Investigation of the Mechanical Behavior and Impact Analysis of Hybrid Composites

R Karthikeyan¹, P N Selvaraju¹, T Sankaramoorthy², B R Ramesh Bapu³

¹Department of Automobile Engineering, Rajalakshmi Engineering College, Chennai, Tamil Nadu, India.
²Department of Mechanical Engineering, R.M.K. College of Engineering and Technology, Chennai, Tamil Nadu, India.
³Department of Mechanical Engineering, Chennai Institute of Technology, Chennai, Tamil Nadu, India.

* Corresponding author: rkarthiannauniv@gmail.com

Abstract. This project work is created by manual procedure of restoring the tiny tension. It will be occurring till one hour and difficulty in atmospheric temperature. We are producing four layers to changing the position and number of times. We investigated the flexures and ductile properties of sisal with glass fiber composites. The results of this paper slightly increasing the fiber properties. The layer grouping has more noteworthy impact on pliable, flexural properties. Generally speaking examination between the properties of the considerable number of covers uncovered that the half breed overlay (GSSG) with both end glass employs on either side is the ideal blend with an honest harmony between the properties and price. Limited component models are made with ANSYS recreation programming. These models are utilized to reproduce the effect tests for half and half fiber composite material with various stacking grouping. Diagrams are plotted to think about the effect conduct of various utilize directions. This innovation brief depicts an examination on to the sisal and glass fiber fortified plate and the particular points of interest of ANSYS Express for this sort of reenactment.

KEYWORDS: sisal, E-glass, polyester hybrid composites, flexural test, tensile test, ANSYS simulation.

1. Introduction

As of late, common strands have drawn overall consideration on a potential fortification material for the composite material. Generally the fiber support is done to get high quality and modulus. Consequently it is important for the strands to have higher modulus. At that point the network material, so load is moved to the fiber from the grid successfully. Normal fiber to the most extreme degree satisfies these rules. Lot of work has been done on different type of natural fibers like jute, sisal, pineapple, abaca and coir. There are many reports about the use of sisal as reinforcing fibers for thermo sets [1]. It has provided considerable improvement of tensile strength when compared to individual reinforcement; this is mainly due to transfer...
of loads and shearing of loads among the fibers [2]. Studied the Hybrid effect in the mechanical properties of short sisal-glass hybrid fiber reinforced low density polyethylene composites what's more, they saw that the impact of concoction change of sisal filaments on the properties of 50:50 sisal/glass fiber composites has likewise been contemplated. [3]. Examined the Influence of short glass fiber expansion on the mechanical properties of sisal strengthened low thickness polyethylene composites [4]. Studied the influence of fiber microstructure on fiber breakage and mechanical properties of natural fiber reinforced polypropylene and studied the tensile modulus, tensile strength and elongation of sisal fiber [5]. Studied the tensile & flexural properties of sisal/glass fiber reinforced hybrid composites. It is observed that the tensile and flexural strength of sisal/glass fiber hybrid component is higher than sisal fiber reinforced composite, but lower than the glass reinforced composite [6]. Have likewise researched the impact of speed, molecule size and weight of affected grating for nylon, carbon fiber strengthened nylon, and epoxy tar, polypropylene and glass fiber fortified plastic [7]. Their results shows that for the particular materials and conditions of their tests, composite materials generally behave in an ideal brittle fashion, i.e., maximum erosion rate occur at normal impact. However, E-glass fiber reinforced polyester composite exhibits erosion rates less than those of the other composites by a factor of 5 [8]. They used this test fixture to characterize the difference in impact damage between several sorts of composite laminates [9]. In recently the sisal fiber properties only depends on fiber sizes, diameter and making temperatures. The mechanical properties of sisal fiber are having higher strength. The mechanical properties are very low in compare to the natural fiber and synthetic fiber with sisal fiber, but economically natural fiber with sisal fiber is best [10].

2. Experimental Procedure

2.1. Materials and Method
E-glass fiber, Sisal fiber, Polyester, Catalyst/Accelerator, Hardener. Glass is the most widely recognized fiber utilized in polymer network composites. Its bit of leeway incorporates its high quality, minimal effort, high synthetic opposition, and great protecting properties. In the current examination E-glass fiber, 360 wandering provided by holy person Gobian ltd was utilized. The filaments wear slice to sizes 150x60 mm from the long sheet. Hardener K-6, aliphatic Primary amine which has a viscosity of 11-23 Mpa at 290 c is used along with the matrix material.

![Sisal fiber and E-Glass fiber](image)

Figure 1. Sisal fiber and E-Glass fiber

2.2. Preparation
We are manually made in hybrid sisal and glass fibers. A wooden mold of 300x300x4mm was used for manufacturing the composite. For speedy and simple expulsion of the composite sheet a shape discharge sheet was put over the glass plate. Shape discharge splash was additionally applied at the internal surface of the form divider after it was determined to the glass plate. Four groups of laminate composite samples with total 4 plies were manufactured by varying stacking sequence of sisal and glass fabrics as presented.
Figure 2. Prepared Sisal-Glass Composite

The matrix materials of sisal and glass fiber of polyester resin and hardener ratio 9:1. We are maintaining some distance during pouring the resin. Some load applied on the composites after we made. After 69hrs we prepare the materials for testing process. In this project we have conducted more tests.

3. Results and Discussion

3.1. Mechanical Testing of Composites

In this composite structures to acquire parameters, for example, quality and solidness is a tedious and regularly troublesome procedure. It is, be that as it may, a fundamental procedure, and can be fairly disentangled by the testing of straightforward structures, for example, level coupons. The information got from these tests would then be able to be legitimately related with shifting degrees of straightforwardness and exactness to any auxiliary shape. The test techniques laid out in this segment just speak to a little choice accessible to the composites researcher. A few, for example, the malleable coupon test, are generally perceived as principles, while there are many various tests for the estimation of shear properties.

3.2. Tensile Tests

Figure 3. Graph of Tensile Strength
Elastic testing uses the traditional coupon test geometry as appeared beneath and comprises of two areas: a focal locale called the check length, inside which disappointment is relied upon to happen, and the two end districts which are braced into a grasp system associated with a test machine. The pressure test is for the most part performed on level examples. The most regularly utilized example geometries are the canine bone example and straight-sided example with end tabs. The standard test method as per ASTM D 7565 has been used; length of the test specimen used is 125 mm. The ductile test is acted in all inclusive testing machine INSTRON H10KS. The test were performed with a cross head speed of 10mm/min. For each test composite of three samples were tested and average value was taken for analysis.

3.3. Flexural Testing
The Flexural test gauges the power required to twist a shaft under 3 point stacking conditions. The information is frequently used to choose materials for parts that will bolster loads without flexing. Flexural modulus is utilized as a sign of a material's solidness when flexed. Since the physical properties of numerous materials (particularly thermoplastics) can shift depending encompassing temperature it is once in a while fitting to test material at temperature that reenact the planned end client condition.

![Figure 4. Graph of Flexural strength](image)

Specimens of 125mm length and 7mm wide were cut and were loaded in three point bending with a recommended span to depth ratio of 16:1 as shown. The test was conducted on the same machine used for tensile testing using a load cell of 10kN at 2.6mm/min rate of loading. The results obtained from the tests are presented.

3.4. Impact Test
The impact behavior of a composite laminate could not be predicted with the help of generalized laws. The ply laminate sequence of a composite material greatly affects its impact behavior. The tests were performed utilizing an instrumented falling weight testing machine with no vitality stockpiling gadget: the most extreme effect vitality is constrained by the flexible falling tallness.
3.5. Analysis of Sisal Glass Fiber

Structural Modeling & Analysis of Tensile Specimen in Ansys

Each analytical model in ANSYS includes the following modules, they are selecting an element type, Defining material properties, creating a model, Meshing the model, Solution, Setting up an analysis, Applying the load, Applying displacements, solving the problem, Postprocessor, etc. To create a complete analysis model, it is usually necessary to go through most of these modules, as described below. Creating the element sections, Introducing material properties (young’s modulus, poisons ratio).

Figure 5. Impact Strength

Figure 6. Stress Behavior of Tensile Specimen GGSS
Figure 7. Stress Behavior of Tensile Specimen GSGG

Figure 8. Stress Behavior of Tensile Specimen GSGS

Figure 9. Stress Behavior of Tensile Specimen GSSG
3.6. Structural Modeling & Analysis of Flexural Specimens in Ansys

Each analytical model in ANSYS includes the following modules, they are selecting an element type, Defining material properties, creating a model, Meshing the model, Solution, Setting up an analysis, Applying the load, Applying displacements, solving the problem, Post processor, etc To create a complete analysis model, it is usually necessary to go through most of these modules, as described below.

![Figure 10. Stress Behavior of Flexural Specimen GGSS](image1)

![Figure 11. Stress Behavior of Flexural Specimen GSGG](image2)
3.7. Structural Modeling & Analysis of Impact Specimens in Ansys

Each analytical model in ANSYS includes the following modules, they are Selecting an element type, Defining material properties, creating a model, Meshing the model, Solution, Setting up an analysis, Applying the load, Applying displacements, solving the problem, Post processor, etc To create a complete analysis model, it is usually necessary to go through most of these modules, as described below.
Figure 14. Stress Behavior of Impact Specimen GGSS

Figure 15. Stress Behavior of Impact Specimen GSSG

Figure 16. Stress Behavior of Impact Specimen GSGS
Figure 17. Stress Behavior of Impact Specimen GSSG

4. Conclusion

- This work is aimed at gaining an initial understanding of the impact behavior of fiber composite. The purpose of this investigation is to characterize the effect of ply sequence on the composite laminates subjected to low velocity impact and obtain the simplest ply design.
- The hybrid laminate sisal and glass fiber are good mechanical properties for compare to others.
- While doing the flexural and impact testing of all sequences in ANSYS, here to (GSSG) has been observed to have the maximum velocity. On comparing different stacking sequence of sisal-glass laminates like GSSG, GGSS, GSGG and GSGS for the tensile, flexural and impact strength, we conclude that the GSSG is the best sequence.

5. References

[1] K.John, S.Venkata Naidu, Chemical Resistance Studies of Sisal/Glass Fiber Hybrid Composites, Journal of Resin Plastic Composites. (2007) 373–376.
[2] Kalapradad G, Joseph K, Thomas S. Influence Of Short Glass Fibre Addition On The Mechanical Properties Of Sisal Reinforced Low Density Polyethylene Composites. Journal of Composite Materials 1997; 31:509±26.
[3] Kalaprasad G, Thomas S, Pavithran C, Neelakantan Nr, Balakrishnan S. Hybrid Effect In The Mechanical Properties Of Short Sisal/Glass Hybrid Fibre Reinforced Low Density Polyethylene Composites. Journal of Reinforced Plastics And Composites1996; 15:48±73.
[4] KristiinaOksman, Aji P. Mathew, RunarLångström, BirgithaNyström, Kuruvilla Joseph , The Influence Of Fibre Microstructure On Fibre Breakage And Mechanical Properties Of Natural Fibre Reinforced Polypropylene (2009) 1847–185
[5] Pavithran C, Mukherjee Ps, Brahmakumar M, Damodaran Ad. Impact Properties of Natural Fiber Composites. Journal Of Material Science Letters 1987; 6:882–4.
[6] V. Naga Prasad Naidu, M.Ashok Kumar, G.Ramachandra Reddy, P.NoorunnisaKhanam, M.Mohan Reddy, K.V.P.Chakradhar, Tensile & Flexural Properties Of Sisal/Glass Fibre Reinforced Hybrid Composites, (2011)2249-8559
[7] Yan Li, Yiu-Wing Mai, Lin Ye, ‘Sisal Fiber and Its Composites: A Review of Recent Developments’. Composites Science and Technology, Volume 60, (2000), 2037-2055.
[8] Zhong J-B., Niu Y-L., Lü J., Wei C.: Effect of Steam Explosion Treatment on Mechanical Properties of Sisal Fiber/Phenol-Formaldehyde Resin Composite. China Plastics Industry, 34, 53–55 (2006).

[9] G. R. Lightsey, in Polymer Application of Renewable Resource Materials, C. E. Carraher, Jr. and L. H. Sperling, Eds., Plenum Press, New York, 1983, p. 193.

[10] SILVA F.A., CHAWLA N., AND TOLEDO FILHO R.D., 2008. “Tensile behaviour of high performance natural (sisal) fibres. Composites Science and Technology” 68, pp.3438- 3443

[11] Arbelaz A, Fernandez B, Cantero G, LlanoPonte R, Valea A and Mondragon I (2005)
“Mechanical properties of flax fiber/poly propylene composites. Influence of fiber/matrix modification and glass fiber hybridization.” Composites Part A. 36, 1637- 1644.

[12] Harriette L. Bos, JorgMussig, Martien JA and Van den Oever (2006) Mechanical properties of short-flax-fiber reinforced compounds. Composites Part A. 37, 1591- 1604.

[13] MunikencheGowda T, Naidu ACB and Rajput Chhaya (1999) Some mechanical properties of untreated jute fabric-reinforced polyester composites. Composites Part A. 30, 277-284.

[14] Bisanda E. T. N.: The effect of alkali treatment on the adhesion characteristics of sisal fibres. Applied Composite Materials, 7, 331–339 (2000).

[15] Joseph P. V., Joseph K., Thomas S.: Short sisal fiber reinforced polypropylene composites: the role of interface modification on ultimate properties. Composite Interfaces, 9, 171–205 (2002).

[16] Wei C., Mu Q-H., Luo W-H.: Influences of treatment methods for sisal stems on properties of sisal fiber/formaldehyde resin composites. China Plastics, 17, 44–47 (2003).

[17] Zhong J-B., Niu Y-L., Lü J., Wei C.: Effect of steam explosion treatment on mechanical properties of sisal fiber/phenol-formaldehyde resin composite. China Plastics Industry, 34, 53–55 (2006).

[18] Mishra S., Mohanty A. K., Drzal L. T., Misra M., Parija S., Nayak S. K., Tripathy S. S.: Studies on mechanical performance of biofibre/glass reinforced polyester hybrid composites. Composites Science and Technology, 63, 1377–1385 (2003).