INFLUENCE OF GLASS FIBER HYBRIDIZATION ON MECHANICAL CHARACTERISTICS OF SISAL FIBRE REINFORCED COMPOSITE MATERIAL

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ABSTRACT

Natural fibres are used to sustainable alternative material for various engineering application due to their properties like low cost, low weight, biodegradability and environmental friendliness. Hybridization of the composite by combining the natural and artificial fibers leads to achieve the greater properties. In this work, natural fiber sisal and artificial fiber Glass used. composites of sisal (S), sisal/glass (SG) and glass/sisal/glass (GSG) were fabricated by hand layup technique process. The mechanical properties of tensile strength, flexural strength and impact strength were evaluated according to ASTM. The result shows that, an increase in E-glass to sisal fiber which leads to increase the properties of tensile strength, flexural strength and impact strength to an greater extend.

KEYWORDS: Composite; Hybrid Composites; Mechanical Characterization; Sisal Fiber; Glass Fiber

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INTRODUCTION

Now a day's Natural fibers are sustainable alternative material for various engineering application such as automotive, aeronautics, marine and sports industry[1-2]. Generally, Natural fibers are produced from different plant and animals. They have many varieties from plant such as banana, jute, bamboo and kenaf. Sisal fiber is extracted from leaves of aloe vera and coir extracted from plant of fruit. However, the natural fiber are low cost, low weight, environmentally superior alternative for glass fiber composites and better thermal properties. Many of researchers focus on a natural fiber and proposed to replace synthetic fiber material due to various advantages such as biodegradability, and acceptable specific properties [3-5]. Hybrid composite more advanced composite as compared to conventional composites. Hybrid composite was prepared by combination of two or more natural fiber or single natural fiber and synthetic fiber [6]. Researchers studied the effect of glass fiber hybridization with the randomly oriented natural fibers has been analyzed and mechanical properties such as tensile strength, flexural strength and impact strength were evaluated. It was found that the addition of two and three layer of glass fiber can improve the tensile strength by a factor of 2.34 and 4.13 respectively. The flexural properties were enhanced on banana-sisal fiber with two layers of glass fibers rather than three layers and the laminate with sisal fiber [7]. The mechanical properties of jute and sisal fiber reinforced epoxy composites treated with sodium hybrid and results found better for composites [8]. The behaviour of hybrid composite reinforced with several types of fibers like jute, pineapple

and glass with proportion of (1:1:1). from the result it was found that tensile strength and flexural strength increases with an increase of fiber content[9-10]. The glass fiber composites and sisal fiber based composites are exhibiting reasonable performance in the industries, with this the research interest gained on the combination of the fibers of Sisal and Glass fiber[11-13]. The current work started with the moto to evaluate the influence of hybridization on mechanical properties of sisal epoxy composites with glass fiber.

MATERIALS AND METHODS

Materials

In this work, the composites were made from sisal and glass fibers provide with epoxy resin as matrix. The sisal is purchased from group of Sri Lakshmi exports and imports, Guntur, Andhra Pradesh, India. E-Glass fiber is purchased from Bangalore, Karnataka, India. Epoxy resin, identified as Araldite LY556 density of 1.2 g/cm³ with an hardener of K6 density 0.98 g/cm³ was used. The physical properties of the E-glass and sisal fabrics are shown in Table 1.

Table 1: Physical Properties of Sisal and E-Glass Fibers

S No.	Properties	Sisal Fiber	E-Glass Fiber
1	Density (gm/cm ³)	1.35	2.54
2	Tensile strength (kN/mm ²)	610–720	1800–2400
3	Stiffness (kN/mm)	30–38	65–75
4	Moisture absorption (%)	11	-
5	Hemicellulose content (%)	10–15	-
6	Lignin content (%)	7–13	-

2.2 Fabrication of composite

In this present work composites were prepared by hand layup method[14]. Composites were made by using a wood mould measurement of 200 mm× 200 mm× 5 mm length, width and depth, respective. Initially, Sisal and glass fibers cut in size of 200 mm ×200 mm for fabrication of laminates. And measured quantity of epoxy was used and then mixed with the hardener in the ratio of 10:1. Totally, three types of composites were prepared: First composite consist of plain sisal. Second composite consist of one-layer sisal and one layer of glass and third one consistof sisalfiber as a middle layer between the glass fibers. For avoiding air bubble formation care was taken during pouring and Pressure was applied from the top then the mold was allowed to cure at room temperature for 24 hrs. After 24 hrs the samples were taken out from the mold, Finally, as per ASTM standard the specimen was cut by using a diamond cutter.

Table 2: Type of Composites Produced

S.No.	Composite	Composition
1	S	Sisal fibre (30%) + Epoxy (70%)
2	SG	Sisal Fibre (30%) + glass fibre (10%) + Epoxy(60%)
3	GSG	Glass fibre (10%)+Sisal fibre (30%)+ glass fibre (10%)+ Epoxy(50%)

Mechanical Testing

The following tests were conducted on the samples:

- Tensile strength
- Flexural strength
- Impact strength

Tensile Strength

The tensile tests were conducted specimen for tensile test is the dog-bone type according to the ASTM D638 standard on

100 KN Kalpak computerized universal testing machine. In this case, the tensile stress was applied in the direction of fibre axis. The tensile strength and modulus of the all the composites were measured using a Universal Testing Machine. The test was conducted with a cross head speed of 10 mm/min.

Flexural Strength

Flexural strength is carried out to find the ability of the material to resist the deformation under the load. The flexural specimens are prepared according to ASTM D618 specification standards. The flexural test is done in a three-point bending fixture then load is applied at the middle of the specimen, it bends and fractures.

$$\text{Flexural strength } \sigma_f = (3PL) / (2WT^2)$$

Where, σ_f is the ultimate flexural stress (MPa), P is the maximum load (N), L is the support span (mm), W is the width of the beam (mm), T is the thickness of beam (mm).

Impact Test

The impact test is done in a charpy impact setup as per ASTM D256 standard. Specimens were prepared as per the standard test method for determining the impact resistance. The specimen must be loaded in the testing machine and allows the pendulum until it fractures or breaks.

Table 3: Mechanical Properties for Prepared Composites

S No	Specimen Label	Tensile Strength (Mpa)	Flexural Strength (Mpa)	Impact Energy (Kj/M ²)
1	Sisal [S]	88.86	261.27	3.5
2	Sisal-Glass [SG]	156.36	322.56	3.6
3	Glass-Sisal-Glass [GSG]	211.83	388.65	3.8

RESULTS AND DISCUSSIONS

Tensile Strength

Figure 1 shows the variation in tensile strength among the three types of composite laminates the values are 88.86 MPa, 156.36 MPa and 211.83 MPa for S, SG and GSG Composites. It also observed that tensile strength of SG and GSG composites were increased by 75.96% and 139 % in addition of glass fiber by 10% and 20% respectively. The overall understanding is that the Sisal-Glass and Glass-Sisal-Glass fiber reinforced with Epoxy resin is giving a good tensile strength compared to sisal natural fibers considered in this work.

Figure 1: Variation of Tensile Strength for Different Composites

Flexural Strength

Figure 2 shows the variation in Flexural strength it is observed that the values are 261.27 MPa, 322.56 MPa and 388.65 MPa for S, SG and GSG composites. it is observed that the value of flexural strength is very high (388.65 MPa) for GSG composite showing good flexural strength in addition of glass fiber by 20%. Glass composite laminate withstands the highest value of flexural load due to the high stiffness.

Figure 2: Variation of Flexural Strength for Different Composites.

Impact Strength

Fig. 3 illustrates the variation of impact strength with S, SG and GSG composites. It is observed that impact strength increased

due to the content of glass fabrics and also to fabrics/matrix good bonding, it is clearly observed that ability to resist impact force is higher GSG (3.8 kJ/m^2) for composite when compare to other specimens.

Figure 3: Variation of Impact Strength for Different Composites.

CONCLUSIONS

This work mainly focused on investigation of mechanical properties of sisal/Glass hybrid epoxy composite. From the experiment, the following conclusions have been arrived at:

- The maximum tensile strength, flexural strength and impact strength are of 211.83MPa, 388.65 MPa, $3.8 \text{ (kJ/m}^2\text{)}$ for GSG composite were obtained, respectively.
- It can be observed that an increase in E-glass in composites leads to increase the properties of tensile strength, flexural strength, and impact strength.

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