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Comparison of Natural Frequency and Mechanical Properties of Natural Fiber and Synthetic Fiber Composite Plates

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Abstract

In this investigation, coconut sheath a new type of reinforcement was used. The composite was fabricated using compression moulding machine. The mechanical properties like Natural frequency, Tensile strength, flexural strength, were studied according to the ASTM standards. The treated coconut sheath specimens were compared with E-glass specimens. For further improvement in the properties, chemical modification such as alkali treatment was given to the coconut sheath fibers. As expected, the mechanical properties of coconut sheath-reinforced composites were improved.

Keywords
Alkali Treatment, Coconut sheath,E-Glass, Natural frequency, Tensile strength, flexural strength.

1. Introduction

A composite is a combination of two or more distinct materials, each of which retains its own distinctive properties, to create a new material with properties that cannot be achieved by any of the components acting alone.

Natural Natural fibres are environment friendly materials and have proved to be a competitor for glass fibre/polyester in terms of strength performance and cost (Baiardo et al. 2004) [1]. Composite materials has a low density, small fee/cheap and biodegradable capability is a relevant characteristic in selecting materials of natural fibers as reinforcement (Ahmed et al., 2007) [2]. Amico et al. found that the compression molding process of making composite affords better strength in all aspects [3]. Alkali treated coir fiber had better impact strength compared to untreated coir fibers (A.Karthikeyen, K.Balamurugan2012) [4]. Alkali Treatment is used to Improve the tensile strength of coir fiber (R. Hari Setyanto et al.2013) [5].

2. Experimental Details

2.1 Materials

Unsaturated polyester was used as matrix. Methyl Ethyl Ketone Peroxide as catalyst and Cobalt-Naphthenate as accelerator were used. Coconut sheath was used as reinforcement with minimum processing like washing, drying, etc. Commercially available E-Glass chopped strand mat was also used as reinforcement for comparison purpose. Figures 1 and 2 show the photographs taken on the coconut tree with coconut sheath (arrow marked) and processed individual coconut sheath.

Figure 2.1.1 Coconut Sheath

2.2 Specimen Preparation

2.2.1 Treated Specimen (10% 0f NaoH)

The fibers (Coconut sheath are cleaned normally in clean running water and dried. A glass beaker is taken and 10% NaOH is added and 90% of distilled water is added and a solution is made.

After adequate drying of the fibers in normal shading for 2 to 3 hours, the fibers are taken and soaked in the prepared NaoH solution. Soaking is carried out for different time intervals depending upon the strength of fiber required. In this study, the fibers are soaked in the solution for three hours. After the fibers are taken out and washed in running water, these are dried for another 2 hours.

2.2.2 Treated Specimen (15% 0f NaoH)

The fibers are cleaned normally in clean running water and dried. A glass beaker is taken and 15% NaOH is added and 85% of distilled water is added and a solution is made.

After adequate drying of the fibers in normal shading for 2 to 3 hours, the fibers are taken and soaked in the prepared NaOH solution. Soaking is carried out for different time intervals depending upon the strength of fiber required. In this study, the fibers are soaked in the solution for three hours. After the fibers are taken out and washed in running water, these are dried for another 2 hours.

2.2 Fabrication of Composites

Compression moulding technique was used for the fabrication of composites. After 3hour, specimens were taken from the mould and cut into required dimensions (200*200*3mm) according to the respective ASTM standards. Then the specimens are resized into the required dimension of (200*20*3mm).Similarly-glass fiber-reinforced polyester composite and treated coconut sheath polyester composite specimens were also prepared.

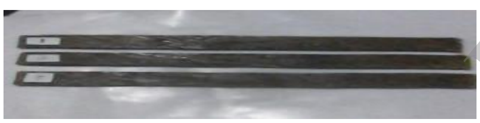


Figure 2.2.1 Treated coconut sheath with 10% NaoH

Figure 2.2.2 Treated coconut sheath with 15% NaoH

Figure2.2.3 Non treated E-Glass

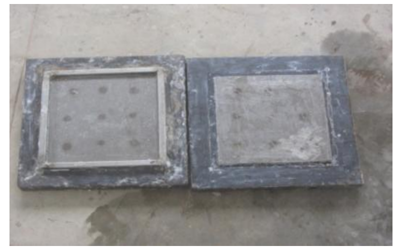


Figure 2.2.4 Compression moulding die

Figure 2.2.5 Treated coconut sheath composite plate

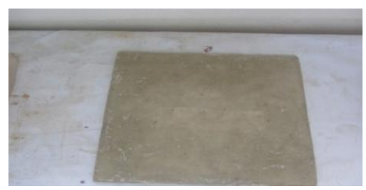


Figure 2.2.6 Non treated E-glass composite plate

3. Model Analysis

The experimental setup used to carry out the modal analysis of composite laminates using impact hammer. The accelerometer (Kistler model 8778A500) is attached at the end of rectangular composite plate (200mm×20mm×3 mm). The modally tuned impact hammer (Kistler model 9722A500) with sharp hardened tip is chosen for getting higher frequencies. The displacement signal from accelerometer has been recorded in personal computer through data acquisition system. Two separate adaptors are used for capturing the output signal, one for receiving accelerometer signal and the other for measuring the magnitude of the response by the hammer from laminates.

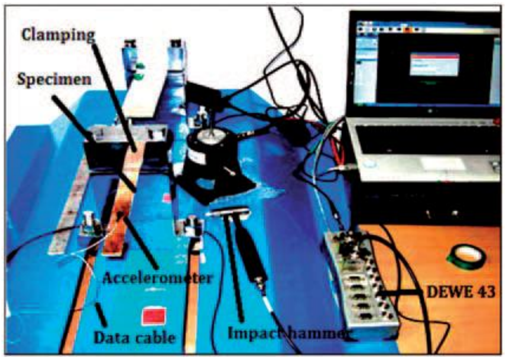


Figure 3.1 Experimental setup for modal analysis

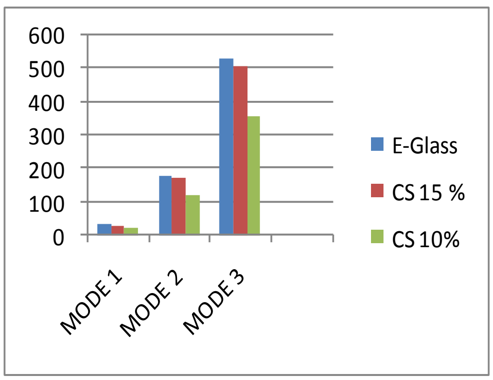


Figure 3.2 Comparisons of natural frequencies

4. ANSYS Results

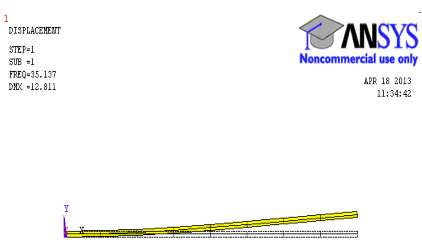


Figure4.1 E-Glass Mode 1

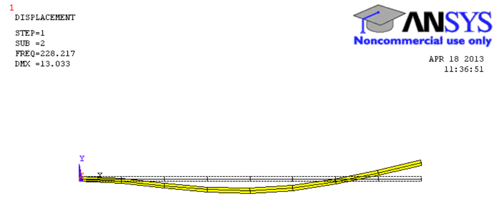


Figure 4.2 E-Glass Mode 2

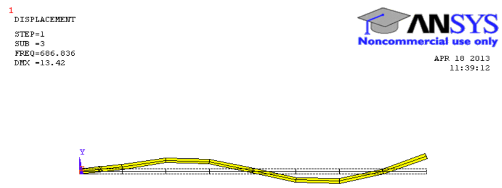


Figure 4.3 E-Glass Mode 3

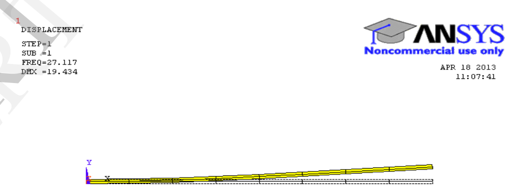


Figure 4.4 Coconut sheath Mode 1

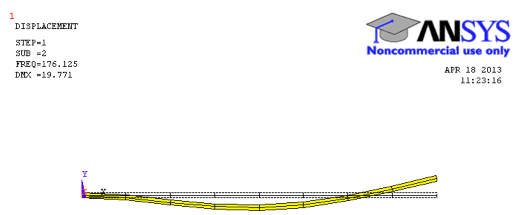


Figure 4.5 Coconut sheath Mode 2

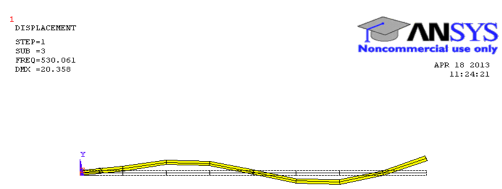


Figure 4.6 Coconut sheath Mode 3

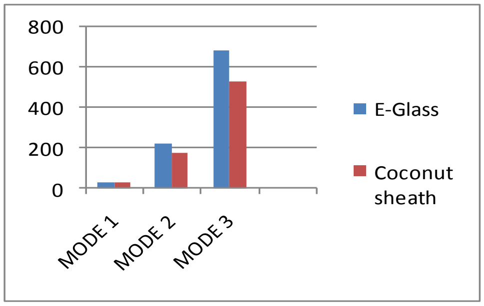


Figure 4.7 Comparisons of natural frequencies (ANSYS)

5. Tensile Strength

The tensile test is generally performed in universal testing machine. The tension test is generally performed on flat specimens. The test-piece used here was of rectangular type and having dimensions according to the standards. The dimension of the specimen is 165mm*20mm*3mm. A uni-axial load is applied through the ends. The tensile test was performed on the samples as per ASTM D638 test standards.

Sample details

- Span Length(mm) - 165
- Thickness (mm) - 3
- Width (mm) - 20
- Ref.Standard - ASTM D638
- Speed of testing (mm/min) - 5
- Grip Length (mm) - 100

Figure 5.1 Tensile Testing Machine

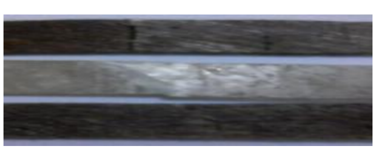
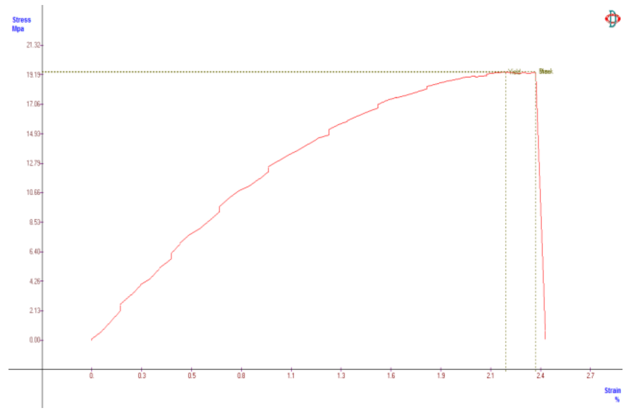
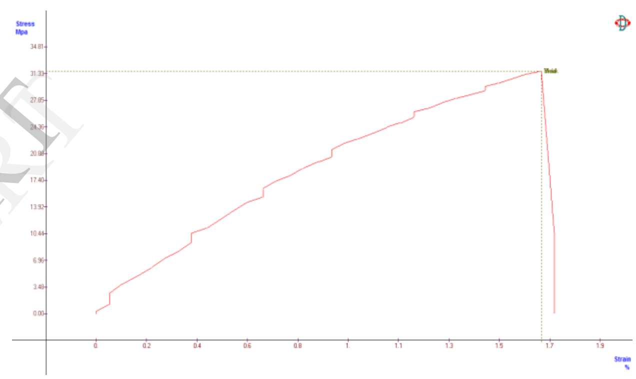


Figure 5.2 Specimens after tensile testing

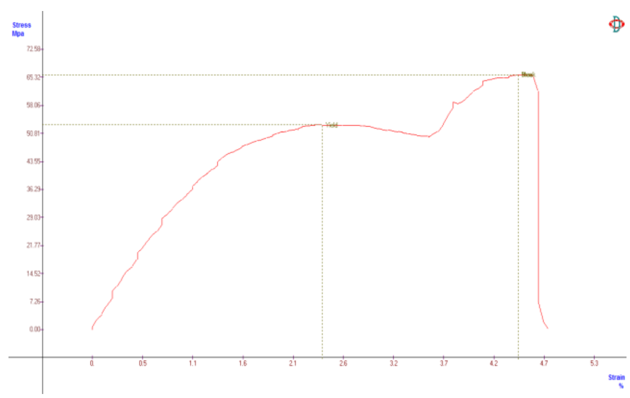
5.1. Graph View



CS 10%



CS 15%



E-Glass

Figure 5.1.1 Graph View - Tensile Strength

6. Flexural Strength

The determination of flexural strength is an important characterization of any Structural material. It is the ability of a material to withstand the bending before reaching the breaking point. Conventionally a three point bend test is conducted for finding out this material property in the present investigation also the composites were subjected to this test in a testing machine. The flexural test is performed in UTM. Flexural test was performed on all the three samples as per ASTM D790 test standards.

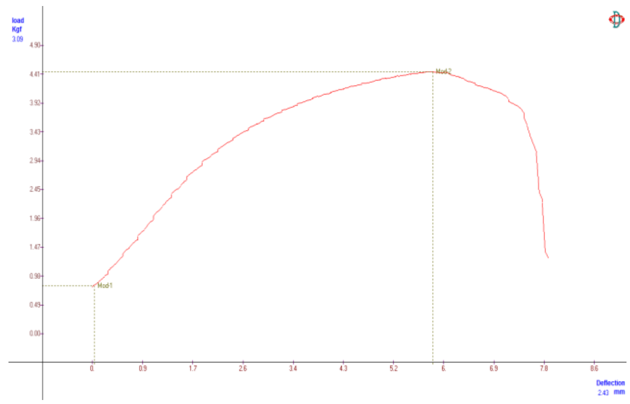
Sample details

- Span Length(mm) - 50
- Thickness (mm) - 3
- Width (mm) - 20
- Ref.Standard - ASTMD790

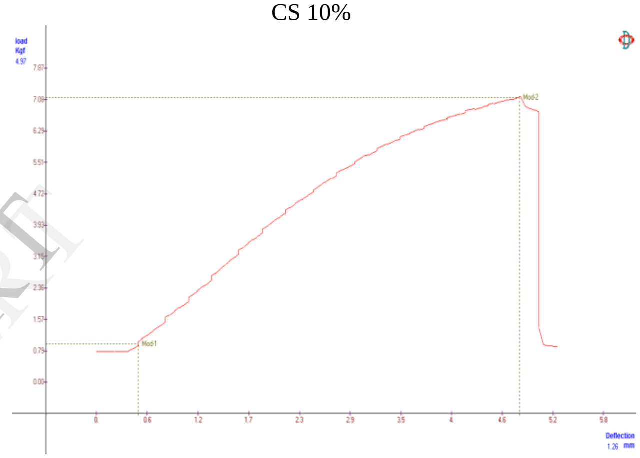
Figure 6.1 Flexural testing machine

Figure 6.2 Specimens after flexural test

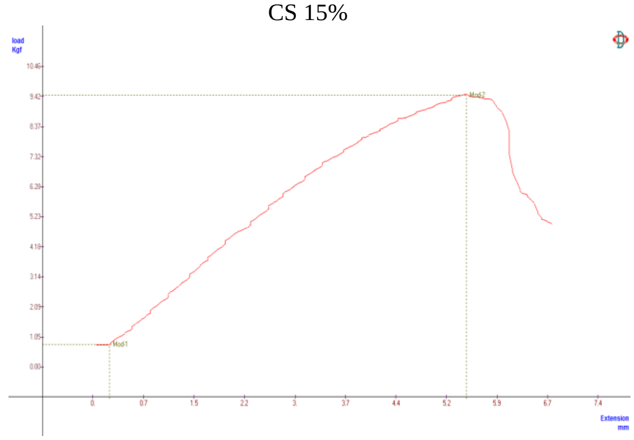
6.1 Graph View



CS 10%



CS 15%



E-Glass

Figure 6.1.1 Graph View - Flexural Strength

7. Conclusion

From the experiments, The 15% alkali treated coconut sheath-reinforced composite showed superior performance in natural frequency, flexural and tensile strength compared to 10% alkali treated coconut sheath-reinforced composite.

Hence, by increasing the percentage of NaoH, the strength and mechanical properties of coconut sheath-reinforced composites can be improved than that of E-Glass fibre-reinforced composites.

8. References

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