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A Comparative Study on Mechanical Properties of Natural and Synthetic Fibre Reinforced Polymer Composites

Dr. V. Naga Prasad Naidu, Dr. G. Naga Malleshwara Rao, Dr. S.L.V. Prasad
Professor of Mechanical Engineering, GATES Institute of Technology, Gooty, Ananthapuramu(Dist.)A.P, India.
Principal & Professor of Mechanical Engineering, GATES Institute of Technology, Gooty, Ananthapuramu(Dist.)A.P, India.
Professor & Head of Mechanical Engineering, GATES Institute of Technology, Gooty, Ananthapuramu(Dist.)A.P, India.

Abstract: *The world has witnessed a continuous demand for different materials due to rapid growth in industrial activities and advancement of civilization. A major solution for this problem is to search for alternative materials that are produced from renewable sources. In the present work the unsaturated polyester based Composites are fabricated separately with natural fibre like Sisal fibre and synthetic fibre as Glass fibre. These Composites are tested to Investigate Mechanical properties like tensile strength, flexural strength, compressive strength and Impact strength. The tensile, flexural and compressive strength of fabricated composites were tested by using universal testing machine where as Impact strength of the composite is analyzed by using Izod impact tester. From this experimental investigation it is observed that both natural fibre reinforced composites and synthetic fibre reinforced composites are showing better mechanical properties. Finally it was concluded that the mechanical properties of glass fibre reinforced composites are better than the natural fibre reinforced composites.*

Key words: *Polymer composites, Natural and synthetic fibre.*

I. Introduction

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

Polymers and their composites are finding ever increasing usage for numerous industrial applications. This[1] is becauseof their corrosion resistance, light weight, good mouldability, transparent, economical and excellent surface finish which make them suitable for the manufacture of tanks, pipe lines, bottles, bags etc.. Fibre reinforced polymer composites [2] are used for wide variety of structural applications as in many aerospace, automotive and chemical industries because of their high strength to weight and stiffness to weight ratio. Fibre reinforced composite [3] materials consists of fibres of high strength and modulus embedded in or bounded to a matrix with distinct interfaces between them. Fibres[4] are principal load carrying members and surrounding matrix keep them in desired location and orientation, act as load transfer medium between them and protects them from environmental damage due to elevated temperature and humidity. The natural or synthetic fibres used in fibre reinforced polymer composites. Cotton, jute and sisal are few examples for natural fibres[5], glass, nylon and carbon fibres are few examples for synthetic fibres[6]. As compared with synthetic fibres Natural fibres have received much attention from researchers all over the world due to its advantages like low cost, renewable, low density, good strength etc..John[7] et al has studied mechanical properties of glass fibre rein forced polymer composites. They observed that these composites have shown better mechanical properties. Khanam et al has studied sisal/silk fibre reinforced polymer composites by varying the length of fibre. They found that 2cm long fibre reinforced polymer composites are having higher tensile, flexural, and compressive strength than one and three centimeter long fibres. Khan et al has studied mechanical properties of jute fibre reinforced polymer composites[8,9].

Present Work

In the present work the mechanical properties of sisal and glass fiber reinforced composite materials is studied. The composite materials are manufactured by hand lay-up process. The mechanical properties such as tensile, compression, flexural and impact strength of these composites are studied and presented in detail.

II. Materials Used For Making Composites

Sisal (Agaves Veracruz) short fibre (2 cm long), obtained from local sources and chopped strand mat of short glass fibre (2 cm long) were used for the present work. The unsaturated polyester resign obtained from Allied marketing co, Secunderabad, T.S, India, methyl ethyl ketene peroxideas accelerator and cobalt naphthenate as a catalyst which are obtained from M/S Bakelite Hylam, Hyderabad, T.S, India ere used.

Fibre Treatment

Sisal fibre(natural fibre) was taken in a glass tray, to which 5% NaOH solution was added and the l fibres were soaked in the solution for 1hr. The fibres were then washed thoroughly with water to remove the excess of NaOH sticking to the fibre. Final washing was carried out with distilled water and the fibres were dried in hot air. The fibres were chopped into short length of 2 cm for preparing composites.

Preparation Of Composite

In the present work the composites were prepared by hand lay-up technique. The matrix of unsaturated polyester and monoester of styrene are mixed in the ratio of 100:25 by weight respectively. Later accelerator of methyl ethyl ketene peroxide 1% by weight and catalyst of cobalt naphthenate of 1% by weight added to the mixture and mixed thoroughly. The releasing agent of silicon is sprayed to the glass mould and the matrix mixture is poured in to the mould. The fibre is added to the matrix mixture which was poured in the glass mould. The excess resign was removed from the mould and the glass plate was placed on the top of the casting were allowed to cure for 24 hrs at room temperature. Then the casting is placed at a temperature of 80$^{\circ}C$ for 4 hrs in an oven. The composite were released from mould and are cut to prepare test specimens as per ASTM standards.

Mechanical Properties

In the present work the Composites are tested to Investigate Mechanical properties like tensile strength, flexural strength, compressive strength and impact strength. Tensile test is widely used to determine strength, ductility and toughness of the materials. 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 compressive test specimen is prepared as per the ASTM D695 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 compressive load 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. The flexural specimens are prepared as per the ASTM D618 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 impact test specimens are prepared according to the required dimension following the ASTM-D256 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 the yield strength.

The tensile, flexural and compressive strength of fabricated composites were tested by using universal testing machine where as Impact strength of the composite is analyzed by using Izod impact tester.

Fig 1. Universal testing machine

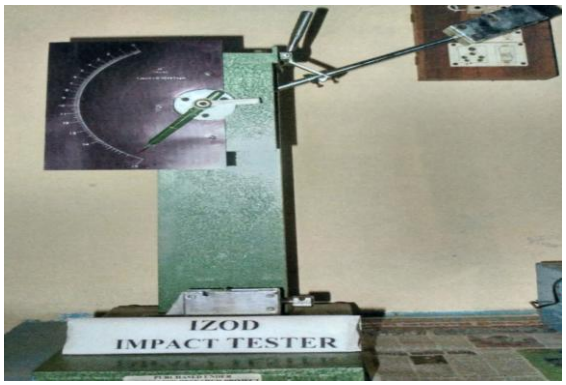

Fig 2. Izod Impact testing machine.

III. Results Nd Discussion

The tensile, compressive, flexural and impact test results of both natural and synthetic fibre reinforced fibre composites are measured and compared

Tensile Strength

The fig. 3 shows the tensile strength of sisal and glass fibre reinforced composites. It is observed that the tensile strength of glass fibre reinforced composites are higher than the sisal fibre reinforced composites. This may be due to high tesile strength of glass fibre as compared with sisal fibre. The tensile strength of sisal fibre reinforced composites is 22.8Mpa and glass fibre reinforced composites are 29.4Mpa.

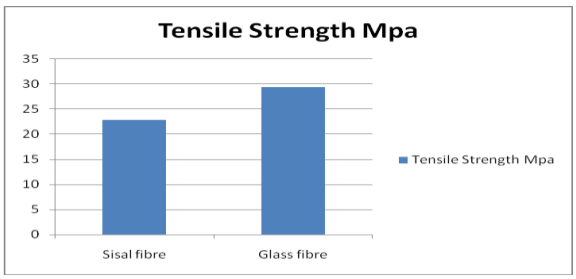

Fig 3. Tensile strength of Sisal/Glass fibre composites

Compressive Strength

The fig. 4 shows the compressive strength of sisal and glass fibre reinforced composites. It is observed that the compressive strength of glass fibre reinforced composites are higher than the sisal fibre reinforced composites. This may due to smaller diameter of the glass fibre as compared with sisal fibre diameter. The tensile strength of sisal fibre reinforced composites is 113.7 Mpa and glass fibre reinforced composites are 151.5Mpa.

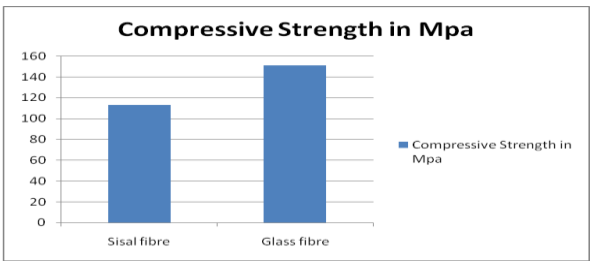

Fig 4. Compressive strength of Sisal/Glass fibre composites

Flexural Strength

The fig. 5 shows the flexural strength of sisal and glass fibre reinforced composites. It is observed that the flexural strength of glass fibre reinforced composites are higher than the sisal fibre reinforced composites. The flexural strength of sisal fibre reinforced composites is 87.3Mpa and glass fibre reinforced composites are 101.9Mpa.

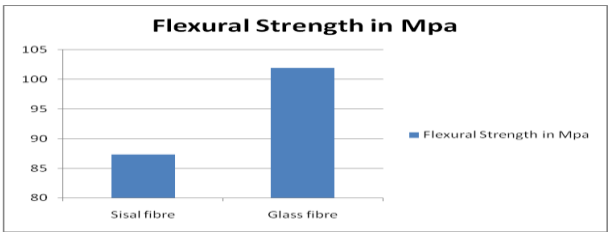

Fig 5. Flexural strength of Sisal/Glass fibre composites

Impact Strength

The fig. 6 shows the impact strength of sisal and glass fibre reinforced composites. It is observed that the impact strength of glass fibre reinforced composites re higher than the sisal fibre reinforced composites. The impact strength of sisal fibre reinforced composites is 6.9KJ/M^2 and glass fibre reinforced composites are 13.64KJ/M^2.

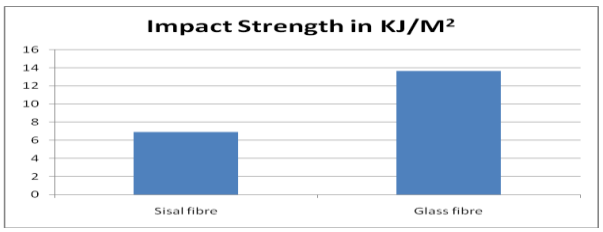

Fig 6. Tensile strength of Sisal/Glass fibre composites

IV. Conclusions

The mechanical properties of sisal fibre and glass fibre reinforced composites made with unsaturated polyester resin have been studied and following conclusions are drawn.

1. It is observed that the tensile strength of glass fibre reinforced polymer composites is higher than the sisal fibre reinforced polymer composites.
2. The compressive strength of glass fibre reinforced polymer composites is better than the sisal fibre reinforced polymer composites.
3. The flexural strength of glass fibre reinforced polymer composites is better than the sisal fibre reinforced polymer composites.
4. The impact strength of glass fibre reinforced polymer composites is better than the sisal fibre reinforced polymer composites.

Finally it is concluded that the mechanical properties of glass fibre reinforced polymer composites are better than the sisal fibre reinforced polymer composites.

Nomenclature

ASTM	: American society for testing and materials.
Cm	: Centimeter.
KJ	: kilo Joule.
M	: Meter.
Mpa	: Mega Pascal.
NAOH	: sodium hydroxide.
UTM	: Universal testing machine.

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