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# FABRICATION AND TESTING OF FIBRE REINFORCED POLYMER COMPOSITES MATERIAL

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***ABSTRACT:*** *The composite materials are replacing the traditional materials, because of its superior properties such as high tensile strength, low thermal expansion, high strength to weight ratio. The developments of new materials are on the anvil and are growing day by day. Natural fiber composites such as sisal polymer composites became more attractive due to their high specific strength, lightweight and biodegradability. Mixing of natural fiber with Glass-Fiber Reinforced Polymers (GFRPs) is finding increased applications. In this study, sisal – glass fiber reinforced epoxy composites is developed and their mechanical properties such as tensile strength, compression strength, flexural strength and impact strength are evaluated. The interfacial properties, internal cracks and internal structure of the fractured surfaces are evaluated by using Travelling Microscope .The results indicated that the incorporation of sisal fiber with GFRP can improve the properties and used as an alternate material for glass fiber reinforced polymer composites.*

## 1. INTRODUCTION

The term composite can be defined as a material composed of two or more different materials, with the properties of the resultant material being superior to the properties of the individual materials being superior to the properties of individual material that make up the composite.

Glass Fiber Reinforced Polymers (GFRPs) is a fiber reinforced polymer made of a plastic matrix reinforced by fine fibers of glass. Fiber glass is a lightweight, strong, and robust material used in different industries due to their excellent properties. Although strength properties are somewhat lower than carbon fiber and it is less stiff, the material is typically far less brittle, and the raw materials are much less expensive. Its bulk strength and weight properties are very favorable when compared to metals, and it can be easily formed using molding processes. Now a day's natural fiber such as sisal and jute fiber composite materials are replacing the glass and carbon fibers owing to their easy availability and cost. The use of natural fibers is improved remarkably due to the fact that the field of application is improved day by day especially in automotive industries. Several researches have been taken placein this direction.

Most of the studies on natural fibers are concerned with single reinforcement. The addition of natural fiber to the glass fiber can make the composite hybrid which is comparatively cheaper and easy to use.

In the present study the mechanical properties of sisal–glass fiber reinforced composite materials is studied. The sisal–GFRP composite materials are manufactured by hand lay-up process. The properties such as tensile, compression, flexural and impact are studied and presented in detail. The results indicated that the addition of sisal in the glass fiber composite material makes the composite hybrid and it improves the properties.

## 2. MATERIAL USED

### 2.1. Glass Fiber-reinforced composites

The manufacturing process for glass fibers suitable for reinforcement uses large furnaces to gradually melt the silica sand, limestone, kaolin clay, fluorspar, colemanite, dolomite and other minerals to liquid form. Then it is extruded through bushings, which are bundles of very small orifices (typically 5–25 micrometres in diameter for E-Glass, 9 micrometres for S-Glass).

Glass-fiber reinforced plastic, or GFRP is a fiber reinforced polymer made of a plastic matrix reinforced by fine fibers of glass. Fiberglass is a lightweight, extremely strong, and robust material. Although strength properties are somewhat lower than carbon fiber and it is less stiff, the material is typically far less brittle, and the raw materials are much less expensive. Its bulk strength and weight properties are also very favorable when compared to metals, and it can be easily formed using molding processes. The plastic matrix may be epoxy, a thermosetting plastic (most often polyester or vinylester) or thermoplastic. Common uses of fiberglass include boats, automobiles, baths, hot tubs, water tanks, roofing andpipes.

**2.2. Sisal Fiber**

Sisal fibers are extracted from the leaves of sisal plant. The fibers are extracted through hand extraction machine composed of serrated knives. The peel is clamped between the wood plank and knife and hand-pulled through, removing the resinous material. The extracted fibers are sun-dried which whitens the fiber. Once dried, the fibers are ready for knotting. A bunch of fibers are mounted or clamped on a stick to facilitate segregation. Each fiber is separated according to fiber sizes and grouped accordingly. To knot the fiber, each fiber is separated and knotted to the end of another fiber manually. The separation and knotting is repeated until bunches of unknotted fibers are finished to form a long continuous strand. This Sisal fiber can be used for making variety of products.

### 2.2.1. Physical property sisal fiber

| | |
|---|---|
| Density (g/cm3) | 1.41 |
| Elongation at break (%) | 6–7 |
| Cellulose content (%) | 60–65 |
| Young’s modulus (GPa) | 12.8 |
| Diameter (µm) | 205–230 |

**CHOPPED SISAL FIBER**

### 2.3. PREPARATION OF COMPOSITE SPECIMEN

The composite materials used for the present investigation is fabricated by hand layup process. Chopped sisal fibers of 50 mm length were used to prepare the specimen. The composite specimen consists of total five layers in which glass fiber layers are fixed in top middle and bottom of the specimen. Second and fourth layers are filled by natural fibers such as sisal fiber. The layers of fibers are fabricated by adding the required amount of epoxy resin. Initially the glass fibers polymer, sisal fiber are dried in sun light to remove the moisture.

The cutter glass fiber is placed on the Mylar sheet for 1.2mm thick and then the resin is coated on the glass fiber using roller brush. Further the compressed sisal is placed on the glass fiber and then coated the resin in natural fiber.Then another glass fiber is placed above the sisal again the resin coated then the fourth layer sisal is placed.Resin coated further evenly distributed in the fiber using roller, the fifth layer is placed glass.After five layers laminated sheet is placed in the compression molding machine with 10bar pressure and 80°c.

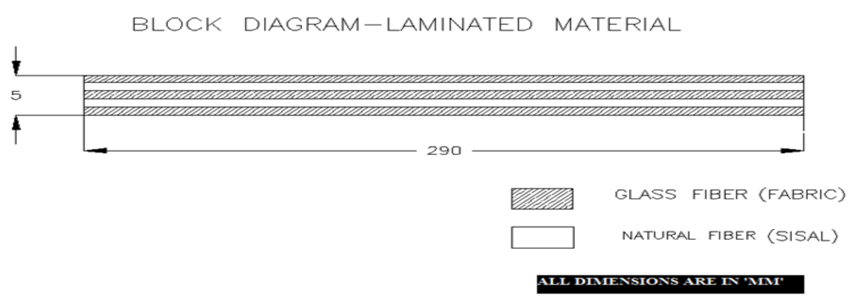
### 2.3.1. Size of laminate

Initially we take the alkaline treatment of sisal fiber and it's chopped into 50mm. Then the chopped sisal fiber is compressed in the compression molding machine into the form of sheet 1.2mm.

The dimension of compressed sisal fiber is,

Width = 290mm, Length = 290mm, Thick = 1.2mm

Then the glass fiber (Woven Roving Mat) is cutting into the required shape, Length = 290mm, width = 290mm




### 2.3.2. Fabrication details

- GLASS = 272g
- NATURAL FIBER = 75+75g
- GLASS FIBER TO RESIN = 1:1
- NATURAL FIBER TO RESIN = 1:2
- EPOXY WITH HARDENER = 570g
- PRESSURE OF COMPRESSION = 10bar
- TEMPERATURE REQUIRED = 80°c

## 3. MECHANICAL TEST

### 3.1.Tensile test

The hybrid composite material fabricated is cut into required dimension using a saw cutter and the edges finished by using emery paper for mechanical testing. The tensile test specimen is prepared according to the ASTM D638 standard. The dimensions, gauge length and cross-head speeds are chosen according to the ASTM D638 standard. A tensile test involves mounting the specimen in a machine and subjecting it to the tension. The testing process involves placing the test specimen in the testing machine and applying tension to it until it fractures. The tensile force is recorded as a function of the increase in gauge length. During the application of tension, the elongation of the gauge section is recorded against the applied force.

Length = 260mm, width = 24mm, thick = 5mm

### 3.2. Flexural test

The flexural specimens are prepared as per the ASTM D790 standard. The 3-point flexure test is the most common flexural test for composite materials. Specimen deflection is measured by the crosshead position. Test results include flexural strength and displacement. The testing process involves placing the test specimen in the universal testing machine and applying force to it until it fractures and breaks. The specimen used for conducting the flexural test . The tests are carried out at a condition of an average relative humidity of 50%.


Length = 119.5mm, width = 12mm, thick = 5mm

### 3.3. Compression test

The compression specimen is prepared as per the ASTM D638 standard. A compression test involves mounting the specimen in a machine and subjecting it to the compression. The compression process involves placing the test specimen in the testing machine and applying compress to it until it fractures. The compress force is recorded as a function of displacement. During the application of compression, the elongation of the gauge section is recorded against the applied force.


Length = 13mm, width =13mm, thick = 11mm

### 3.4. Impact test

The impact test specimens are prepared according to the required dimension following the ASTM-A370 standard. During the testing process, the specimen must be loaded in the testing machine and allows the pendulum until it fractures or breaks. Using the impact test, the energy needed to break the material can be measured easily and can be used to measure the toughness of the material and theyield strength

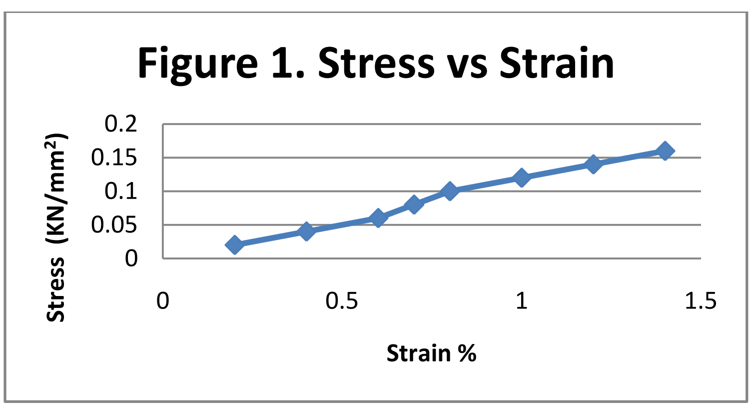
Length = 64mm, width = 12mm, thick = 5mm.

## 4. RESULTS AND DISCUSSION

The use of composite materials in the different fields is increasing day by day due to their improved properties. Engineers and Scientists are working together for number of years for finding the alternative solution for the high solution materials. In the present study natural fibers are added to the glass fiber reinforced composite materials and their effect on mechanical properties is evaluated and their properties are compared.

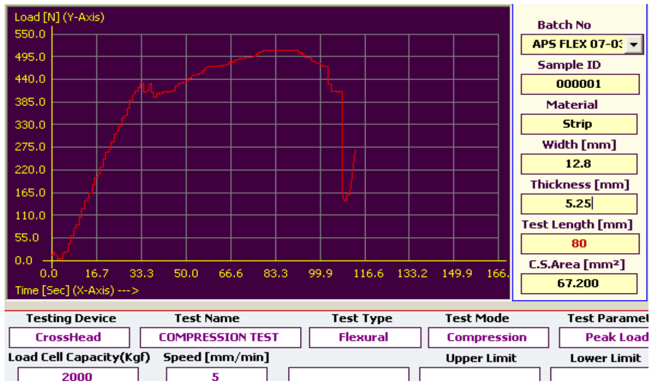
### 4.1. Tensile properties

The specimen size is 260x24x5mm.The different composite specimen samples are tested in the universal testing machine (UTM) and the samples are left to break till the ultimate tensile strength occurs. Stress–strain curve is plotted for the determination of ultimate tensile strength and elastic modulus. The sample graph generated directly from the machine fortensile test with respect to load and displacement for sisal - GFRP.The results indicated that sisal–GFRP specimen gives tensile strength is low.The Maximum tensile force (MTF) of the sisal–GFRP composite is in the range of 24.080 KN respectively.




### 4.2. Flexural properties

The sample graph of flexural strength observed for the sisal–GFRP composites. The result indicated that the maximum applied load up to around 500 N, after that it tends to decrease. The load vs time graph for different composites tested. The specimen of flexural test size is 119.5x12x5mm and the span of flexural test is 80mm.




## 4.3. Compression properties

The specimen size for compression test is 13x13x11mm.The sample graph generated directly from the machine for compression test with respect to load and displacement for sisal - GFRP. That the graph shows that the maximum load is 28.180KN the respective displacement is 2.3mm.

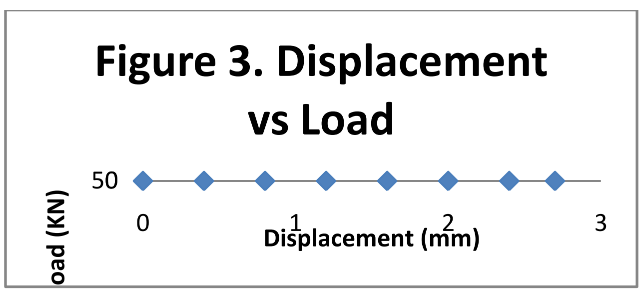
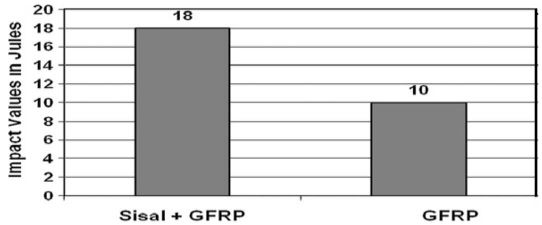


Figure 3. Displacement vs Load

## 4.4. Impact properties

The impact test carried out for the present investigation is Charpy impact test. The results indicated that the maximum impact strength is obtained for Sisal–GFRP composites are 18J. The specimen size of impact test is 64x12x5mm.

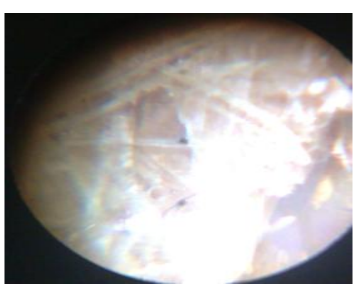



### 4.5. Hardness Properties

The Rockwell harness test carried out for the sisal-GFRP materials and obtained the result is applied 100kg for1/16inch penetrator the B scale reading is 96.67HRB. Size of specimen is length =30mm, width =30mm.

### 4.6. Microscope microstructure

The surface characteristics of the composite material used for the investigation is studied through microscope. The Microscope images are taken to observe the interfacial properties, internal cracks and internal structure of the fractured surfaces of the composite materials. All the specimens are coated with conducting material before observing the surfaces through microscope. The image Observed for the sisal–GFRP composite material subjected to tensile test is presented .The image for the sisal–GFRP composite materialwhich subjected to impact test. During theimpact of the specimen, the composite material is disintegratedin the breaking point.



## 5. CONCLUSION

Thus the Sisal-GFRP composite samples are fabricated and tested.The hybrids composite are subjected to mechanical testing such as tensile, flexural and impact test. Based on the results, the following conclusions are drawn:

- The results indicated that sisal–GFRP specimen gives tensile strength is low. The Maximum tensile force (MTF) of the sisal–GFRP composite is in the range of 24.080 KN.
- The result indicates for flexural test in the sisal-GFRP is high compare glass and sisal fiber separately. The maximum load is with stand 500N with 116sec.
- In the compression test the result indicates that very high strength 28.180KN and the respectively displacement is 2.3mm.
- The maximum impact strength is obtained for the sisal-GFRP fiber composite and has the value of 18 joules.
- The Rockwell hardness test the strength obtain 96.67 HRB.
- The microstructure of the fiber is obtained in the breaking point of tensile and impact test of specimen. To obtain the interfacial properties, internal cracks and internal structure of the fractured surfaces of the composite materials.

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