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INVESTIGATION OF TENSILE AND IMPACT BEHAVIOUR OF ABACA-RAFFIA HYBRID COMPOSITE

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ABSTRACT

Current technological development forces the industries to find new alternate and non-conventional materials that may replace conventional materials. Hence, industries are aiming to develop composite materials that are made from two or more constituent materials with significantly different physical and chemical properties. Hence, the composite materials have better properties than their constituent materials. In this paper an attempt has been made to fabricate and investigate the tensile and impact properties natural fiber composites made up of abaca and raffia fibers with three different compositions. The method adapted is hand layup process. The result shows that the hybrid composite made up of abaca and raffia have better properties than mono fiber composites. Failure morphology analysis is done using scanning electron microscope on the tested specimens.

Keywords: natural fibres, abaca, raffia, tensile and impact properties, hand layup method.

1. INTRODUCTION

Composite materials has' high specific strength and modulus, thus replacing many conventional metals. Among various types of composites, composites with natural fibres play a very crucial role in the manufacturing of clothing, automotive and textile industries. A study is made on the properties of woven roving composite laminates and their performance. From this study and analysis, it is concluded that the laminates are suitable for automotive panel board applications [1]. The chance of the formation of micro-voids between fibre and matrix during the preparation of composites greatly influences the tensile properties of fibres [2]. It has been reported that abaca fiber has a high tensile strength, resistance to rotting and has a specific flexural strength compared to that of glass fiber [3]. Tensile behavior of sisal and coir reinforced hybrid composites using Vinyl Ester Resin is experimented and it is found that tensile strength of hybrid composites is greater than individual composites containing any one of the constituents [4]. Natural composites have fairly good mechanical properties, high specific strength, non-abrasive, eco-friendly and bio-degradability characteristics. Due this reason, they are exploited as replacements for the conventional fibres, such as glass, aramid and carbon [5]. Investigation on mechanical properties of hybrid composites using jute, flax, abaca, banana, and pine apple are done and it is concluded that natural fiber composites have better strength [6,7, 8, 9].

2. EXPERIMENTAL SETUP

Table-1 shows the fibers, resin and hardener used in this work for making the composites.

Table-1. Materials used.

Fibers	Resin	Hardener
Abaca(manila hemp)	Epoxy resin	HY 951
Raffia		
Glass fibre		

Hand layup method is used in this work for making the composite laminates. Here, glass fiber laminates are placed in the mould after spreading the thinner on its surface. Then, resin and hardener mixture is applied on the surface of the glass fiber and the raffia fibres are arranged on it. Again glass fibre laminate is placed on it and resin; hardener mixture is spread over which again raffia fibres placed. On the top most layer glass fiber is placed and then a weight of 18 Kg is placed on it for 20 hours for complete curing of the composite. The same procedure is repeated for abaca and glass fibre composite and abaca, raffia and glass fibre composites. Then the composite laminate was cut to required dimensions as per ASTM –D638 standard. Figures-1, 2, and 3 show the prepared test specimens for tensile test.

Figure-1. Abaca test specimen.

Figure-2. Raffia test specimen.

Figure-3. Abaca + Raffia test specimen.

3. TESTING OF MATERIALS

a) Tensile test

A material is gripped at both ends by an apparatus, which slowly pulls the piece lengthwise until it fractures. The pulling force is called a load, which is plotted against the material length change, or displacement. The load is converted to a stress value and the displacement is converted to a strain value. If a composite material is pulled out until it breaks, a lot of information about the various strengths and mechanical behaviours of that material can be obtained.. In this {virtual} experiment, we will examine the tensile behaviour of three different composite fibre materials. {They have similar uses but very different properties.} Figure-4 shows the ASTM standard of tensile test specimen.

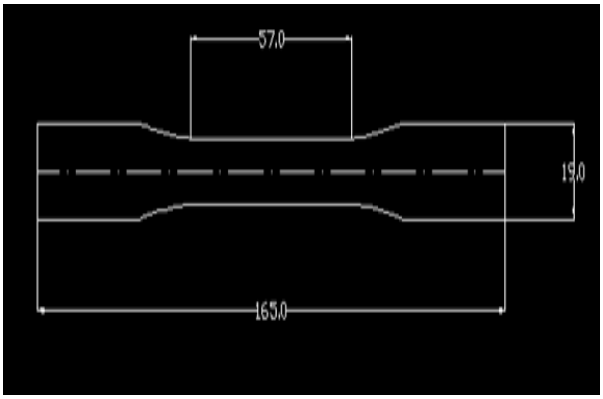

Figure-4. Tensile test specimen [ASTM: D638].

b) Impact test

The Impact test is a dynamic test in which a V-notched test piece, gripped vertically, is broken by a single blow of a freely swinging pendulum. The blow is struck on the same face as the notch and at a fixed height above it. The energy absorbed is measured. This absorbed energy is a measure of the impact strength of material. Figure-5 shows the ASTM standard of impact test specimen.

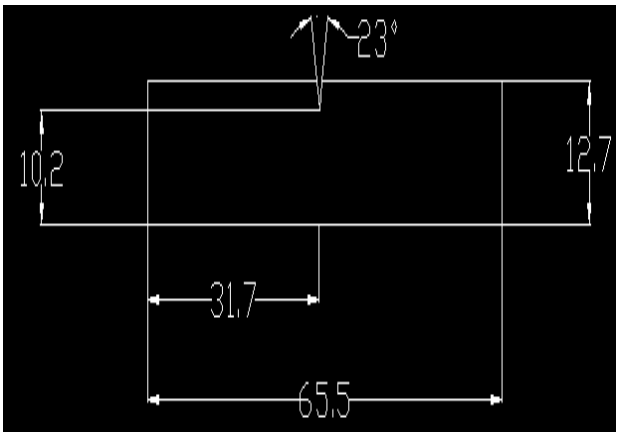

Figure-5. Impact test specimen [ASTM: D256].

4. RESULTS AND DISCUSSIONS

a) Tensile test

The Tensile test was conducted on the composite specimens namely ABACA, RAFFIA, ABACA + RAFFIA and the load Vs. displacement graphs are plotted. Table-2 shows the tensile properties of tested composites. Figures-6, 7, and 8 show the stress Vs strain of three types of composites fabricated in this work.

Table-2. Tensile test properties of tested composite specimens.

Composite	Break Load (kN)	Elongation %	Ultimate Tensile Strength (Mpa)	Tensile Modulus (Mpa)
GFRP+ABACA	3.15	16.33	92	380
GFRP+RAFFIA	3.24	23.67	95	537
GFRP+ABACA +RAFFIA	4.34	28.63	127	615

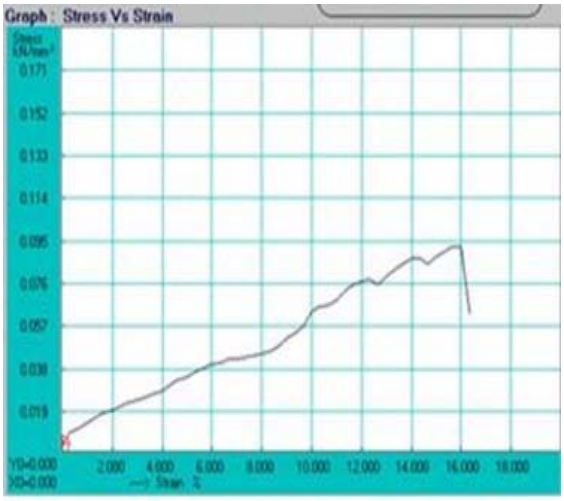

Figure-6. Tensile behaviour of Abaca +GFRP composite.

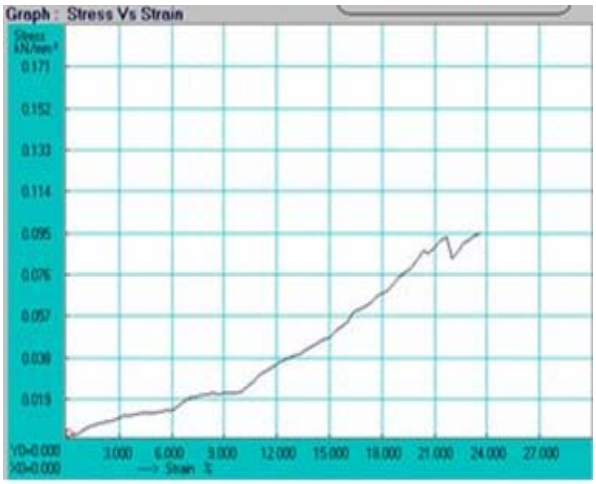

Figure-7. Tensile behaviour of raffia+ GFRP composite.

Figure-8. Tensile behaviour of Abaca + Raffia +GFRP composite.

The above three graphs show the stress and strain relation between the various composites. It can be seen that the tensile properties of the hybrid composite Abaca + Raffia + GFRP are higher than other two specimens.

b) Impact test

The Impact test was conducted on the composite specimens namely ABACA, RAFFIA, ABACA + RAFFIA and the energy absorbed by the composite are tabulated. It was found that ABACA+RAFFIA+GFRP hybrid composite absorb less energy as compared to other composites. This is due to the presence of more number of GFRP layers and resin in this composite.

S. No.	Composition	Energy absorbed (In Joules)
1	ABACA+GFRP	4.4
2	RAFFIA+GFRP	3.9
3	ABACA+RAFFIA+GFRP	3.5

5. FAILURE MORPHOLOGY ANALYSIS

In this work failure morphology analysis was carried out using scanning electron microscope (SEM) to know the fractured surface properties and characteristics. Initially, the samples are dried and coated with thick gold layers (18-22 nm). Then the coated specimen is placed under SEM to observe the fractured surface properties. The SEM images of tensile tested specimen are shown. It is understood from the Figures-9 and 10, after the application of tensile stress on the specimen, the crack out first and then the adhesion starts breaking between the matrix and the resin. Since, abaca-raffia combination yields good strength, they broke collectively after the application of the tensile stress.

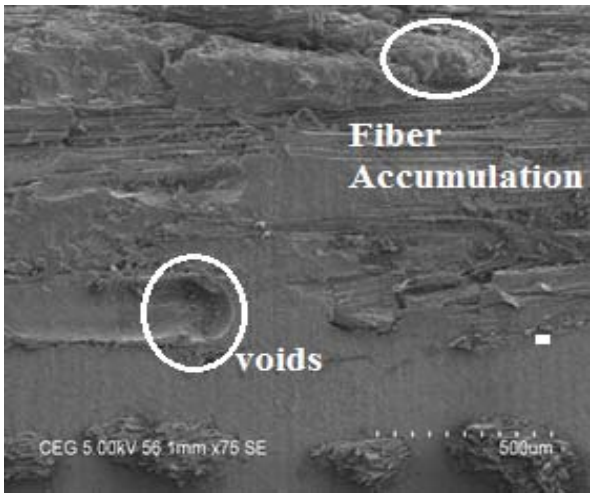

Figure-9. Tensile test SEM image.

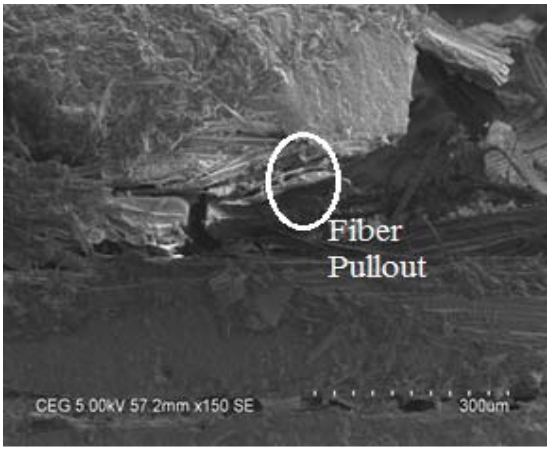

Figure-10. Tensile test SEM image.

6. CONCLUSIONS

In this work, composites are fabricated with Abaca, Raffia, and Abaca + Raffia fibre s and it is concluded that the hybrid composite gives better mechanical properties than other two. Based on the results, following conclusions were inferred.

- The ultimate tensile strength of the GFRP+ABACA+RAFFIA composite is 0.127 kN/mm^2 which is higher than that of the GFRP+ABACA composite with 0.092kN/mm^2 and GFRP+RAFFIA composite with a value of 0.095 kN/mm^2.
- Abaca glass fiber composite absorbs more energy than others.

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