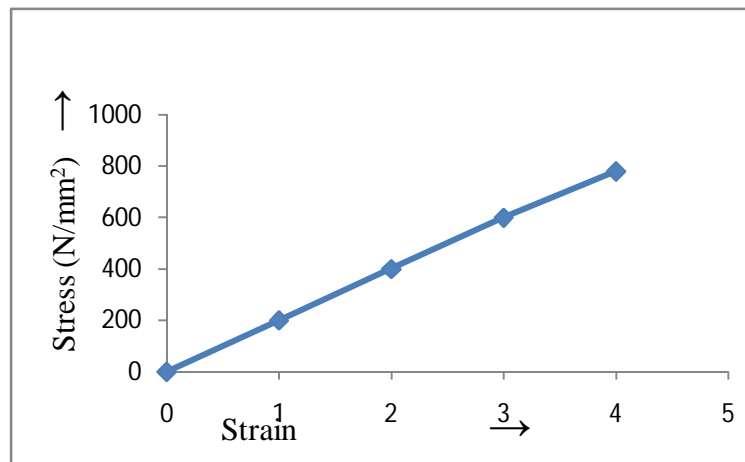


**Jute fiber**



**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 $\mu$ 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  $\times 10^{-3}$  m and thereafter they both decrease.



Typical Stress-Strain Curve For a Banana Fiber of Diameter  $0.2 \times 10^{-3}$  m Tested at a Speed of  $0.5 \times 10^{-3}$  m min<sup>-1</sup>

Sample Number	Diameter of fiber( $\mu$ m)	Initial Young's modulus ( $\text{GN m}^{-2}$ )	SD* initial Young's modulus ( $\text{GN m}^{-2}$ )	Breaking strength ( $\text{MN m}^{-2}$ )	SD breaking strength ( $\text{MN m}^{-2}$ )	%Strain	SD %Strain
1	50	32.703	8.190	779.078	209.300	2.750	0.957
2	100	30.463	4.689	711.661	239.614	2.469	0.798
3	150	29.748	8.561	773.002	297.104	3.583	1.114
4	200	27.698	7.083	789.289	128.588	3.340	0.688

Banana Fiber Properties (Various Diameters)

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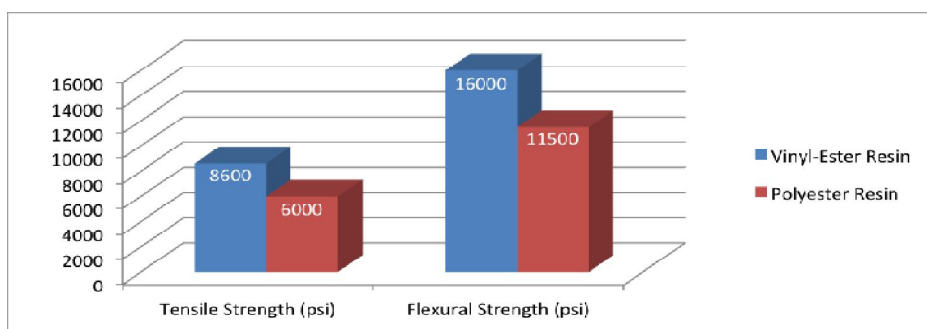
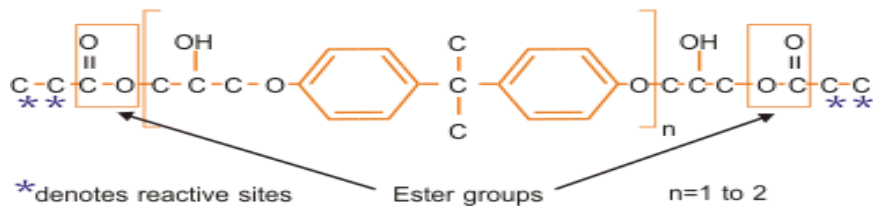
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Sample number	Length( $10^{-3}$ )	Ultimate breaking strength (MN $m^{-2}$ )	SD Ultimate breaking strength (MN $m^{-2}$ )	% breaking strain	SD % breaking strain
1	10.00	1055.516	260.612	13.770	3.439
2	20.00	930.734	270.430	6.735	1.393
3	35.00	891.706	196.775	6.387	1.809
4	50.00	711.661	239.614	2.469	0.738
5	100.00	731.185	224.275	2.714	0.636

Mechanical Properties of Banana Fibers of Different Lengths. Gauge Length =  $50 \times 10^{-3}$  m and CHS =  $20 \times 10^{-3}$  m min<sup>-1</sup>

## Vinyl Esterresin

Vinylester resins are similar in their molecular structure to polyesters, but differ primarily in the location of their reactive sites, these being positioned only at the ends of the molecular chains. As the whole length of the molecular chain is available to absorb shock loadings this makes vinylester resins tougher and more resilient than polyesters. The vinylester molecule also features fewer ester groups. These ester groups are susceptible to water degradation by hydrolysis which means that vinylesters exhibit better resistance to water and many other chemicals than their polyester counterparts, and are frequently found in applications such as pipelines and chemical storage tanks.



Comparative tensile & Stiffness of resins

## III. FABRICATION OF HYBRID COMPOSITE MATERIAL

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,

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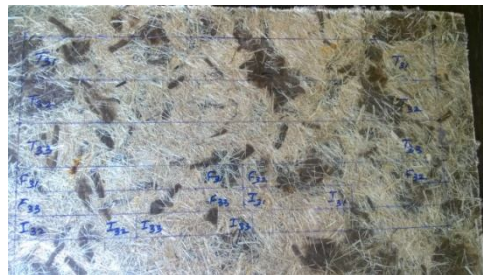
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high-strength fiberglass reinforcements. Advanced composite thermoplastics can also be compression moulded with unidirectional tapes, woven fabrics, randomly oriented fiber mat or chopped strand. The advantage of compression moulding is its ability to mould large, fairly intricate parts.

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

## Fabricated Composite Material



## Fabrication of Treated Composite Material

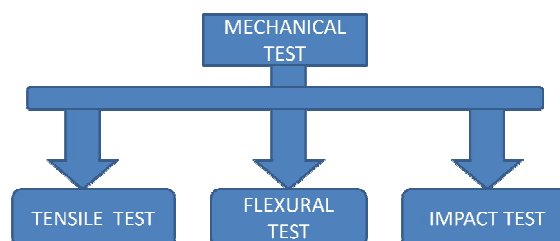
Here discontinuous fiber is used for fabricate the natural fiber composites. First the natural fibers are cleaned in the distilled water. The cleaned natural fibers are dried in the sun light. The dried natural fibers are again cleaned by chemical cleaning process. In chemical cleaning process the 5% sodium hydroxide is mixed with one litre of distilled water. The dried natural fibers dipped in the diluted sodium hydroxide solution. It's again dried in sun light. The dried natural fibers are cut in the length of 3-5mm. The cut natural fibers are used in fabricate the treated composite material. We are taking the ratio of 60:40. i.e 60% is indicated amount of resin and 40% for amount of fibers.

## Fabrication of Untreated Composite Material

In this process the fibers are cut the same size of the treated fibers(3-5mm). But, we are taking ratio of 70:30. i.e 70% is indicated amount of resin and 30% for amount of fibers.

## IV. MECHANICAL TESTING

Fabricated specimen is tested as per ASTM Standard to find the mechanical properties. Various mechanical testing are given in.



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## Various Mechanical Tests



Tensile Testing



Flexural Testing



Impact Testing

## V. EXPERIMENTAL RESULT AND DISCUSSION

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

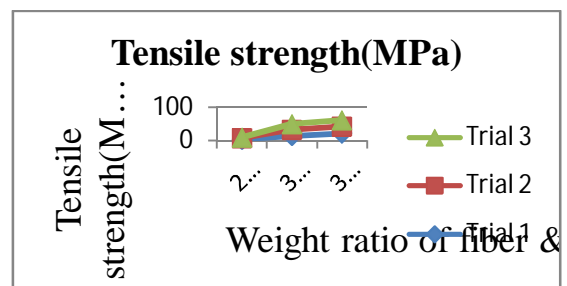
- Tensile test result
- Flexural test result
- Impact test result

### Tensile TestResult

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

Treated composite material results are given below:

Samples	Trial 1	Trial 2	Trial 3	Average tensile strength(MPa)
Plate 1	3.581	3.326	2.502	3.136
Plate 2	14.332	17.835	18.237	16.801
Plate 3	21.386	20.326	19.836	20.516



### Flexural Test result

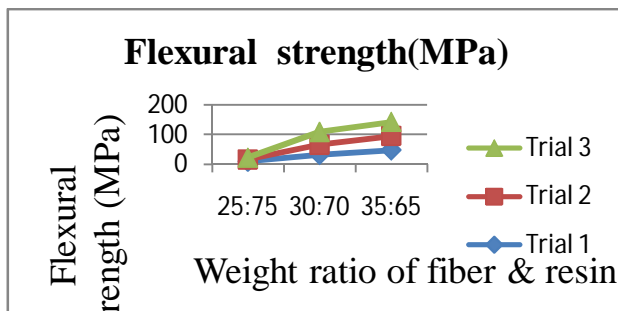
Flexural is also known as bending test .It is done by applying a point load at the center of the composite. It's also carried out using universal testing machine. The Test is conducted for composite material of Jute & Banana Vinyl Ester resin.

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Sample No	CS Area [mm <sup>2</sup> ]	Peak Load [N]	Flexural Strength (MPa)	Flexural Modulus (GPa)
1	39.000	7.358	5.942	331.793
2	39.000	12.076	9.754	432.061
3	39.000	9.717	7.848	381.097
4	0.000	3.337	2.695	70.900
5	0.000	11.133	7.266	5026.836
6	39.000	9.717	7.848	381.927

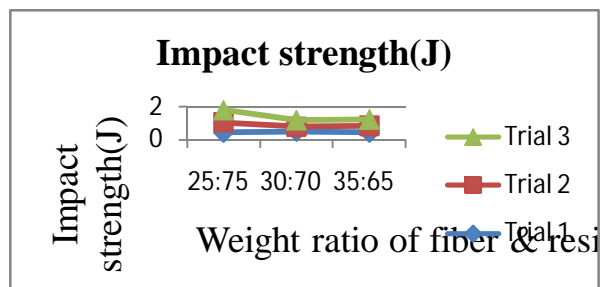


## Flexural Result Analysis

### Impact Test result

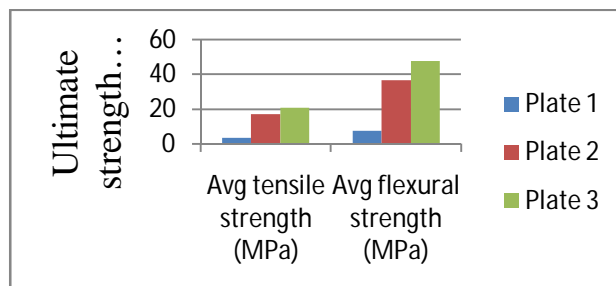
The impact test is done on the specimen by applying a sudden load on it. The various test result for the composite material with varying the material composite is tabulated as follows:

Samples	Trial 1	Trial 2	Trial 3	Average impact strength(J)
Plate 1	0.45	0.60	0.75	0.6
Plate 2	0.50	0.30	0.40	0.4
Plate 3	0.45	0.40	0.40	0.416



## COMPARISON OF TENSILE, FLEXURAL & IMPACT STRENGTH

Types of Tests	Plate 1	Plate 2	Plate 3
Avg tensile strength (MPa)	3.136	16.801	20.516
Avg flexural strength (MPa)	7.411	36.329	47.567
Avg impact strength (J)	0.6	0.4	0.416



## VI. CONCLUSION AND SCOPE FOR FUTURE WORK

From our analysis we get a conclusion that the mechanical properties of the untreated composite are good. The strength of the untreated composite is greater than the treated composite.

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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