

# Comparative Study on Properties of Coir and Sisal Fibre Reinforced Composites

Yashwanth M K<sup>1</sup>, G. L. Easwara Prasad<sup>2</sup>, Akshay N K<sup>3</sup>

Assistant Professor, Department of Civil Engineering, MITE, Moodbidri, Karnataka, India<sup>1</sup>

Principal, Mangalore Institute of Technology and Engineering, Moodbidri, Karnataka, India<sup>2</sup>

Assistant Professor, Department of Civil Engineering, NMAMIT, Nitte, Karnataka, India<sup>3</sup>

**ABSTARCT:** In the present study the mechanical properties of coir reinforced epoxy resin composite and sisal reinforced epoxy resin composite is studied .The experimental study by using short coconut coir fibres and sisal fibres reinforced with Epoxy LY556 resin composite is reported in earlier studies. The coir fibres and sisal fibres are collected from Orissa, India having a length of 30mm. Experiments conducted as per ASTM standards, and results of tensile, flexural strengths are reported. It is also reported that the fibre length is having significant effect on the properties of composites. The tests conducted on 2mm, 4mm and 6mm thick specimens varying the percentage of coir fibre and sisal fibre from 7.5%, 10%, 15%, 20% and 30% of volume fractions. In case of coir fibre reinforced composite as the change in fibre volume fraction from 7.5% to 30%, tensile strength increases gradually up to 20% fibre volume fraction and decreases thereafter but flexural strength increases gradually up to 15% fibre volume fraction. From our study usage of coir composite panels at 20% fibre volume fraction depicts the maximum tensile strength and fibre volume fraction at 15% depicts the maximum flexural strength. But in case of Sisal reinforced composite tensile strength increases gradually up to 15% fibre volume fraction and decreases thereafter but flexural strength increases gradually as fibre volume fraction increases.

**KEYWORD:** Epoxy Resin, Coir Fibre Composite, Sisal Fibre Composite, Tensile strength and flexural strength

## I. INTRODUCTION

The advantages of composite materials over conventional materials stem largely from their higher specific strength, stiffness and fatigue characteristics, which enable structural design to be more versatile. By definition, composite materials consist of two or more constituents with physically separable phases [2, 3]. Composites are materials that comprise strong load carrying material i.e., fibres (known as reinforcement) embedded in weaker material (known as matrix). Reinforcement provides strength and rigidity, and supporting structural loads. The matrix or binder (organic or inorganic) maintains the position and orientation of the reinforcement. Significantly, constituents of the composites retain their individual, physical and chemical properties; yet together they produce a combination of qualities which individual constituents would be incapable of producing alone. The reinforcement may be platelets, particles or fibres and are usually added to improve mechanical properties such as stiffness, strength and toughness of the matrix material.

Natural fibres such as jute, sisal, pineapple, abaca and coir [4–13] have been studied as a reinforcement and filler in composites. Growing attention is nowadays being paid to coconut fibre due to its availability. The coconut husk is available in large quantities as residue from coconut production in many areas, which is yielding the coarse coir fibre. Coir is a lingo-cellulosic natural fibre. It is a seed-hair fibre obtained from the outer shell, or husk, of the coconut. Because of its hard-wearing quality, durability and other advantages, it is used for making a wide variety of floor furnishing materials, yarn, rope etc [14]. Hence, research and development efforts have been underway to find new use areas for coir, including utilization of coir as reinforcement in polymer composites [15-22].

It is found that for 5mm length, 20mm length and 30mm length of coir fibre embedded with the epoxy resin as matrix at the ratio of 30: 70, tensile strength increased from 3.208MPa to 13.05MPa, tensile modulus increased from 1.331 GPa to 2.064 GPa, flexural strength increased from 25.41 MPa to 35.42MPa.

# International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Special Issue 9, May 2016

## II. RELATED WORK

This chapter outlines some of the recent studies reported by the earlier researchers. As a result of the increasing demand for environmental friendly materials and the desire to reduce the cost of traditional fibre reinforced petroleum-based composites, new bio-based composites have been developed.

**Maries Idicula, N. R. Neelakantan et al.,(2004) [1]** The mechanical performance of short randomly oriented banana and sisal hybrid fibre reinforced polyester composites was investigated with reference to the relative volume fraction of the two fibres at a constant total fibre loading of 0.40 volume fraction ( $V_f$ ), keeping banana as the skin material and sisal as the core material. The impact strength of the composites was increased with fibre loading. Tensile and flexural properties were found to be better at 0.40  $V_f$ . The experimental tensile strength and tensile modulus of hybrid composites were compared with those of theoretical predictions.

**Girisha.C et al., (2012) [16]** Natural fibres (Sisal and Coconut coir) reinforced Epoxy composites were subjected to water immersion tests in order to study the effects of water absorption on the mechanical properties. Natural fibres like coconut coir (short fibres) and sisal fibres (long fibres) were used in hybrid combination and the fibre weight fraction of 20%, 30% and 40% were used for the fabrication of the composite. Water absorption tests were conducted by immersing specimens in a water bath at 250° C and 1000° C for different time durations. The tensile and flexural properties of water immersed specimens subjected to both aging conditions were evaluated and compared with dry composite specimens. The percentage of moisture uptake increased as the fibre volume fraction increased because of the high cellulose content of the fibre. The tensile and flexural properties of natural fibre reinforced Epoxy composite specimens were found to decrease with increase in percentage moisture uptake.

## III. MATERIALS AND METHODS

**Matrix:** Epoxy LY 556 resin with Methyl Ethyl Ketone Phosphate (MEKP) catalyst and cobalt naphthanate hardener. The catalyst, hardener and resins are mixed in the ratio of 1:1:50 (catalyst, hardener, resin) in ml

**Fibres:** The fibres used for the fabrication of the composites are Coconut coir and Sisal fibres

**Coconut Coir:** Coconut Coir is a lingo-cellulosic natural fibre. It is a seed-hair fibre obtained from the outer shell, or husk, of the coconut, the fruit of *Cocos-nucifera*. The coarse, stiff, reddish brown fibre is made up of smaller threads, each about 0.03 to 0.1 cm long and 12 to 24 micrometer in diameter; coir is composed of lignin, a woody plant substance, and cellulose. The individual fibre cells are narrow and hollow, with thick walls made of cellulose. Mature brown coir fibres contain more lignin and less cellulose than fibres such as flax and cotton and are thus stronger but less flexible. The coir fibre is relatively waterproof and is the only natural fibre resistant to damage by salt water.



Figure 1: Coir Fibre

**Sisal fibres:** Sisal is a natural fibre (Scientific name is *Agave sisalana*) of Agavaceae (Agave) family yields a stiff fibre traditionally used in making twine and rope. Sisal is fully biodegradable and highly renewable resource of energy. Sisal fibre is exceptionally durable and a low maintenance with minimal wear and tear. Sisal fibre is extracted by a process known as decortications, where leaves are crushed and beaten by a rotating wheel set with blunt knives, so that only fibres will remain.

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Figure 2: Sisal Fibre

**Fibre Surface Treatment:** Washed and dried sisal fibres and coir were taken in separate trays, to these trays 10% NaOH solution was added, and the fibres were soaked in the solution for 10 hours. The fibres were then washed thoroughly with water to remove the excess of NaOH sticking to the fibres. The coir fibres were chopped into short fibre length of 3 cm for moulding the composites. For Sisal fibres the length was maintained as long fibres

**Specimen Casting:** The sisal fibres and coir fibres of 30mm length (3cm) were taken and distributed with random orientation. The volume fraction 7.5%, 10%, 15%, 20% and 30% of fibres were spread on the mould. Then second layer of resin mix was applied. Required thickness of the specimen like 4mm, 6mm and 8mm were casted using this technique and kept for about 20 minutes to harden. Then specimens were removed from the mould and kept it for curing.

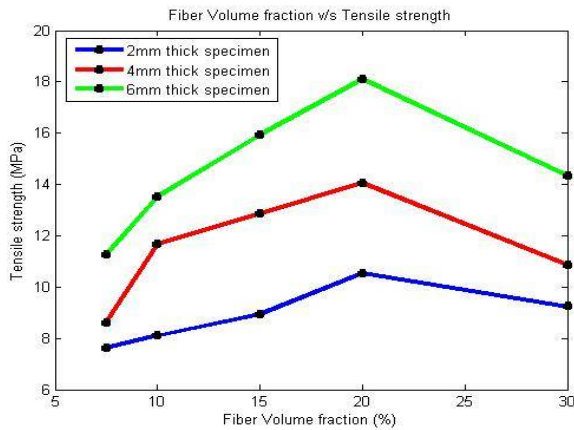


Figure 3: Coir and Sisal fibre composite panels of different thickness.

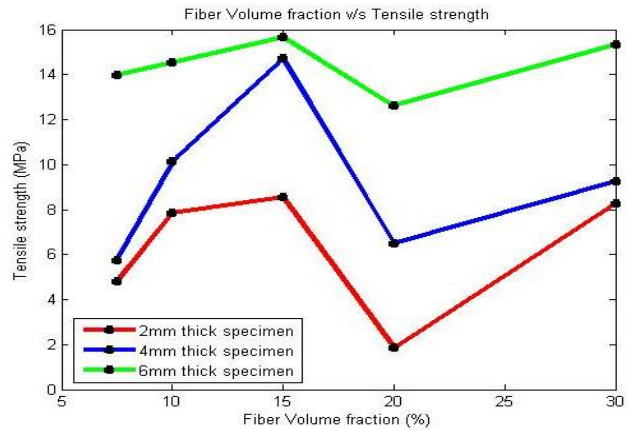
**Mechanical testing:** The tensile strength of the composites was measured with a universal testing machine in accordance with the ASTM D-638 procedure at a crosshead speed of 5 mm/min. The flexural tests were performed on the same machine, using the 3-point bending fixture according to ASTM D-790 with the cross-head speed of 5 mm/min.

#### IV. RESULTS AND DISCUSSION

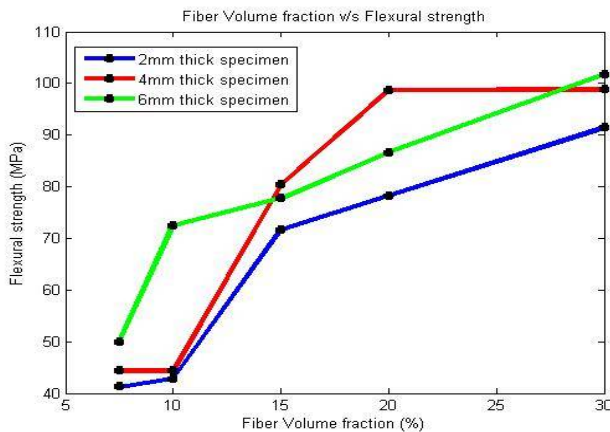
The variation of tensile strength verses fibre volume fraction of coir and sisal reinforced polyester composites panels is represented in Fig 4 and Fig 5 respectively. Fig 6 and Fig 7 depicts the flexural strength verses fibre volume fraction of coir and sisal reinforced polyester composites panels respectively.



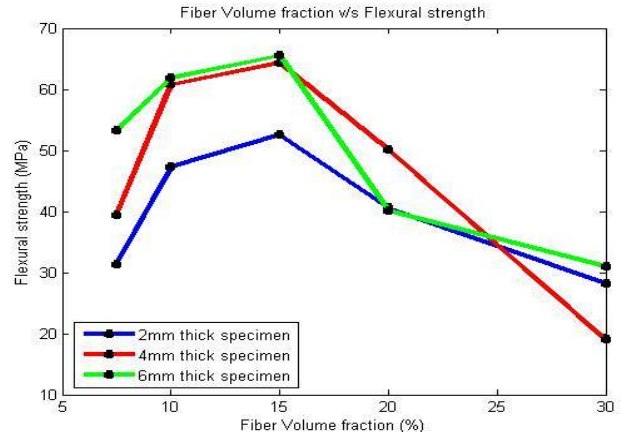
**Figure 4: Effect of percentage of fibre volume on Tensile Strength of coir fibre composites.**



**Figure 5: Effect of percentage of fibre volume on Tensile Strength of sisal fibre composites.**



**Figure 6: Effect of percentage of fibre volume on Flexural Strength of coir fibre composites.**



**Figure 7: Effect of percentage of fibre volume on Flexural Strength of sisal fibre composites.**

Figure 4 and Figure 5 depicts that there is a considerable increase of tensile strength as the percentage of fibre increases to a 10% to 15% in sisal fibre reinforced polyester composite and 15% to 20% in coir fibre reinforced polyester composite and then the strength decreases in both the composite respectively. The maximum tensile strength of 15.8MPa and 18.2MPa is obtained for 15% and 20% fibre volume fraction in 6mm thick sisal fibre reinforced and 6mm thick coir fibre reinforced polyester composites respectively. Figure 6 shows the variation of flexural strength of coir composite panels with different % of fibre volume fraction. By increasing the thickness of panels (2mm, 4mm and 6mm), the flexural strength increases up to 15% fibre volume fraction. This shows that optimum flexural strength is obtained at 15% fibre volume fraction. Figure 7 shows the variation of flexural strength of sisal composite panels with different % of fibre volume fraction. By increasing the fibre volume fraction and thickness of panels (2mm, 4mm and 6mm) flexural strength goes on increases. The maximum flexural strength recorded was 101.778MPa which is obtained for 6mm thick panel.

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(An ISO 3297: 2007 Certified Organization)

Vol. 5, Special Issue 9, May 2016

## V. CONCLUSION

Sisal fibres and coir fibres are effective reinforcement of polymers thus creating a range of technological applications beyond its traditional uses such as ropes carpets, mats etc. The incorporation of natural fibres such as sisal and coir in to polyester matrix shows the moderate improvement in the tensile properties of the composites. For all the composites tested the tensile strength of the composite increased for its optimum value from 10% to 20% of volume fraction of fibres. The value decreases further for the increase in the volume fraction. The tensile strength of Coir fibre reinforced polyester composite is comparatively high compared to tensile strength of sisal fibre reinforced composite. From our study usage of coir composite panels at 20% fibre volume fraction depicts the maximum tensile strength and fibre volume fraction at 15% depicts the maximum flexural strength and usage of sisal composite panels at 15% fibre volume fraction depicts the optimal tensile strength and fibre volume fraction at 30% depicts the maximum flexural strength. Due to low density of the natural fibres used in this present study compared to synthetic fibres (Glass fibres, carbon fibres, etc...), the composites can be regarded as a useful light weight Engineering materials.

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