RESEARCH ARTICLE OPEN ACCESS

Effect of Chemical Concentration on Mechanical Behaviour and Surface Roughness of Plain-Woven Fabrics Biodegradable Composites

Ranga vital G S[1,] Tejas D[2], Yashwanth L[3], Chandrashekar J G[4], Amaresh Gunge[5]
[1,2,3,4,5] Department of Mechanical Engineering, Nagarjuna College of engineering and technology, Bangalore

Abstract:

The natural fibers are available with the presence of hemicellulose, lignin unwanted and other dust particles, these contaminates effect on the strength and level of internal bonding between fiber to the matrix. The present work investigates the effect of the chemical concentrations and strength. Initially plain-woven banana fabrics treated with different chemical concentration for 4 hours at room temperature. The treated composite samples were prepared as per the ASTM standards and tested for mechanical behavior (tensile, flexural and impact). Later the surface modification, nature of fracture behavior of treated can be analyzed by SEM

Keywords —Mechanical, Tensile, Flexural, Impact, Woven fiber

I. INTRODUCTION

A composite material is composed of at least two materials, which combine to give properties superior to those of the individual constituents.

Composite materials are commonly classified at following two distinct levels: represented in Fig 1 Classification of Matrix Materials

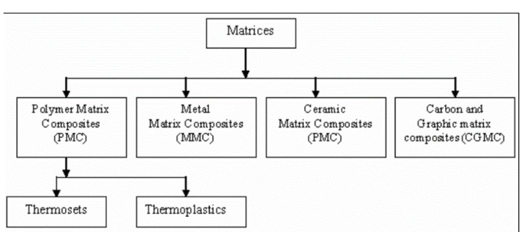


Figure 1: - Classification of Matrix Materials

The **first level** of classification is usually made with respect to the matrix constituent.
The major composite classes include

Organic Matrix Composites (OMCs), Metal Matrix Composites (MMCs) and Ceramic Matrix Composites (CMCs). The term organic matrix composite is generally assumed to include two classes of composites, namely Polymer Matrix Composites (PMCs) and carbon matrix composites commonly referred to as carbon-carbon composites.

The **second level** of classification refers to the reinforcement form - fiber reinforced composites, laminar composites and particulate composites. Fiber Reinforced composites (FRP) can be further divided into those containing discontinuous or continuous fiber.**Fiber Reinforced Composites** are composed of fibers embedded in matrix material. Such a composite is considered to be a discontinuous fiber or short fiber composite if its properties vary with fiber length. On the other hand, when the length of the fiber is such that any further increase in length does not further increase, the elastic modulus of the composite, the composite is considered to be continuous fiber reinforced. Fibers are small in diameter and when pushed axially, they bend easily although they have very good tensile properties. These fibers must be supported to keep individual fibers from bending and buckling.**Laminar Composites** are composed of layers of materials held together by matrix. Sandwich structures fall under this category. **Particulate Composites** are composed of particles distributed or embedded in a matrix body. The particles may be flakes or in powder form. Concrete and wood particle boards are examples of this category.

II. LITERATURE SURVEY

A.yu. Smolin, E.V. Shilko, S.V Astafurov, modelling mechanical behaviours of composites with various ratios of matrix inclusion properties using movable cellular automaton method, Results were found that Based on movable cellular automaton

Figure2: Banana Fabrics

method, the models for computer-aided studying mechanical behaviour of composites with special properties of inclusions and inclusion matrix interphase were developed. It is interesting that the fracture energy of the ceramics with increased elastic properties of the pore surface may reduce. This effect may explain the peculiarities of mechanical behavior of gel-filled zirconia ceramics.

The work carried out by **Dixit S. and Verma P**, The Effect of Hybridization on Mechanical Behavior of Coir/Sisal/Jute Fibers Reinforced Polyester Composite Material, this work being an experimental study on untreated (coir/ sisal/ jute) fiber-reinforced polyester composites. It has been shown in this study the tensile properties of natural fiber composites can be significantly improved by natural fibers in a sandwich construction. Significant reduction in water absorption of natural fiber composites is also obtained with the sandwich construction. This work also demonstrates the potential of these hybrid natural fiber composite materials for use in a number of consumable goods.

The Research Carried by **V.Dattoma, B.Gambino, R.Nobile , F.W.Panella**, Mechanical behavior of composite material in presence of wrinkles, the results were Failure mechanism induced by wrinkles in Open Hole configuration has been experimentally studied both in tension and compression. Knockdown of ultimate strength is coherent with results that can be founded in literature. Initial delamination in traction appears at load comprises between 43% and 59% of the ultimate strength in the case of the more severe wrinkles, while is generally absent in compression, with the exception of the layup characterized by the lower stiffness.

III. OBJECTIVES OF THE RESEARCH WORK

The objectives of this Research work are as follows:

1. To study the effect of chemical treatment on plain woven fabrics.
2. Plain woven fabrics treated with different percentages of concentrations for 4 hours.
3. To prepare the natural fiber composite specimens by using hand lay-up method as per ASTM standards.
4. Composite laminates tested for mechanical behavior (tensile, flexural and impact)
5. Comparing the strength between untreated and treated composite specimens.
6. Nature of fracture behavior will be examined after the tensile test.

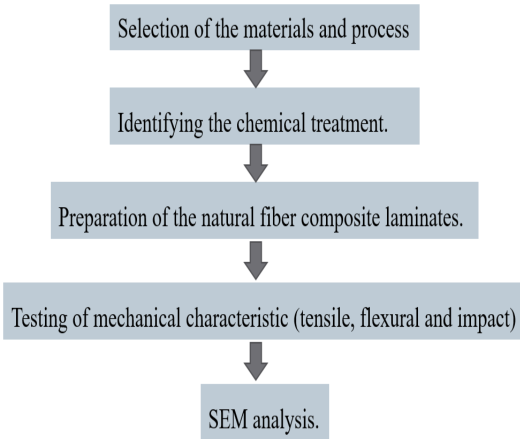
IV. MATERIALS & METHODOLOGY

A. ***Materials Used***

1. Plain woven jute fabrics
2. Polyvinyl Alcohol (PVA)

Figure 3 : - Plain woven jute fabrics & Polyvinyl Alcohol

B. ***Methodology Followed***



V. RESULTS AND DISCUSSIONS

A. Tensile Properties

The samples manufactured from composite materials reinforced with Polyvinyl Alcohol have been subjected to the tensile test. Figure 4-6 show the characteristic curves for plain woven fabrics.

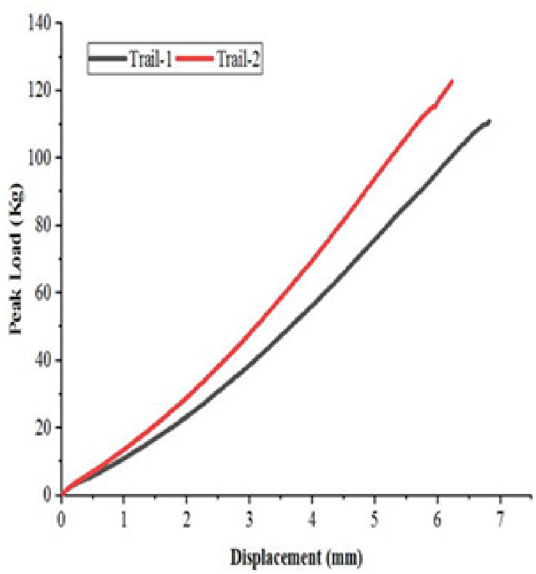


Figure 4: Untreated Tensile Curve

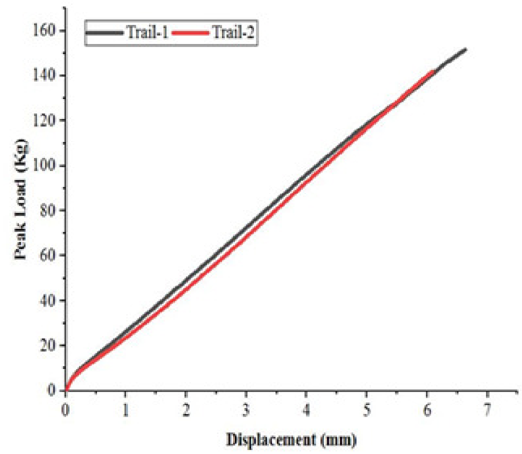


Figure 5: 2% Chemical Concentration Tensile Graph

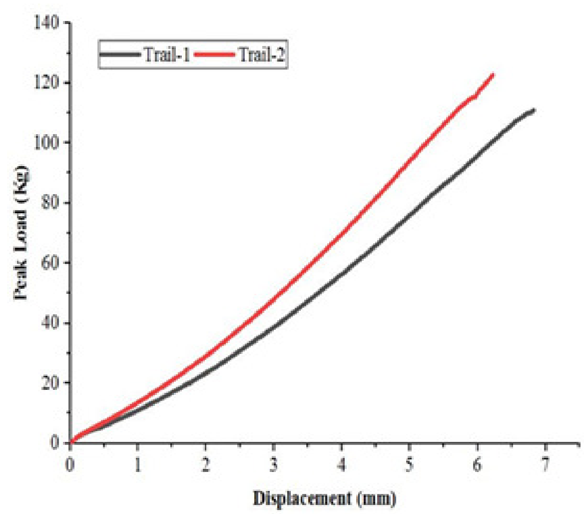


Figure 6: 4% Chemical Concentration Tensile Graph

Chemically treated with 3 different concentrations namely Untreated Fabrics (Fig:4), Treated with 2% Concentration (Fig:5),Treated with 4% Concentration (Fig:6).

The experimental results for the composite laminates with untreated, 2% chemical concentration, 4% chemical concentration, are present in Table 1

TABLE 1:
Comparison Between Different Chemical Concentration for Tensile Test

Sample No.	Peak Load (Kg)		Avg. Peak Load (Kg)
	Trail-1	Trail-2	
S1 (untreated)	110.9	125.2	118.05
S2 (2%)	156.4	156.7	156.55
S3 (4%)	185.8	206.4	196.1

By comparing, composite laminate with 4% chemical concentration have average peak load of 196.1 kg higher than the composite laminates with 2% chemical concentration & Untreated one.

B. Flexural Properties

The samples made from composite materials reinforced with Polyvinyl Alcohol have been subjected to the flexural test. Figure 7-9 show the characteristic curves for plain woven fabrics

Chemically treated with 3 different concentrations namely Untreated Fabrics (Fig:7), Treated with 2% Concentration (Fig:8),Treated with 4% Concentration (Fig:9).

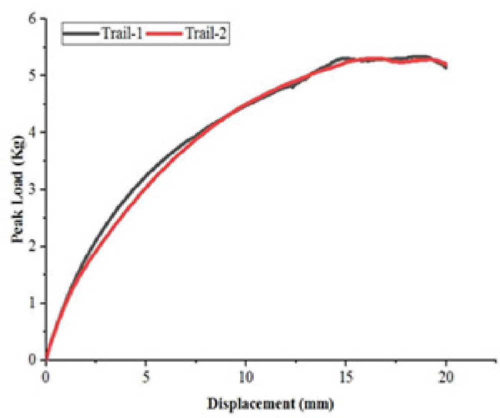


Figure 7: Untreated Flexural Graph

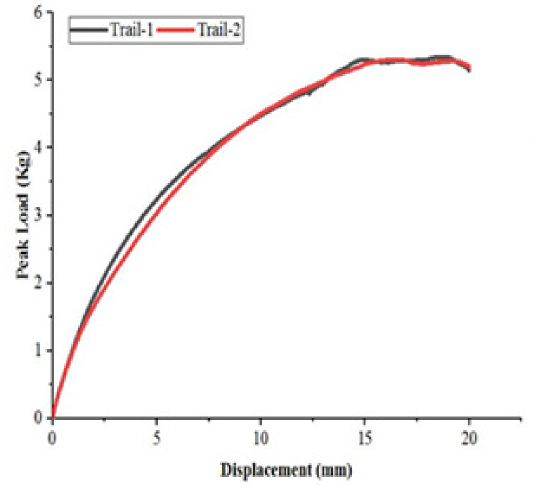


Figure 8: 2% Chemical Concentration Flexural Graph

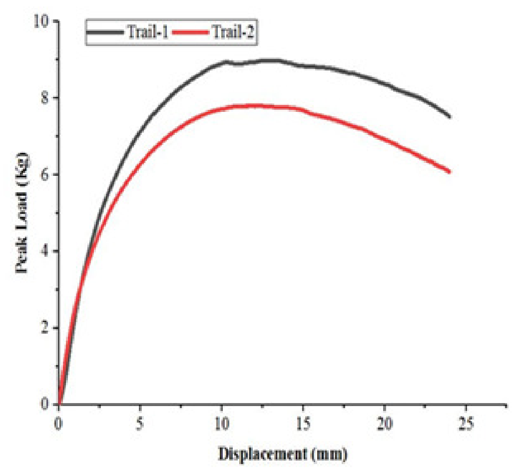


Figure 9: 4% Chemical Concentration Flexural Graph

The experimental results for the composite laminates with untreated, 2% chemical concentration, 4% chemical concentration, are present in Table 2

TABLE2:
Comparison between different chemical concentration for flexural test

Sample No.	Peak Load (Kg)		Avg. Peak Load (Kg)
	Trail-1	Trail-2	
S1 (Untreated)	5.34	5.30	5.32
S2 (2%)	8.993	7.802	8.39
S3 (4%)	13.05	15.59	14.28

By comparing, composite laminate with 4% chemical concentration have average peak load of

14.28kg higher than the composite laminates with 2% chemical concentration & Untreated one.

C. Impact Properties

The samples made from composite materials reinforced with Polyvinyl Alcohol have been subjected to the Impact test.

Chemically treated with 3 different concentrations namely Untreated Fabrics, treated with 2% Concentration,Treated with 4% Concentration.

The experimental results for the composite laminates with untreated, 2% chemical concentration, 4% chemical concentration, are present in Table 3

TABLE 3:
Comparison between different chemical concentration for impact test

Sample No.	**Peak Load (Kg)**		**Avg. Peak Load (Kg)**
	Trail-1	**Trail-2**	
S1 (Untreated)	3.40	2.95	3.175
S2 (2%)	3.60	2.95	3.275
S3 (4%)	4.60	4.50	4.55

By comparing, composite laminate with 4% chemical concentration have average peak load of 4.55kg higher than the composite laminates with 2% chemical concentration & Untreated one.

D. Scanning Electronic Microscope

The fracture behavior of untreated and treated composite specimens after the tensile test was conducted using SEM and shown in Figs: 10,11,12

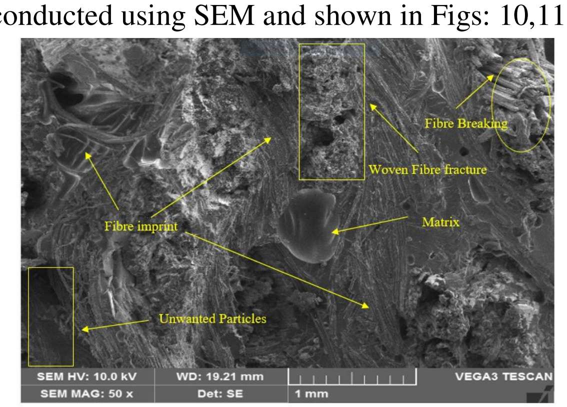


Figure 10: Image of Untreated composite laminate breaking area

The front view of untreated composite laminate shown in Fig.10. Untreated materials contain hemicellulose, lignin, waste impurities and dust particles were responsible for weak internal reinforcement and lower strength. Hence, to overcome this, chemical treatment is necessary for improving strength and internal bonding.

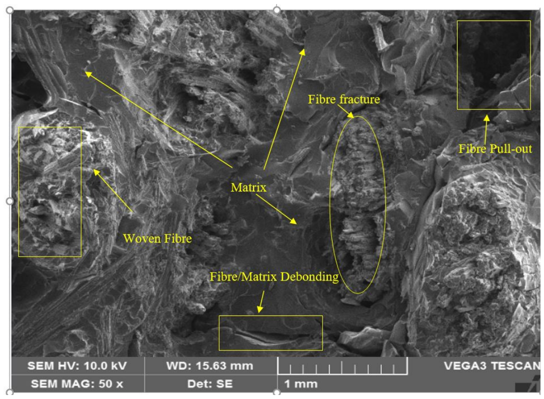


Figure 11: Image of 2% chemically treated composite laminate breaking area

SEM image of 2% Chemically treated composite laminate (Shown in Fig11) and also came to know that when compared to untreated laminate, area of contact between fabric to matrix were improved. also noticed that the presence of unwanted particles leads to lower strength and noticed weak bonding. From SEM analysis, it was clearly seen in the nature of fabric pull-out and fabric fracture behavior. Hence, from SEM examination. it was noticed that 2% not enough to complete removal of unwanted particles from the fiber.

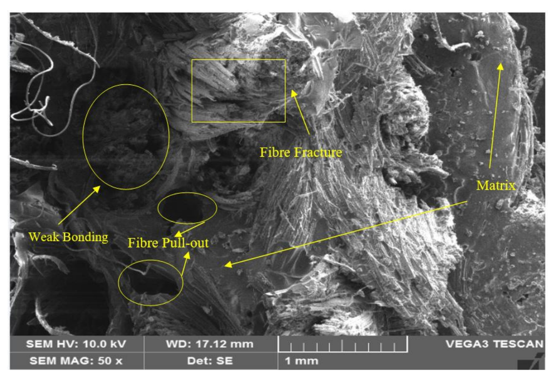


Figure 12: Image of 4% chemically treated composite laminate breaking area

By comparing with untreated and 2% composite laminates, there was more amount unwanted and other impurities were removed because the percentage of concentration increased from 2% to 4%, which led to an improvement in strength and roughness. It also noticed that the fabric surface damaged due to effect of chemical concentration and fabric pullout in bundles and weak bonding takes place.

VI.CONCLUSION

In the above work successfully fabricated the composite laminate by using hand lay-up method and the following conclusions are made.

1. Chemical treatment played a major role for improving the strength and bonding.
2. 4% Potassium Permanganate ($KMnO_4$) treated composite specimen got more tensile, flexural and impact strength has compared with untreated and other set of treated composite specimen
3. Failure analysis analyzed by SEM analysis and found that up to 4% there was continuous improvement in surface modification

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