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Investigation of mechanical properties of $KMnO_4$ treated Sansevieria cylindrical fiber reinforced polymer composite

D. Hariharashayee[1], M. Akram Abu Hanif[2], S. Aravind[3], S. Mohamed Yasar[4], M. Abdul Azeez[5]

[1]*Assistant Professor, Erode Sengunthar Engineering College, Erode, Tamil Nadu*

[2,3,4,5]*Student, Erode Sengunthar Engineering College, Erode, Tamil Nadu*

ABSTRACT

The tensile, flexural and water absorption properties of randomly oriented short Sansevieria cylindrical fiber and Epoxy (SCFs) composites are described. Composites were fabricated using Potassium Permanganate (KMnO4) treated Sansevieria cylindrical fibers (SCFs) with the fiber length of 30mm each and 40% weight percentage of fiber. At this length and weight percentage, the tensile, flexural and water absorption properties of the composite were increased and a curtailment in properties occurred for higher fiber length composites. To improve the interfacial bond between SCFs and Epoxy resin, chemical surface treatments have been performed on the fibers in varying composition of 10%, 20%, 30%, 40% of Potassium Permanganate (KMnO4) in distilled water respectively. Each type of treated SCFs samples was separately used for fabricating the composites. The fiber density and fineness were approximately 0.915 ± 0.005 g/cm3 and 9 Tex, respectively. Above the other KMnO4 treatment compositions, 30% KMnO4 treated SCFs revealed the optimum increase in tensile, flexural and water absorption properties.

Keywords: *Sansevieria cylindrica, Potassium permanganate (KMnO4), Weight percentage, Interfacial bond, Orientation.*

1. INTRODUCTION

Cellulose is a natural bio polymer fiber and can be obtained from a large variety of plants. The fiber is renewable and bio degradable. Eco-friendly, biodegradable and recyclable products are gaining importance in the market which has brought natural fiber in to focus. Long leafy plants yield a higher degree of fiber. The present result focuses on the exploration of Sansevieria Cylindrica Fibre for different composites. Sansevieria is a genus of about 70 species with great variation within the genus. To develop an environmentally friendly material and partly replace currently used synthetic fibers in fiber-reinforced composites. The benefits of natural fiber composites include high specific strength and modulus, low cost, light weight, and recyclability. Therefore, natural fiber-based composites have good potential for use as structural materials. The SCFs epoxy sheets were prepared by using compression moulding for replacing the asbestos-cement sheet. In the present work, an attempt was made to use Alkali treated SCFs as reinforcement with Epoxy resin. A detailed investigation was also carried out on randomly oriented short SCFs polymer composites, especially on the 30mm fiber length and fiber weight percent of 40. The tensile, flexural and Water absorption of these composite plates were also analyzed.

2. MATERIALS

Fiber Extraction and Materials

The SCFs were separated from the Sansevieria cylindrica leaves Fig 2.1 (a), which were collected from farms around the district of Sivagangai in Tamil Nadu, India, using a mechanical process called decortication. In this process, the Sansevieria cylindrica leaves were fed into a fiber-extracting machine called a mechanical decorticator. The fibers were extracted, and the pulps were separated. The decorticated fibers were dried in the sunlight to remove he moisture content, and machine combed for separation. In this research work, the washed SCFs were dried for 24 h in sunlight and then used for characterization Fig 2.1 (b). The chemical used for the modification of SCF fiber surface is potassium permanganate. The matrix used for the investigation epoxy resin with HY951 as a hardener.

a b

Fig 2.1 (a) Sansevieria cylindrica plant

Fig 2.1 (b) Decorticated sansevieria cylindrical Fibre

c

Fig 2.1 (c) 30 mm of sansevieria cylindrical fiber

Preparation of composite specimen

The compression moulding method was adopted for the fabrication of composites. The cleaned and dried SCFs were chopped into 30 mm, Fig 2.1(c), A known weight of 40% SCFs of definite length was randomly spread between two mild steel plates. Extreme care was taken to obtain a uniform distribution of fibers. A load of 2 tons was applied to the mild steel plates by hydraulic compression to the settlement of fiber in the mould size of 290 mm x 290 mm x 3 mm. Then, 65% of unsaturated Epoxy resin and 1:3 ratio of hardener is prepared as matrix solution before pouring. The degassed matrix solution was applied to the compressed sheet by using a brush, and air bubbles were removed carefully with a grooved roller. The mould was closed, and hydraulic pressure was applied until complete closure. The closed mould was kept under pressure for 24 h. The composites were fabricated in the form of a flat plate with a size of 290 mm x 290 mm x 3 mm. Composite plates were prepared for fiber weights of 40% with 10%, 20%, 30%, 40% alkali treated fiber.

Fibre surface treatments

The raw SCFs were subjected to different ratio of potassium permanganate surface treatments. SCFs were chopped into 30 mm (critical fiber length) length before giving the treatment. The SCFs were soaked in 10%, 20%, 30%, and 40% potassium permanganate in distilled water for half an hour Fig 2.2. The fibers were then decanted and dried in air for 24 hrs to 30 hrs.

Fig 2.2 Sansevieria cylindrica fibers soaked in ($KMnO_4$) Treatment

3. METHODS AND PROPERTIES

i) Tensile Test

Test specimens were cut from the composite plates as per the ASTM standard. Tensile testing was carried out in a universal testing machine with a 400-kN capacity with a gauge length of 25 mm and breadth of 25 mm as per standard ASTM D 3039.

ii) Flexural Test

The three-point flexural properties were determined by an INSTRON universal testing machine 4301 with a 5-metric ton capacity, a gauge length of 125 mm breadth of 13 mm as per ASTM D 790-00.

iii) Water absorption test for composites

In order to measure the absorption characteristics of the composites, rectangular specimens were prepared to have dimensions of 39 mm x 10 mm x 3 mm. The specimens were dried in an oven at 105oC, cooled in a desiccator using silica gel and immediately weighed. The dried and weighed specimens were immersed in distilled water according to ASTM D 570-99. The water absorption tests were carried out by immersing the specimens for 2 h in hot and 24 h in cold water. After immersion, the excess water on the surface of the specimens was wiped up using a piece of soft cloth and the final weights of the specimens were then taken. The increase in the weight of the specimens was calculated using the following equation:

Water absorption (%) = Final weight - Original weight x 100 / Original weight

4. RESULTS AND DISCUSSION

i) Tensile properties

The dispersion and interfacial adhesion between the hydrophobic matrix and hydrophilic filler are the critical factors in determining the mechanical properties of composites. In the present work, surface modification of the SCF was carried out to achieve better mechanical properties of composites. It was found that the stress-strain curve of cured Epoxy resin is similar to that of brittle materials. The behavior is elastic in nature. The addition of fibers makes the matrix ductile, which is evident from the high elongation at break value of all the short SCFP composites. The stress value was found to increase non-linearly with a strain in short SCFP composites.

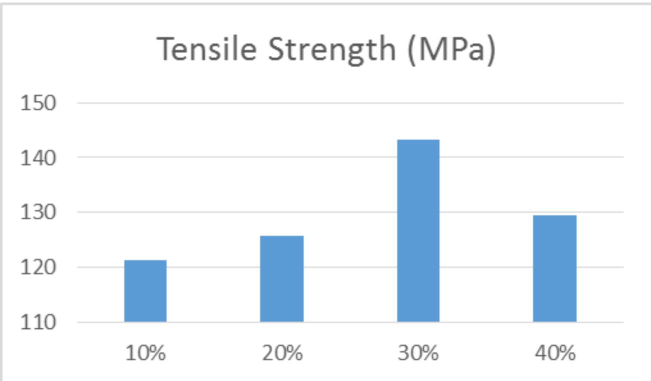

Fig 4.1 Ultimate Tensile Strength of 10%, 20%, 30% & 40% ($KMnO_4$) Treated fibre composites

Our results Fig 4.1 are in accordance with the findings of Sreenivasan et al [1]. They analyzed about improving the tensile properties of SCFs with polyester composites. It was revealed that the tensile strength was improved in 30% alkali treated fiber than the other compositions.

ii) Flexural properties

The effect of fiber treatments on the flexural stress-strain behavior of short SCFP composites is presented as the upper and lower surface of the specimen under three-point bending load are subjected to bending stress (compression and tension) and the axisymmetric plane is subjected to shear stress. There are two failure modes in materials: flexural and shear failure. The specimen fails when the bending or the shear stress reaches the corresponding critical value. Usually, the force–deflection curve obtained by three-point bending is able to reveal the modes of failure. Here the 30% alkali treated SCFs polymer composites are found to show higher flexural strength and modulus compared to other alkali percentage composites, Fig 4.2 indicating that the KMnO4 treatments performed on SCFs improve stress transfer from the matrix to the fiber up to 30% Surface treated fibers. Comparatively, the maximum flexural strength and modulus were registered by 30% Alkali treated KMnO4 composites.

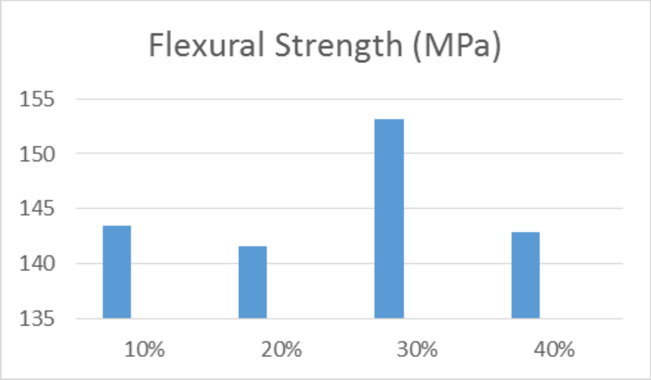

Fig 4.2 Flexural Strength Properties of 10%, 20%, 30% & 40% (KMnO4) Treated fibre composites

iii) Water absorption characteristics

Water absorption behavior of the SCFP composites in cold and hot water immersion is conducted. It is noted that the cold and hot water absorption of Epoxy resin is negligible due to the absence of water absorbing elements in it. Comparatively, the maximum quantity of water both in cold and hot state was absorbed by 10% SCF polymer composites. Fig 4.3 shows 30% Alkali treated SCF polymer composites showed lower water absorption tendency compared to those prepared with other compositions. This observation suggests that the hydrophilic nature of SCF has substantially decreased upon its chemical treatment with potassium permanganate of 30% composition. This can be described as the decrease in the number of hydroxyl groups in the cellulose during chemical treatments.

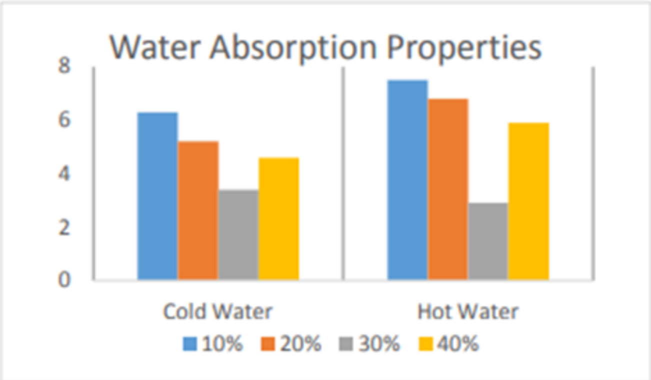

Fig 4.3 Cold and Hot Water Absorption Properties

5. CONCLUSIONS

The following conclusions were drawn from the test results:

- The mechanical properties of 40% KMnO4 treated SCF polymer composites were found to be greater than that of 10%, 20%, 30%, treated polymer composites.
- 40% KMnO4 treated SCF polymer composites possessed the maximum tensile strength of around 143 MPa among the other treated SCF polymer composites.
- 40% KMnO4 treated SCF polymer composites yielded the maximum flexural strength of about 153 MPa when compared with other treated SCFP composites.
- Comparatively the maximum quantity of water both in cold and hot state was absorbed by 10%, 20%, 30%, treated polymer composites. The chemical treatments used in this research decrease the water absorption tendency of 40% treated SCF polymer composites. Also 40% KMnO4 treated SCF polymer composites showed minimum water absorption when compared with other treated SCF polymer composites.

6. ACKNOWLEDGEMENT

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7. REFERENCES

[1] Sreenivasan VS, Ravindran D, Manikandan V, Narayanasamy R. Mechanical properties of randomly oriented short Sansevieria cylindrica fiber/polyester composites. Mater Des 2011;32:2444–55.
[2] Manikandan V, Ponnambalam SG, Sabu Thomas, Velmurugan R. Mechanical properties of short and uni-directional palmyra fiber reinforced composite. Int J Plast Technol 2004;8:205–16.

[3] Sreenivasan VS, Somasundaram S, Ravindran D, Manikandan V, Narayanasamy R. Microstructural, physicochemical and mechanical characterization of Sansevieria cylindrica fibers – an exploratory investigation. Mater Des 2011;32:453–61.

[4] Seena Joseph, Sreekala MS, Oommen Z, Koshy P, Thomas Sabu. A comparison of the mechanical properties of phenol formaldehyde composites reinforced with banana fibers and glass fibers. Compos Sci Technol 2002;62:1857–68.

[5] Sreekumar PA, Thomas Selvin P, Saiter Jean marc, Kuruvilla Joseph, Unnikrishnan G, Thomas Sabu. Effect of fiber surface modification on the mechanical and water absorption characteristics of sisal/polyester composites fabricated by resin transfer moulding. Composites Part A 2009;40(11):1777–84.

[6] Sanadi AR, Prasad SV, Rohatgi PK. Sunhemp fibre-reinforced polyester. Part 1. Analysis of tensile and impact properties. J Mater Sci 1986;21:4299–304.

[7] Velmurugan R, Manikandan V. Mechanical properties of palmyra/glass fiber hybrid composites. Composites Part A 2007;38(10):2216–26.

[8] Kalaprasad G, Joseph K, Thomas S, Pavithran C. Theoretical modelling of tensile properties of short sisal fibre- -reinforced low-density polyethylene composites. J Mater Sci 1997;32:4261–7.

[9] ASTM Standard D3379. Standard test method for tensile strength and Young's modulus for high modulus single-filament materials. In Annual book of ASTM standard, vol. 08.03.2002.

[10] ASTM Standard D 3039. Standard test methods for tensile properties of plastics. In Annual book of ASTM standard, vol. 08.03.2002.

[11] ASTM Standard D 790-00. Standard test methods for flexural properties of unreinforced and reinforced plastics and electrical insulating materials. In Annual book of ASTM standard, vol. 08.01.2002.

[12] ASTM Standard D 6110-97. Standard test methods for determining the izod impact resistance of unnotched specimens of plastics. In: Annual book of ASTM standard, vol. 08.03.2002.

[13] ASTM Standard D 785-98. Standard test method for rockwell hardness of plastics and electrical insulating materials. In Annual book of ASTM standard, vol. 08.01.2002.

[14] ASTM Standard D 570-99. Standard test methods for water absorption of plastics. In Annual book of ASTM standard, vol. 08.01.2002.

[15] M. Kanimozhi, "Investigating the Physical Characteristics of Sansevieria Trifasciata Fiber", International Journal of Science and Research Publications,Volume 1, Issue 1, December 2011.

