

# Experimental Investigation of Mechanical Performance on Natural Fibre Using Hybrid Laminate

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**ABSTRACT-** Natural fibres act a vital role in the area of composites and have established wide acceptance in this area. In this work, stacking orders of hybrid laminates are studied, with glass fibre (E-glass) and natural fibre (sisal) termed as GFSRL (Glass Fibre Sisal Reinforced Laminate) and SGFRL (Sisal Glass Fibre Reinforced Laminate). The purpose of this study is to investigate its mechanical behaviour on the effect of addition of sisal fibre. Both these laminates are made by hand layup technique and then compressed. The GFSRL and the SGFRL specimens are subjected to Axial, Flexure and Impact tests according to ASTM standards. The mechanical performances on the effect of alignments of fibre combinations are experimentally investigated.

**KEYWORDS:**E-glass fibre, Sisal, Tensile, Flexural, Impact.

## I.INTRODUCTION

Natural fibres are economically less weight and environmentally superior alternatives to Synthetic fibres. The specific properties of the natural fibre composites in some cases better than synthetic fibres. This suggests that natural fibre composites have a potential to replace in many applications like automobile and aircraft industry. The artificial fibres possess twice the weight of natural fibres and more cost, cause damage to human beings and energy for extraction is more compared to natural fibres. Researches made it possible to develop first hybrid laminate incorporating metal alloy called fibre metal laminate. A reinforcement of aramid fibre with Aluminium named as ARALL (Aramid reinforced Aluminium Laminate) emerged during the year 1978 and its commercial product came out in 1982. Later as an improvement of ARALL, GLARE (GLASS Reinforced Aluminium Epoxy laminate) was developed for aeronautical use with advanced glass fibre, in the year 1990 and its commercial product came out in 1999.

Aramid fibre has good specific strength and high impact resistance; however its poor compressive strength is a major limitation for these hybrid laminates. In this point of view, connection of the sisal and e-glass fibre that used to prepare the reinforced composite with suitable matrix of Epoxy. The composites are prepared by various stacking orders and volume fraction. To find the mechanical properties of GFSRL and SGFRL laminates.

## II.METHODOLOGY

Fabrication of sisal and glass fibre reinforced polymer based Composites. Evaluation of mechanical properties such as tensile strength and flexural strength and modulus, compressive strength, machining parameters for different fibre volume length and fibre volume fraction. Besides the above aims is to develop new class of composite by incorporating fibre reinforcing phases into a polymeric resin.

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## III. MOULD PREPARATION



Fig. 3.1 Moulds for Making Composite Plates.

For the sample preparation the first and foremost step is the preparation of the mould which ensures the dimension of 300×300mm the composite to be prepared. We have to prepare moulds for the preparation of the composite having 6mm and 5mm thickness. A clean smooth surfaced wooden board is taken and washed thoroughly. The Steel plate (as shown in Fig. 3.1) was covered with a mould release sheet.

### A. E-GLASS AND SISAL FIBRE REINFORCED COMPOSITES



Fig. 3.2(a)

The laminates to be tested for different behaviors such as tensile, flexure and impact are prepared with varying stacking orders of fibres. The GFSRL Specimens considered for tensile, flexure and impact loading is oriented with stacking sequences of (Gf/ Si /Gf/ Si /Gf / Si/ Gf / Si). Here the glass fibre is placed in the top and bottom layers of the laminate, as it has low bending resistance, when compared to other materials in the laminate.



Fig. 3.2(b)

Further, SGFRL specimens considered for tensile, flexure and impact loading are oriented with different stacking sequence of (Si/ Si /Si /Gf / Gf ).The laminates are arranged with epoxy resin through hand lay-up technique. The epoxy is mixed with the hardener in 10:1 ratio. Then they are cured at room temperature and compressed for ten

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minutes in the compression molding machine at a pressure of 70 kg cm<sup>2</sup> and at temperature of 800C and thus the final FML is obtained.(as shown fig 3.2a&3.2b)

## IV.MECHANICAL TESTING

S.No.	Test	ASTM Standard	Specimen Size (mm)
1.	Tensile Test	D3039	250X 25
2.	Flexural Test	D 790	154X 13
3.	Impact Test	D 7136	64X12.7

Table 4.1 ASTM Standard for Specimen Preparation

After fabrication the test specimens were subjected to various mechanical tests as per ASTM standards. The mechanical tests that we carried out are tensile test, impact test and flexural test. The specimen size and shape for corresponding tests are as shown in table 4.1.

### A.TENSILE TEST



Fig. 4.1 Specimen for Tensile Test

The GFSRL and SGFRL hybrid laminates fabricated as above for the tensile loading are cut and tested according to ASTM D 3039 standard in the INSTRON 3369 Universal Testing Machine. The test specimen is positioned vertically in the grips of the testing machine. The grips are tightened evenly and firmly to prevent any slippage. The test specimen is shown (Fig. 4.1)

### B.FLEXURAL TEST



Fig. 4.2 Specimen for Flexural Test

The GFSRL and SGFRL specimens fabricated as above for the Flexural test are cut according to ASTM D790. Flexural test was conducted to study the behaviour and ability of material under bending load. The load was applied to the

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specimen until it is totally break. The flexural test was conducted for different types of fibres length and volume fractions of composite (as shown in Fig. 4.2).

### C.IMPACT TEST



Fig. 4.3 Specimen for Impact Test

The GFSRL and SGFRL specimens fabricated as above for the impact loading are cut and tested according to ASTM D 7136 standard in the Izod impact test set-up and the test specimen are (as shown in figure 4.3)

## V.RESULTS AND DISCUSSION

### A.TENSILE TEST RESULTS

MATERIAL	MAXIMUM LOAD (N)	MAXIMUM DISPLACEMENT (mm)
Specimen 1 (6mm)	3800	4400
Specimen 2 (5mm)	4200	4000

Table 5.1 Load vs Displacement

Tensile test was carried out with the hybrid fibre epoxy composites by applying tensile load on the specimen which was mounted in an universal testing machine. The test was conducted for both the laminates GFSRL and SGFRL.

- i. Maximum load (N)
- ii. Maximum Displacement (mm)

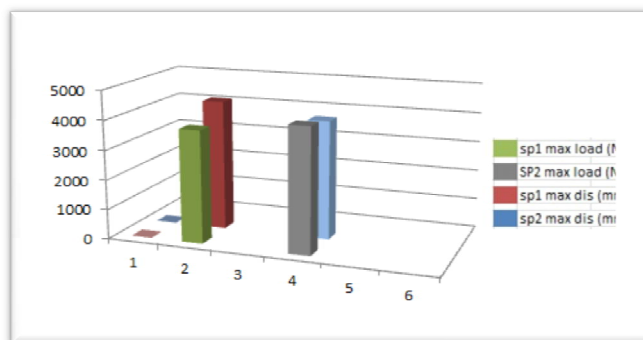


Fig.5.1 GraphShowingLoad vs. Displacement

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The experimental results of tensile load GFSRL and SGFRL Hybrid laminates are demonstrated Fig 5.2. The tensile stress for 8 layered GFSRL are found to be 47.33 N/mm<sup>2</sup> respectively and that tensile stress for 5 layered SGFRL are found to be 65 .61 N/mm<sup>2</sup> respectively.

## A.FLEXURAL TEST RESULTS

Flexural properties such as flexural strength and modulus are determined by ASTM Test method D790. In this test composite beam specimen of rectangular cross section is loaded in three-point bending mode. Tests were carried out at room temperature and as per the Indian standards. The test was conducted for both the laminates GFSRL and SGFRL.

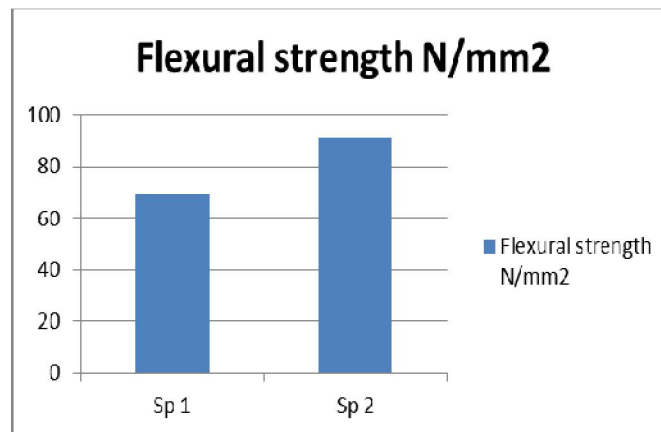


Fig.5.2 Flexural test

The flexure behavior of the GFSRL and SGFRL hybrid laminates are demonstrated Fig.5.2. The flexure strength of the 8 layered GFSRL are found to be 69.23 N/mm<sup>2</sup> respectively and that flexure strength of the 5 layered SGFRL are found to be 91.28 N/mm<sup>2</sup> respectively.

## B.IMPACT TEST RESULTS

Izod impact test are performed on commercially available machines in which a pendulum hammer is released from a suitable height to contact beam specimen with a kinetic energy. Whereas vertical cantilever beam specimen is used in the Izod test The energy absorbed in the breaking specimen. Usually indicated by the position of a pointer on a calibrated dial attached to the testing machine equal to the difference between the energy of the pendulum hammer at the instant of impacting that two specimen of various stacking order of GFSRL and SGFRL as shown figure 5.3

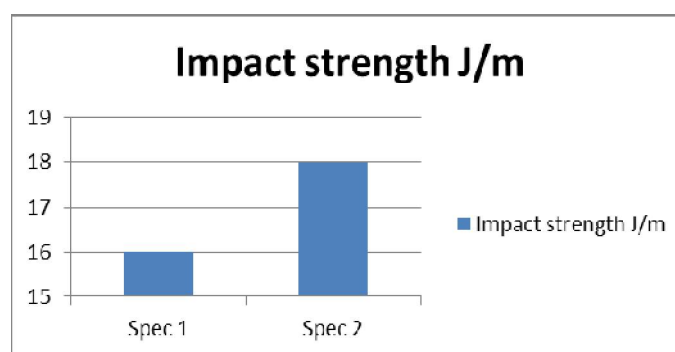


Fig. 5.3 Impact test

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The experimental results of GFSRL and SGFRL hybrid laminates when subjected to sudden impact loads are shown in (Fig. 5.3.) The resulting impact test of GFSRL and SGFRL laminates are 16 J/m and 18 J/m respectively.

## VI.CONCLUSION

The mechanical properties of e-glass and sisal natural fibre composites were prepared by epoxy resin matrix. The composite were prepared with different volume fractions. The following conclusions are made from the results and discussion. The tensile strength, flexural strength & impact strength of the hybrid composite is higher at 5 layer laminate than 8 layer laminate composite. It has been found that at the 5 layer composite produce optimum tensile strength, flexural strength and also impact strength. Mechanical properties of the composite depend upon the fibre volume fraction of the composite. The results obtained from this study conclude that 5 layer composite is suitable for light weight and low load applications. Composite properties further improved by fibre surface treatment, which enhances adhesion between fibre and matrix..

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