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Evaluation of Tensile Behavior of Sea Shell-Jute Fabric Reinforced Composite

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ABSTRACT—*The aim of this paper is to study the tensile behavior of sea shell-jute fabric reinforced composites. The composites were prepared by using sea shell powder as filler material in jute fabric reinforced with epoxy composite. The tensile behaviors of this composite were studied by varying the sea shell filler percentage. The experimental investigation has revealed that, 5% sea shell filler in jute fabric reinforced composite give maximum tensile strength of 8400N with less deformation. The results were supported with SEM analysis. The present study of an interesting filler material (sea shell) on jute fabric reinforced composite.*

Keywords— ***Sea shell, filler, Jute fabric, tensile behavior, SEM.***

1, INTRODUCTION

A composite material is formed by combining two or more materials to give a unique combination of properties [1].Fiber reinforcement composite are certainly one of the oldest and most widely used composite materials. Fibers or particles embedded in matrix of another material would be the best example of modern-day composite materials, which are mostly structural. We get better fiber reinforcement by study and development of bonding mechanism between the fiber and matrix, fiber orientation, fiber reinforcement size, distribution and morphological structures [2].With growing environmental awareness, ecological concerns and new legislations, bio fiber reinforced polymer composites have received increasing attention during the recent decades. In late 1980s researchers are more concentrated on producing the product from natural fiber reinforced biodegradable polymer composites to avoid global environmental problems. But as compared to polymers natural fibers cost is more and have low strength and stiffness [5]. Jute is the second common natural fiber cultivated in the world next to cotton. Jute fiber is obtained from two herbaceous annual plants, white corchoruscapsularis (white jute) originating from Asia and corchorusolitorius (Tossa jute) originating from Africa [4]. Natural fillers (NF) reinforced materials offer many environmental advantages, such as reduced dependence on non-renewable energy/material sources, lower pollution and greenhouse emission. Natural fillers (flax, hemp, etc.) represent an environmentally friendly alternative to conventional

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reinforcing fibers (glass, carbon). Advantages of natural fillers over traditional ones are their low cost, high toughness, low density, good specific strength properties, reduced tool wear (non-abrasive to processing equipment), enhanced energy recovery, Recently, there is a growing interest in agricultural waste and plant as a substitute for wood-based raw materials [3].

Among the various fillers, sea shell could be very interesting material as filler in biodegradable polymer composites, due to its good thermal stability compared to other. The sea shell can be easily crushed into chips or particles; the sea shell is mainly composed of calcium carbonate ($CaCO_3$) in two forms Calcite and aragonite or a mixture of them with some organic compounds. Advantages of natural fillers over traditional ones are their low cost, high toughness, low density, good specific strength properties, reduced tool wear (non-abrasive to processing equipment), and enhanced energy recovery[5].

2. MATERIALS AND METHODS

2.1 Materials

The composites were produced from sea shells which were collected from Ponambur Beach, Mangalore, Karnataka, India. Jute fabric was purchased from Narasimha cloth Centre, Bangalore. Atul Ltd. Lapox L–12 Resin and Hardener K – 6 were purchased from Yuje Marketing, Bangalore, India..

Sea Shell Powder+Jute Fabric+Resin+Hardener=Polymer Based Biodegradable Polymer Composite

2.2 Methodology

The overall goal of this work was to examine the tensile property and it SEM observation of sea shell filler in jute fabric composites. In order to examine the possibility of superior performance and reduced cost of composite materials, treated jute fabrics were used and sea shell powder as a filler. The collected sea shells were soaked in water for duration of 8 hours by adding bleaching to clean the sea shells, after cleaning it is dried in natural atmosphere temperature (sun light) for duration of one week and subsequently broken in to small pieces. It is then converted in to fine powder in grinder.So formed powder with random grain size was sieved between 100 to 125 microns with the aid of appropriate sieves. The density of sea shell is found to be 1.7 g/cm^3.The jute fabric was treated by adding 5% of 1$molL^{-1}$ normality NaOH per liter of water [1]. Chemical treatment on jute fabric will usually remove the moisture content thereby increasing its strength. Also, chemical treatment enhances the mechanical properties. This treatment clears all the impurities and also stabilizes the molecular orientation. In view of this, the jute fabric used in the preparation of the composite is pre-treated with acidic solution [4]. This treatment is made for constant duration of time of 3 hours. After chemical treatment

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the jute fabric was washed thoroughly with running water to remove residues of chemical content in it. The washed jute mat is dried at room temperature. Then cut the jute fabric dimension of 250×250 mm, calculated the number of jute layer, amount of resin and weight of sea shell filler for various composition by volume fraction. Finally tensile test was conducted on prepare specimens as per ASTM D 3039.

Composition	Weight in %
Cellulose	71.5
Hemicelluloses	20.4
Lignin	13
Moisture content	13.7
Waxes	0.5

Table 4.3 Chemical Composition of Jute Fabric

3. RESULT AND DISCUSSION

To analyze the mechanical behavior of natural composites tensile test is one of the most important techniques[1]. Mechanical properties of matrix and filler reinforced composites depend on the nature of matrix material, the distribution and orientation of the reinforcing fibers, the nature of the fiber-matrix interfaces. Even small changes in the physical nature of the reinforcement for a given matrix may result in prominent changes in the overall mechanical properties of composites and SEM analysis has been observed to know the proper bonding between reinforcement and matrix material.

3.1 Mechanical Property

3.1.1 Tensile Test

Tensile strength is the ability of the material to resist the deformation under gradually applied load conditions.

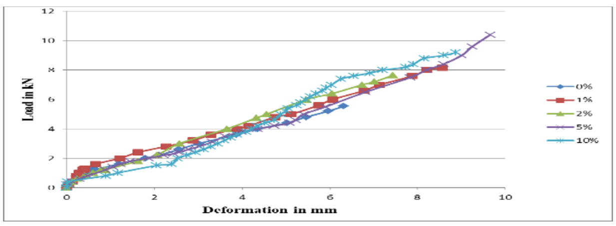


Fig. 3.1 The tensile strength for 0%, 1%, 2%, 5% and10% sea shell filler content

The Fig.3.1 shows the effect of sea shell filler content on the tensile strength of the all combination of composites. For 10% filler content the deformation is more compare to the other five filler contents. And 5% filler content shows more tensile strength compare to the other filler content. There is no decreasing of tensile strength in composites with increasing the filler percentage. This shows that, the density of the filler is not affecting the tensile strength of the composite material up to 5%. But in 10% the initial load absorbing is less compare to other percentage of filler contents this may happens due to insufficient bonding between fiber and matrix[4], because the distribution of filler is uniform in each layer and the used jute fabric is having uniform thickness (it means, the fiber distribution is same throughout the layer).

Table 3.1 Comparison of Commercial Nuwoodwith Sea Shell Powder-Jute FabricComposites

Composition	Tensile Strength in (N)
0% Sea Shell Filler	5540
1% Sea Shell Filler	5600
2% Sea Shell Filler	7000
5% Sea Shell Filler	8400
10% Sea Shell Filler	9200
Commercial Nuwood	2000

3.2 SEM micrographs analysis

To study micro-mechanical analysis of the failure of specimen, the broken specimens were taken with SEM scans for various combinations of composites. The scans were taken at critical regions of failed specimen, out of which the selected scans were discussed below.

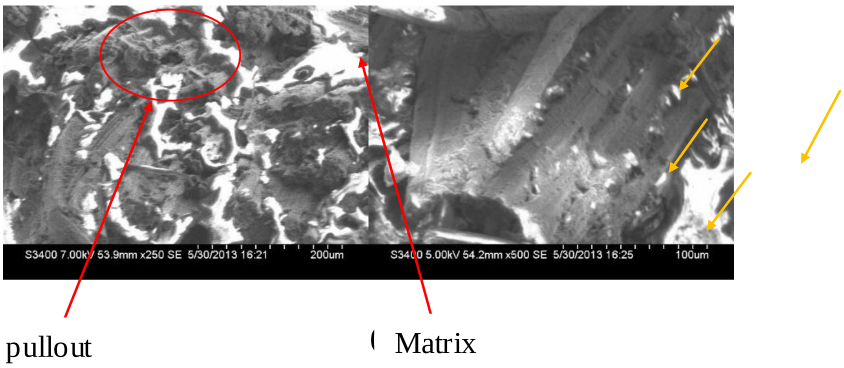
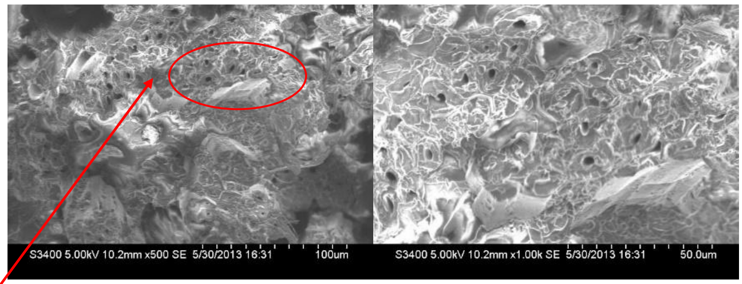


Fig. 3.2 SEM micrographs of tensile fracture surface for 0% sea shell filler content

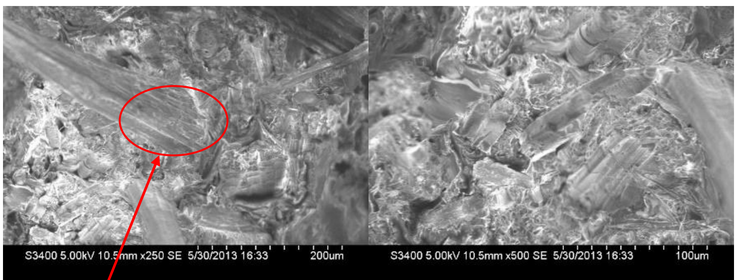
From this SEM it is clear that failure dominated by fiber-matrix and matrix-matrix shearing, matrix and fiber failure, and fiber-matrix interface failure. Fig 3.2 (a) indicates the fiber-matrix interface failure is indicated by pullout way fractured surface [6]. This shows the fiber distribution is uniform. Figure also indicates the group of fibers pullout, the reason for the fracture is may be due to nonhomogeneous distribution of matrix.



Fiber failure (b) 1000X Sea shell and Matrix

Fig. 3.3 SEM micrographs of tensile fracture surface for 5% sea shell filler content

The SEM micrographs of the fracture surface of treated 5% sea shell filler content composite as shown in fig. 3.3 having magnification of 500X and 1000X. The highly dense honeycomb structure can be observed from SEM graph. From the SEM images clearly identified that the failure mode fiber in composite due to the failure of jute fiber. Hence the tensile strength and deformation of the treated 5% fiber content composite increases compared to the 0% sea shell filler content composite.



Fiber failure)X

Fig. 3.4 SEM micrographs of tensile fracture surface for 10% sea shell filler content

The SEM micrographs of the fracture surface of treated 10% sea shell filler content as shown in fig. 3.4 having magnification of 250X and 500X.From the SEM images clearly identified that the failure mode fiber in composite due to the failure of epoxy and jute fiber. But as compare to the 0% and 5% sea shell filler content, before failure of 10% sea shell filler content composite resist more [7]. It can be absorbed in SEM. There is no jute fiber pullout, the fiber is breaks after attaining its ultimate load absorbing capacity and also the presence of sea shell filler is gives the good bonding and resisting property to the jute fiber against deformation.

4.CONCULSION

Natural fiber processing in country like India is a labor-intensive manual process. Increase the use of sea shell may also find supplying of raw materials and using economically. In Indian sea shore availability of sea shell seems to be promising and available in huge for production and application of sea shell composites.

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