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# IMPACT TOUGHNESS OF SHORT FIBRED SISAL REINFORCED COMPOSITE

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***Abstract:*** ***Natural fibres are widely used as plastic composite material reinforcement. Sisal fibre is a promising reinforcement for use in composites on account of its low cost, low density, high specific strength and modulus, no health risk, easy availability in some countries and renewability. In the present work short sisal fiber used as reinforcement and epoxy resin as matrix. The composite was prepared with randomly oriented fiber with different proportions of fiber and matrix ratio by means of open molding process. The effect of fiber loading on mechanical properties such as impact strength, tensile strength and hardness properties are investigated. The composite with a 30% wt. sisal fibre for 5mmm specimen thickness gives high impact toughness at a notch depth of 6mm and is desired to prevent the failure of sisal-epoxy composite during an impact loading. The impact toughness increases with increasing the fibre volume fraction and also increases with decreasing the specimen thickness. The material has high impact toughness that improves the ductility and impact energy.***

***Key words:*** ***Sisal, Epoxy, Composite material, Impact toughness***

## 1. INTRODUCTION

For the past several years, public attention has gone on natural fibers as a resource due to the fast growth. Now a day, natural fibres are widely used as reinforcements both in partially and totally biodegradable Natural fiber Composites. Natural fibers are an alternative resource to synthetic fibres as reinforcement for polymeric materials for the manufacture of cheap, renewable, and environmentally friendly composites. Waste plastic has caused unbearable stress to environment in recent years [9]. Natural fibers obtained from cellulose-based plants are being used as reinforcement of polymer composite owing to both environmental and technical advantages. One important technical characteristic of most lignocellulosic fibers is the bend flexibility, which allows them to resist impact forces. As a consequence, there is an increasing application of these lignocellulosic fibers in automobile parts that, during a crash event, should absorb the impact energy without splitting into sharp pieces. The use of polymer composites reinforced with natural fiber obtained from cellulose-based plants such as flax, coir, sisal and curaua is increasing in the automobile industry with annual growth rates above 20% [10]. Sisal fiber is a promising reinforcement for use in composites on account of its low cost, low density, high specific strength and modulus, no health risk, easy availability in some countries and renewability. In recent years, there has been an increasing interest in finding new applications for sisal-fibre-reinforced composites that are traditionally used for making ropes, mats, carpets, fancy articles and others. The sisal fibre as shown in fig 1.1. The majority of engineering composite materials consist of a thermosetting epoxy matrix reinforced by continuous glass or carbon fibres. The epoxy, when polymerized, is an amorphous and highly cross-linked material. This cross-linked microstructure results in many useful properties such as a high modulus and failure strength, low creep, etc. The mechanical properties of short-fiber-reinforced polymer composites depend on many factors, such as fiber–matrix interaction, fiber volume fraction, fiber aspect ratio (length to diameter ratio), and fiber orientation. Fiber aspect ratio should be above a critical value for maximum stress in the fiber before composite failure [8].

Impact is defined as the resistance of a material to rapidly applied loads. An impact test is a dynamic test in which a selected specimen which is usually notched is struck and broken by a single blow in a specially designed machine. The purpose of impact testing is to measure an object's ability to resist high-rate loading. The presence of a notch simulates the pre-existing cracks found in large structures. The main objective of the impact test is to predict the likelihood of brittle fracture of a given material under impact loading. The test involves measuring the energy consumed in breaking a notched specimen when hammered by a swinging pendulum.

Fig 1.1 Sisal fibre

Epoxy resins are polyether resins containing more than one epoxy group capable of being converted into the thermoset form. These resins, on curing, do not create volatile products in spite of the presence of a volatile solvent. The epoxies may be named as oxides, such as ethylene oxides (epoxy ethane), or epoxide. The epoxy group also known as oxirane contains an oxygen atom bonded with two carbon atoms, in which their turns are bound by separate bonds as shown in fig.1.2

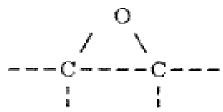


Fig 1.2 epoxy resin bond

## 2. Materials

Following materials have been used in the proposed work. Composites were prepared for three material combinations. In the present work fiber-reinforcement is discontinuous random oriented. The chosen composite includes the following materials.

- Matrix Material
- Reinforcement (short sisal fiber)

**2.1 Matrix material:** Lapox-12 (L-12) Epoxy Resin is used as Matrix material, with K-6 Hardener. The purpose of using this as Epoxy is that, it is a medium viscosity, non-crystallizing epoxy material, with room temperature curing properties and it provides good resistance to alkalis and possesses good adhesive properties. The purpose of using hardener is, it acts as curing agent. Some of the important properties of Epoxy are listed in the Table 2.

**Table 2.1: Some important properties of Epoxy Resin (L-12)**

| Properties | Values |
|---|---|
| Density, $\rho_{epoxy}$ | 1.30 g/cm$^3$ |
| Tensile strength | 50 - 60 MPa |
| Compressive strength | 110 - 120 MPa |
| Modulus of elasticity, $E_{epoxy}$ | 4.4 - 4.6 GPa |

### 2.2 Reinforcement

Sisal fibre is a promising reinforcement for use in composites on account of its low cost, low density, high specific strength and modulus, no health risk, easy availability in some countries and renewability. The short sisal fiber is used as the reinforcement material. Some of the important mechanical properties of sisal fiber are listed in the Table 2.2.

**Table 2.2 : Some important properties of sisal fiber**

| Properties | Values |
|---|---|
| Density, $\rho_{sisal}$ | 1.45 g/cm$^3$ |
| Tensile strength | 604Mpa |
| Compressive strength | 148MPa |
| Modulus of elasticity, $E_{epoxy}$ | 9.4Gpa |

## 3. Preparation of composite

The sisal fibre chopped to 2-4mm length. In the present work Composite was prepared by compression molding technique. The composite contains 20, 25, and 30% wt 0f sisal, contained epoxy resin 80, 75, and 70%wt, respectively. Take calculated amount of sisal fibre and epoxy resin mix thoroughly until the epoxy resin distribution evenly and add hardener and mix it thoroughly before pouring it into mould box. The mixture is poured in to mold box. Close the upper surface of mould box with aluminum foil to prevent the sticking of composite to load applied on it. Put a weight on the mould to make composite compress and adhere to each other and allow it for 2 to 3 days for curing. Cured composite is shown in fig.3.1

Fig.3.1 Cured composite

**4. Specimen preparation and test machine**

The Izod impact test specimens were prepared according to ASTM D256. The dimensional view of specimen is shown in figure below. The specimen used is a rectangular bar of 63.5mmX12.7mmX12.7 mm cross-section with a U-notch. In the present work the depth of notch and specimen thickness can be varied. The digital Izod impact testing machine is used for impact test. The machine shows the impact energy absorbed by the material.

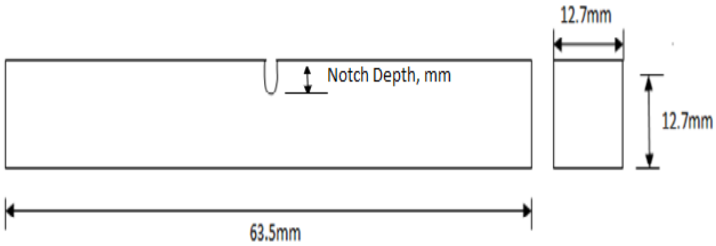


Fig 4.1 The dimensional view of specimen

**5. Results and discussions**

From fig 5.1. shows the variation of impact toughness with notch depth for 5mm specimen thickness with different fiber volume fraction. From graph observed that the impact toughness of the composite material is high at 6mm notch depth when compared to 0, 1, 2, 3, 4, 5, and 7mm for all fiber volume fractions because good fiber matrix interface adhesion and the impact toughness material is low at 3mm notch depth when compared to 0, 1, 2, 3, 5 and 7mm for all fiber volume fractions because low fiber matrix interface adhesion. From graph also observed that the impact toughness is high at 30% fiber volume fraction when compared to 20% and 25% and the maximum value of impact toughness with 30% fiber volume fraction at 6mm notch depth is 9.522KJ/m$^2$.

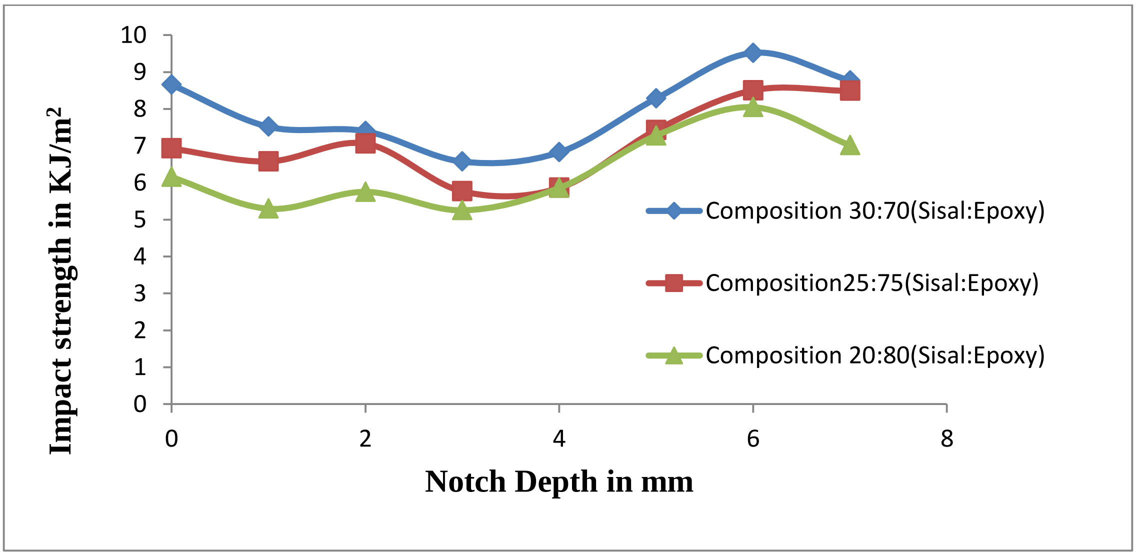


Fig 5.1

From fig.5.2 shows the variation of impact toughness with notch depth for 9mm specimen thickness with different fiber volume fraction. From graph observed that the impact toughness of the composite material is high at 6mm notch depth when compared to 1, 2, 3, 4, 5, and 7mm for all fiber volume fractions because good fiber matrix interface adhesion and the impact toughness of the composite material is low at 1mm notch depth when compared to 0, 2, 3, 4, 5 and 7mm for all fiber volume fractions because low fiber matrix interface adhesion. From graph also observed that the impact toughness is high for 30% fiber volume fraction when compared to 20% and 25% and the maximum value of impact toughness with 30% fiber volume fraction at 6mm notch depth is 9.121KJ/$m^2$.

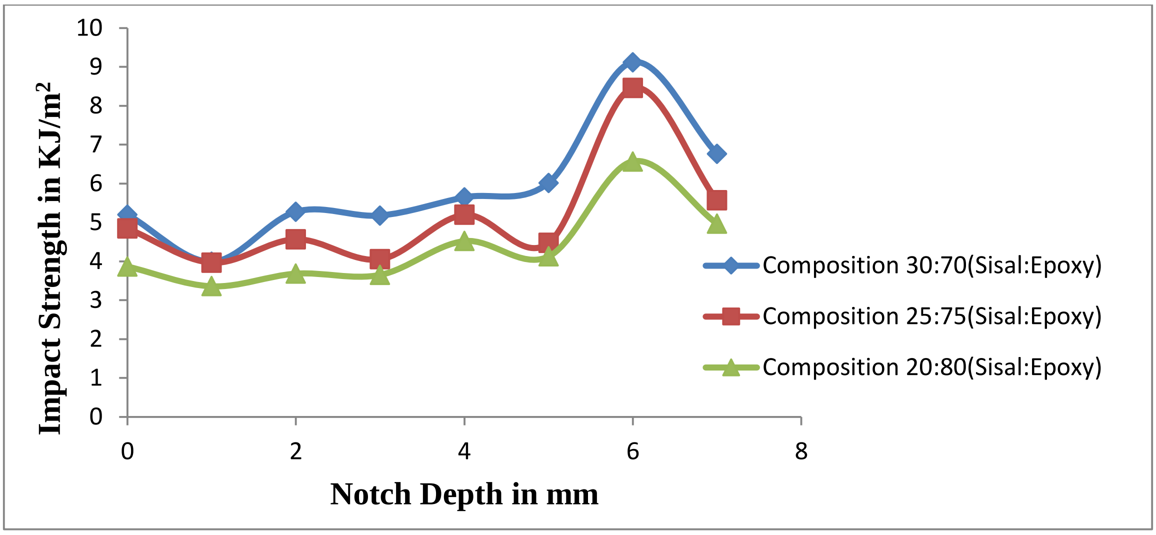


Fig 5.2

From fig.5.3 shows the variation of impact toughness with notch depth for 12.7mm specimen thickness with different fiber volume fraction. From graph observed that the impact toughness of the composite material is high at 6mm notch depth when compared to 0, 1, 2, 3, 4, 5, and 7mm for all fiber volume fractions because low fiber matrix interface adhesion and the impact toughness of the material is low at 0mm and 2mm notch depth when compared to 1, 3, 4, 5 and 7mm for all fiber volume fraction because poor fiber matrix interface adhesion. From graph also observed that the impact toughness is high at 30% fiber volume fractions when compared to 20% and 25% and the maximum value of impact toughness with 30% fiber volume fraction at 6mm notch depth is 6.463KJ/$m^2$.

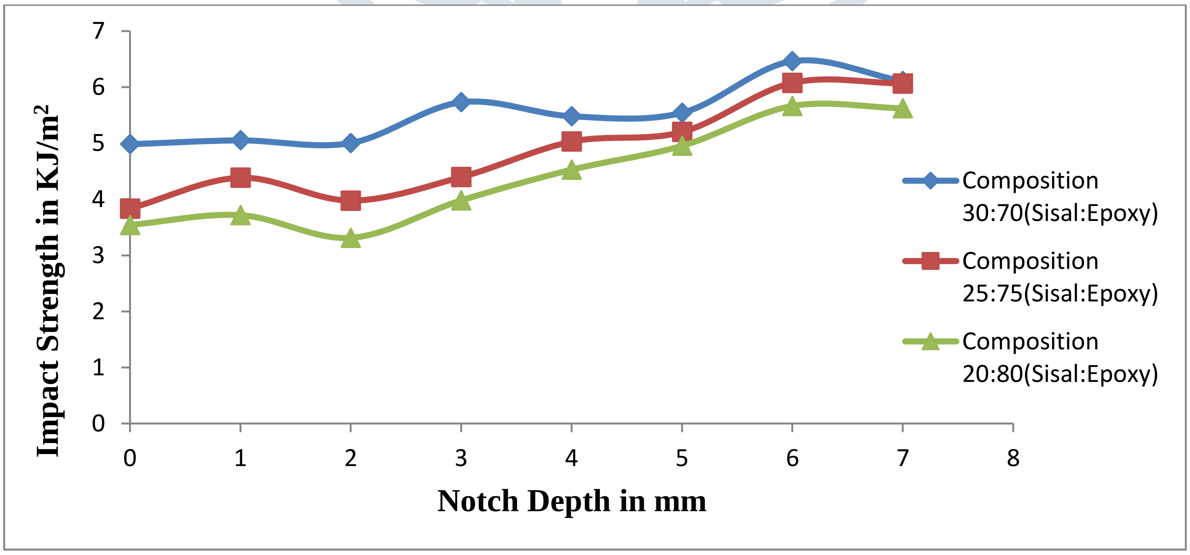


Fig 5.3

**6. Conclusion**

In the present research short sisal fibre-epoxy composite was prepared with varying fiber volume fraction. The variations of impact toughness of sisal-epoxy composite are investigated. It is observed that, Composite with 30% wt short sisal fibre for 5mm thickness specimen with a notch depth of 6mm has high impact toughness and it reaches to 9.522KJ/$m^2$. This is desired to prevent the failure of sisal-epoxy composite during an impact loading and also improves the ductility of the composite materials. Therefore, impact toughness increases with increase in fiber volume fraction and also increases with decreasing the specimen thickness.

**7. References**

1. Yan Li, Yiu-Wing Mai, Lin Ye “Sisal fibre and its composites: a review of recent developments” Composites Science and Technology 60 (2000) 2037±2055.
2. J. B. Zhong, J. Lv, C. Wei Key ”Mechanical properties of sisal fibre reinforced ureaformaldehyde resin composites” EXPRESS Polymer Letters Vol.1, No.10 (2007) 681–687.
3. Fernando de Oliveira, Elaine C. Ramires and Elisabete Frollini”Impact properties of sisal fiber reinforced composites: polyurethane and phenolic matrices based on sodium lignosulfonate”, 16th International Conference on Composite Structures ICCS 16.
4. V. Naga prasad Naidu, G.Ramachandra Reddy, M.Ashok Kumar, M.Mohan Reddy, P. Noorunnisha Khanam, S.venkata Naidu, “Compressive & impact properties of sisal/glass fiber reinforced hybrid composites” , International Journal of Fiber and Textile Research 2011; 1(1): 11-14.
5. S. L. Favaro1, T. A. Ganzerli1, A. G. V. de Carvalho Neto1, O. R. R. F. da Silva2, E. Radovanovic “Chemical, morphological and mechanical analysis of sisal fiber-reinforced recycled high-density polyethylene composites” EXPRESS Polymer Letters Vol.4, No.8 (2010) 465–473.
6. M. Ashok Kumar, G. Ramachandra Reddy, Y. Siva Bharathi, S. Venkata Naidu and V. Naga Prasad Naidu “Frictional Coefficient, Hardness, Impact Strength, and Chemical Resistance of Reinforced Sisal-Glass Fiber Epoxy Hybrid Composites “, Journal of COMPOSITE MATERIALS, Vol. 44, No. 26/2010.
7. P. Anticha, A. Vazqueza, I. Mondragonb, C. Bernala, Polymer Division, Engineering Faculty, “Mechanical behavior of high impact polystyrene reinforced with short sisal fibers”, Composites: Part A 37 (2006) 139–150.
8. V. Alvarez, A. Vazquez and C. Bernal “Effect of Microstructure on the Tensile and Fracture Properties Of Sisal Fiber/Starch-based Composites”, Journal of COMPOSITE MATERIALS, Vol. 40, No. 1/2006.
9. C.V. Srinivasa, K.N. Bharath “Impact and Hardness Properties of Areca Fiber-Epoxy Reinforced Composites”, J. Mater. Environ. Sci. 2 (4) (2011) 351-356.
10. Ailton da Silva FerreiraI, Felipe Perissé Duarte LopesI, Sergio Neves Monteiro, Kestur Gundappa Satyanarayana “Charpy impact resistance of alkali treated curaua reinforced polyester composites”, Revista Matéria, v. 15, n. 2, pp. 132 – 139, 2010.