INFLUENCE OF ORIENTATION ON TENSILE AND FLEXURAL PROPERTIES OF SISAL FIBER POLYESTER COMPOSITE

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ABSTRACT

In this paper, the influence of orientation on tensile and flexural properties of oriented sisal fiber polyester composite is studied and results were discussed. The composites are fabricated by following different types of fiber orientation in the compression moulding machine. The tensile and flexural properties of the composites with the orientation of 0˚/45˚/0˚ and 0˚/90˚/0˚ were studied and discussed in this paper. The fibers are arranged in particular degrees with the help of a special type of mould, manufactured solely for the fabrication of oriented composites. The results show that the oriented composite has superior tensile and flexural properties when compared with randomly oriented composite.

Keywords: Sisal fiber, Fiber orientation, Polyester composite, Tensile property, Flexural property.

INTRODUCTION:

Fibers that are obtained from natural sources are known as natural fibers. Natural fibers have become the recent trend in composite materials studies. It has many advantages than artificially manufactured synthetic fibers. Natural fibers are low in cost. These fibers have high specific properties and low density. Natural fibers are eco-friendly unlike synthetic fibers because they are bio degradable and non-abrasive. The scientific name of sisal plant is Agave sisalana. This plant is belongs to southern Mexico, but nowadays it is cultivated all over the world. The fiber is obtained from its rosette of sword shaped leaves. The fiber is extracted by a process known as decortication. The plant has a life span of 7-10 years. On an average per leaf of a sisal plant contain about 1000 fibers. Sisal fibers are also widely used around the globe for various other commercial purposes.

Lot of works carried out by using the natural fibers particularly with use of sisal fiers. The mechanical properties of sisal fiber polyester composites are studied by V.M. Fonesca et al., 2004. They observed an enhancement in the mechanical properties of sisal fiber polyester composite as a function of polyester matrix formation. Velmurugan et al., 2004 studied the tensile, flexural and impact properties of palmyra fibre composites. P.A. Sreekumar et al., 2007 found that the tensile, flexural and impact of sisal fiber increase with increase in fiber loading. The various natural fibers like Sisal, Bamboo, Banana and Vakka are studied in detail by Murali Mohan Rao et al., 2010. The merits of the natural fiber and the properties of the natural fiber are studied in detail by D. Chandra Mohan et al., 2011.

Fiber orientation deals with the arrangement of fiber in particular degree in the composite. Mechanical properties of natural fiber hybrid composite is studied by Alavudeen et al., 2015 and they found an enhancement in the mechanical properties of the composite due to orientation. C. Bennet et al., 2014 studied the effect of lamina fiber orientation on the mechanical properties of natural fiber hybrid composite. They discovered that change in orientation showed significant effect on the tensile and vibrational properties.

The present work deals with the effect of orientation on tensile and flexural properties on sisal fiber oriented composite. Tensile and flexural tests are conducted for the composite and the results exhibit an enhancement in the mechanical properties.

MATERIALS AND METHODS:

The sisal fiber which is used for the fabrication of composite is bought from M/S Shiva Exports, Tirunelveli, Tamilnadu, India. Polyester resin is used for the fabrication of the composite. The details of the resin used:

- Resin: Isophthalic polyester resin (Commercial grade: VBR 4503)
- Catalyst: Methyl ethyl ketone peroxide (MEKP)
- Accelerator: Cobalt naphthenate.

The resin is bought from M/s. Vasavibala Resins Pvt Ltd., Chennai, Tamil Nadu, India. These are the essential materials for the fabrication of the composite.

Experimental procedure: Initially the fibers are combed and are arranged neatly as long fibers. The orientation to be followed in the composite is selected. Desired amount of fiber is taken in order to achieve the weight percentage of 50±2. Then the fibers are arranged in the particular angle as per the orientation selected in the specially designed mould. The mould consists of markings for every angle, from which we can ensure that the fibers are in the desired angle. The resin is prepared in the meantime. For every 100ml of the resin 1.5 ml of catalyst and 1.5ml of accelerator are added to it. The resin is poured over the fibers are in kept in compression moulding machine at a pressure of 170kg/cm2. The composite is left in the moulding machine for about 24 hours for curing.

Tensile test: The tensile test was conducted by using Instron (Series-3382). Tensile test determines the strength of the composite. The force needed to break the composite is measured in tensile test. Tensile test is done in universal test machine. The machine consists of two grips to hold the specimen on either side. When the machine is operated it pulls the specimen from either side until it breaks. The extent to which the specimen elongates or stretches until the breaking point can also be found out in the tensile test. The results of the tensile test are useful in determining where the composite can be used.

The most common specimen is a constant rectangular cross section as per the ASTM: D3039-08, 20 mm wide and 200 mm long. Tensile test result is measured in MPa.

Flexural test: The flexural test was conducted by using the Instron (Series-3382). The force required to bend beam under three point loading conditions is measured by flexural test. The results helpful in determining materials for parts that will support loads without flexing. The setup consists of a support span above which the specimen is placed and the load is applied at the center with the help of a loading nose. The load produces three point bending at a specified rate. Commonly the specimen with the size (as per ASTM: D790-10) 125mm×13mm×13mm. Flexural strength is measured in terms of MPa.

RESULT AND DISCUSSION:

TENSILE TEST:

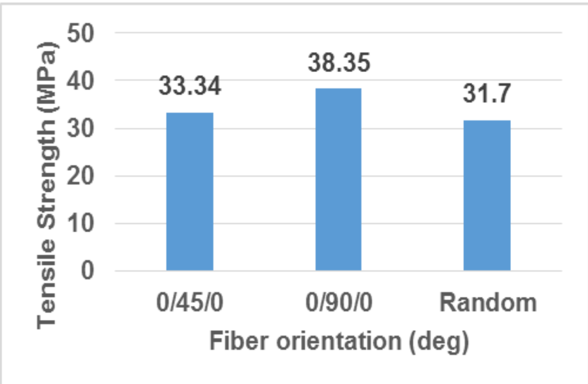

Fig.1 Tensile strength of composites

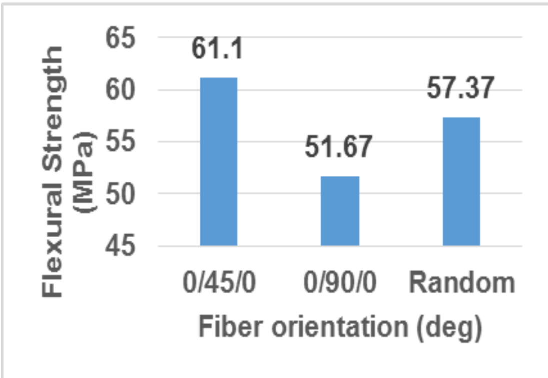

Fig.2. Flexural strength of composites

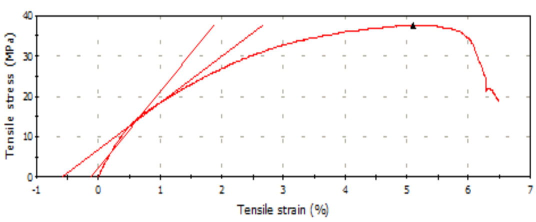

Fig.3 Tensile Stress -Strain of composite

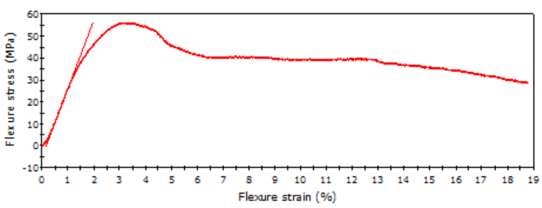

Fig.4 Flexural Stress -Strain of composite

The strength of the composites depends upon many factors such as fiber orientation, bonding between the fiber to matrix and etc. The fig.1 indicates the tensile strength of different orientations by using sisal fiber reinforced composites. As mentioned in fig.1 the tensile strength of 0˚/90˚/0˚ composite has higher than the other type of composites. This could be due to the uniform distribution of stress transfer between the fibers compare to the 0˚/45˚/0˚ and random type of composites. Further the most of the fibers are orientated longitudinally so as to withstand the tensile load along the length of fiber orientation. One of the tested tensile specimen's stress-strain curve is shown in fig.3. The random type of composites are not distributed the load ie improper stress transfer between the fibers leads the failure.

FLEXURAL TEST

The flexural properties of composites were tested by using the 3 point bend test. The flexural strength of 0˚/45˚/0˚, 0˚/90˚/0˚ and random orientation is presented in fig 2. The flexural strength was found to be higher in 0˚/45˚/0˚ (61.1 MPa). Incorporating the degrees of 0˚/45˚/0˚ for fabricating the composites gives a superior capacity for withstanding compressive strength and offers improved resistance to shear. Further the proper interlocking between the fibers in 0˚/45˚/0˚ enhances the flexural strength of the composites. One of the tested flexural stress-strain curve is shown in fig. 4. The percentage of improvement from 0˚/90˚/0˚, random to 0˚/45˚/0˚ are 15.38% and 6.50%.

CONCLUSION

Based on the above experiments, the following conclusions have been made:

- All the three type of different oriented sisal fiber polyester composites were fabricated by using the compression moulding technique. The three types of composites are 0˚/45˚/0˚, 0˚/90˚/0˚ and random orientation.
- 50±2 wt% of fiber was maintained in all the three types of composites.
- The maximum increase in tensile and flexural strength was found in the oriented combination of 0˚/90˚/0˚ and 0˚/45˚/0˚.

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