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# Evaluation on Mechanical Properties of Hybrid Composites Reinforced with Kenaf/Banana Fibers

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*Abstract:* -- **The role of natural fibers reinforced hybrid composite are growing in a field of engineering and technology due to favourable properties. In the present unsustainable environmental condition natural fibers are serving better materials in terms of biodegradability, low cost, high strength and corrosion resistance when compared to conventional materials. Development of the polymer hybrid composite as a sustainable alternative materials for some engineering applications, particularly in aerospace application and automobile applications are being investigated. The main objective is to fabricate the single banana, Kenaf fiber and hybrid composites and to evaluate the properties of hybrid composites. The hybrid laminates are fabricated by using Banana & Kenaf as reinforcing materials with polyester resin. The specimens are prepared according to ASTM standards and the tensile, flexural and hardness tests are carried out. From this study it is observed that the hybrid composites are showing better results compared to the individual fiber composites**

**Keywords: Kenaf fiber, Banana fiber, Composite material.**

## 1. INTRODUCTION

A composite material is defined as the combination of two or more constituent materials, which are essentially insoluble into each other such that the properties of the combination are better than the sum of the properties of each constituent taken separately. The objective of this combination is to drive the best qualities of the constituent materials. These composites exhibit desirable qualities, which the constituents themselves may not possess. Since a decade strong emphasis is given on environmental awareness and attention is given towards the development of recyclable and environmentally sustainable composite materials. Environmental legislation is imposing laws on manufactures to consider the environmental impact of the products at all stages of their life including the recycling and disposal issues. These environmental factors have recently generated considerable interest in the development of recyclable and biodegradable composite materials. Therefore, research in the field of production of composites using natural fibers has attracted much attention in the material science and engineering discipline. In addition Natural fibers are renewable, cheap, completely or partially recyclable and biodegradable. Plants such as flax, cotton, hemp, jute, sisal, kenaf, pineapple, ramie, bamboo, banana etc., as well as wood used from time immemorial as a source of fibers are often applied as the reinforcement of composites. Naturally, composites reinforced with such natural fibers have thus been a subject of intense study for low strength, low cost application in contrast to the synthetic fiber reinforced composites. Since the interfacial bond between the reinforcing fibers and the resin matrix is an important element to realize the mechanical properties of the composites.

Composite materials are intended to combine desired characteristics of two or more distinct materials. The reinforcement can be synthetic (e.g. glass, carbon, boron and aramid) or of natural sources (e.g. curaua, sisal, jute, piassava, hemp, coir, flax and banana). The main benefits of exploitation of natural fibers are: abundance and renewability, low cost, non-abrasiveness, simple process, non-toxicity, high flexibility, acoustic insulation and low density . On the other hand, there are some drawbacks such as their poor mechanical properties and high moisture absorption.[1] Venkateshwaran et.al [2] reported Mechanical and water absorption behaviour of banana/sisal reinforced hybrid composites. They observed that the effect of fiber length and weight percentage increases the flexural modulus and impact strength when increase in length of fiber and weight percentage of fiber. Ramesha, et. al [3] studied the Sisal /GFRP composites sample passes good tensile strength and Jute/GFRP composites specimen showed the maximum flexural load. R. Velmurugan et al. [4] concluded the maximum strength is achieved when the length of the fiber in the laminate is equal to the critical fiber length. The strength of short fiber composites depends on the type of fiber matrix, fiber length, fiber orientation, fiber concentration and the bonding between the fiber and matrix. Ramesh et al.[5] has indicated that, there is the significant improvement in mechanical properties and the process of hybridization reduces the risks related to the environmental concern. Sapuan et al.[6] has fabricated the composites by using banana fiber is a waste product of banana cultivation and whichis easily available in tropical countries like malaysia and south india. This fiber has many advantages and holding high mechanical strength when compared to the synthetic fibers. They have prepared three samples with different geometries and evaluated the maximum stress value and young's modulus along two directions and found the maximum deflection under the maximum load conditions. Venkateshwaran et al.[7] studied the mechanical properties such as tensile strength, flexural strength, impact strength and water absorption rate of sisal and banana fibers reinforced epoxy composite materials. They have observed that there is the significant improvement in mechanical strength and reduction in water absorption rate while hybridizing the sisal fiber up to 50% by weight with banana fiber reinforced epoxy composites. Yuanjian et al.[8] have investigated the impact and fatigue behaviour of non-woven hemp fiber composites which is reinforced with polyester and found that there is the remarkable improvement in such properties.

## 2. EXPERIMENTAL DETAILS

### *2.1. Materials*

In this experiment, for fabricating the composites specimen kenaf and banana fibers are used. The dried and cleaned fibers were used for preparation of mat. Plain weave fabric(mat) was prepared in a simple handloom machine having fabric count of 36 x 36 (per inches) that is 36 fibers in warp (longitudinal) direction and 36 fibers in weft (crosswise) direction per inch. The polyester resin and suitable hardner

### *2.2 Preparation of composite specimen*

The materials used for the experiment is prepared by hand layup process. kenaf and banana fibers are used for specimen preparation. The lamina consisting layers of natural fibers. The first layer is the kenaf fiber, fill the polyester resin over the kenaf fiber and then fill the banana fiber over the resin before the resin get dried and the subsequent layers are filled. The air gaps formed between the layers during fabrication are gently squeezed out by using roller. Finally these laminas are kept in press, for over 24 hours to get the perfect shape and thickness. The thickness of the lamina is limited to 4mm and the size is 30x30 cm. After dried, the edges of the specimen are neatly cut by using saw as per the required dimensions.

### *2.3. Mechanical Properties of Composites*

#### *2.3.1. Tensile test*

The edges of the specimen are finished by using file and emery paper for tensile testing. There are three different types of specimen are prepared, the first specimen consists of kenaf fibers, the second is of banana fibers and the third is of hybrid(kenaf/banana) fiber. The specimen preparation, dimensions, gauge length and speeds are according to the ASTM D standard. The test is performed on the Universal Testing Machine (UTM) and the surrounding temperature is 32ºC. A tensile test specimen placing in the testing machine and applying load until it fractures. Due to the application of load, the elongation of the specimen is recorded. The experiments are repeated for three times and the average values are used for presentation.

***Fig.1. Tensile test specimens***

#### *2.3.2. Flexural test*

Preparation of the flexural test specimens as per the ASTM D standards and 3-point flexure test is used for testing. The deflection of the specimen is measured and the tests are carried out at an average relative humidity of 50% and the temperature about 32ºC. From the testing machine the flexural load as well as the displacements are recorded for all the test samples.

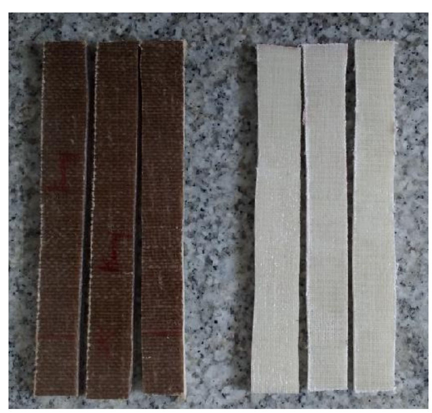

***Fig.2. Flexural test specimens***

### *2.3.3 Hardness Test*

The hardness of the composites is determined by using Rockwell hardness tester. The indicating dial has 100 divisions. Considering the B scale with a weight of 100kgf, using 2.5mm ball indenter.

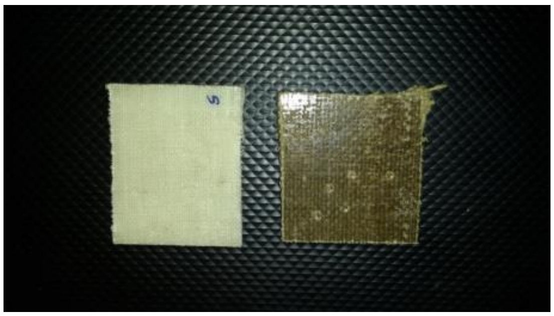

*Fig.3. Hardness test specimens*

## 3. RESULTS AND DISCUSSIONS

In this study single fiber and hybrid fibre composites and their effects on tensile, flexural and hardness properties are evaluated and compared. The results of the tensile and flexural testing of the composites samples are given in Table 1.

| Sample | Ultimate Tensile strength (MPa) | Flexural strength (MPa) |
|---|---|---|
| Kenaf composite | 86 | 88 |
| Banana composite | 77 | 86 |
| Hybrid(Kenaf/Banana)composite | 90 | 92 |

*Table-1:Tensile and flexural properties of different composite samples (Average of Three samples)*

3.1 Tensile properties

The composite samples are tested in the universal testing machine (UTM) and the stress-strain curve is plotted. The typical graph generated directly from the machine for tensile test for kenaf, Banana and hybrid composites as shown in Fig.3, 4 and 5.

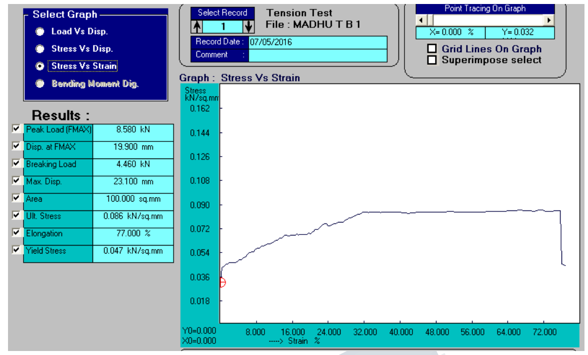


*Fig. 3. Stress strain curve for tensile test of kenaf fiber composite.*

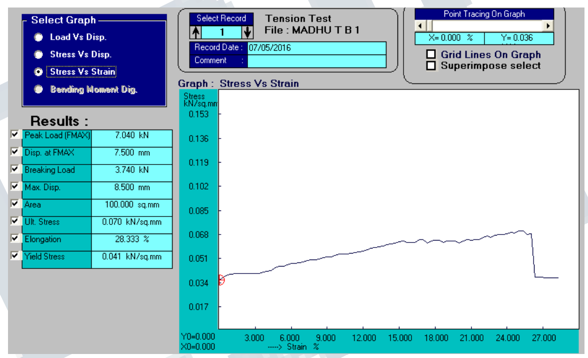


*Fig. 4. Stress strain curve for tensile test in banana composite.*

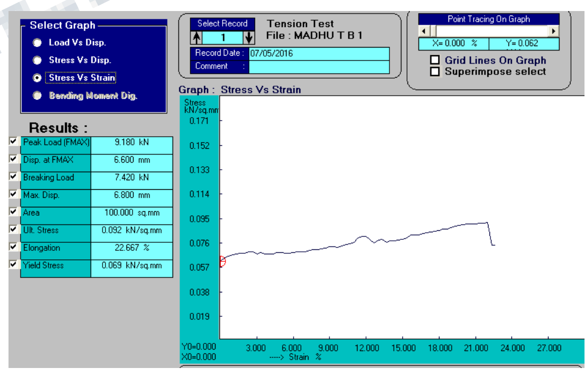


*Fig. 5. Stress strain curve for tensile test in hybrid composite.*

The ultimate tensile strength (UTS) of the different composite samples are tested and presented in Fig 6. The results indicated that the ultimate tensile strength of the hybrid composite is slightly higher than the kenaf and banana fiber composites.

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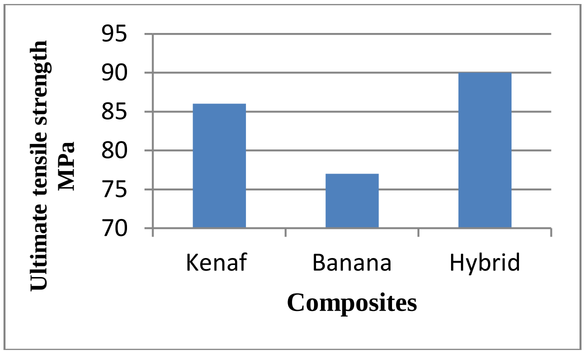


*Fig.6 UTS comparison of different composite samples*

### *3.2 Flexural properties*

The flexural properties of the composite samples tested in the UTM and the typical stress-displacement curve generated for for kenaf, Banana and hybrid composites as shown in Fig.7, 8 and 9

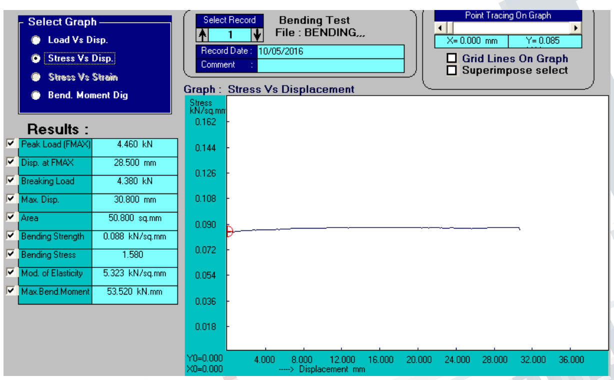


*Fig. 7.Stress-displacement curve for kenaf composite.*

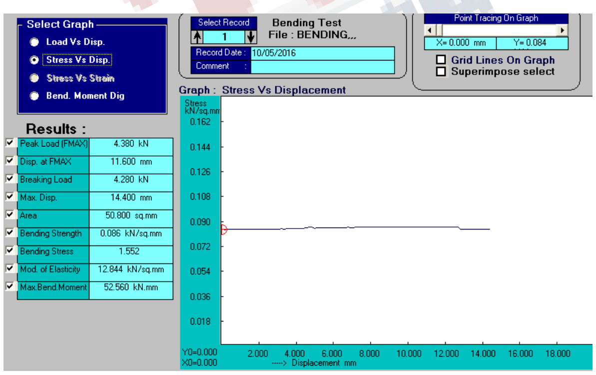


*Fig.8.Stress-displacement curve for banana composite.*

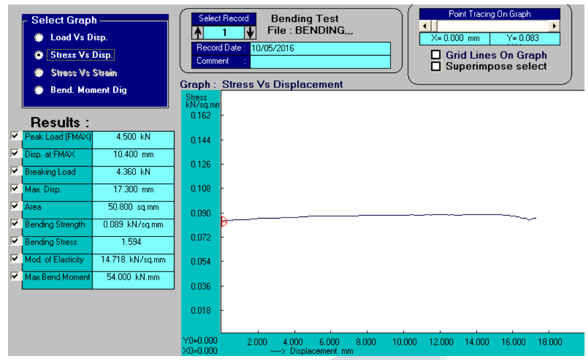


*Fig.9.Stress-displacement curve for hybrid composite.*

The flexural strength for different composite samples are observed and presented in Fig.10. From the figure, it is asserted that the flexural strength capacity of hybrid composites is better than kenaf and banana fiber composites tested.

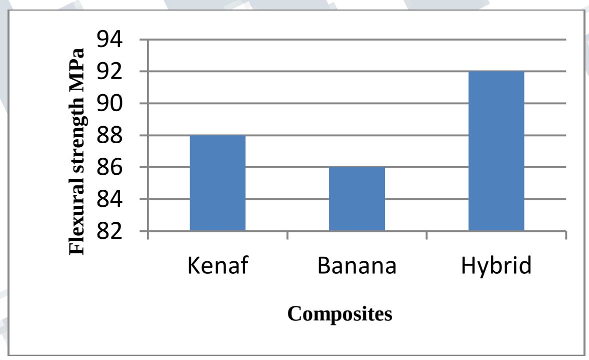


*Fig.10. Flexural load comparison of different composite samples.*

### *3.3 Hardness test*

The composite samples are tested in the Rockwell hardness tester using 2.5mm ball indenter.

| Sample | Average RHN |
|---|---|
| Kenaf composite | 105 |
| Banana composite | 107 |
| Kenaf/Banana composite | 108 |

*Table 2:RHN for different composite samples (Average of Three samples)*

The hardness number for different composites as shown table 2. it is found that the hybrid composite has better hardness number than the kenaf and banana fiber composite samples.

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## 4. CONCLUSIONS

This experimental investigation of mechanical behavior of Kenaf ,Banana and hybrid composites leads to the following conclusions.

- This work shows the successful fabrication of Kenaf, Banana & Hybrid natural polymer composites by simple hand lay-up technique.
- The characterization of the composites reveals that the hybridization is having significant effect on the mechanical properties of composites.
- The hybrid composites samples posses good tensile strength and can withstand the strength upto 90Mpa.
- The hybrid composite specimen is holding the maximum flexural load of 4.5KN slightly higher than the kenaf and banana fiber composite samples.
- From Rockwell hardness tester, it is found that the hybrid composite has better hardness number than the kenaf and banana fiber composite samples.
- From the above tests it is found that the Mechanical properties of Hybrid(kenaf &banana) composite is higher compared to kenaf & banana composites.

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