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EXPERIMENTAL AND MICROGRAPH ANALYSIS OF E-GLASS FIBRE AND BAMBOO, COIR FIBRE POLYESTER COMPOSITES

Rajmohan. B,

rajmohanbose1990@gmail.com

Sunder Selwyn. T, Harineshwaran. A.S, Sivasankaran. S

Department of Mechanical Engineering, PDKVCET, Chennai, Tamilnadu, India

Abstract: Nowadays, Reinforced plastics are highly used in civil and automobile industries instead of steel and aluminium materials to reduce the weight of structural parts. This study aims to compare mechanical properties and SEM micrographs of the synthetic E-Glass fibre reinforced composite with natural fibers bamboo & coir reinforced composite. In this work, an Autoclave Molding machine fabricated Bamboo & Coir fibre reinforced polyester composite material and GFRP. Alkaline treatment was done for natural fibers to improve their mechanical properties. As a result, the composite material shows better mechanical and micrograph properties exposed by Mechanical Properties like Hardness, Flexural strength, impact strength, and Surface topology using Scanning Electron Microscope (SEM). This study Concentrates on using biodegradable natural materials as reinforcing for producing a bettered satisfactory property instead of the synthetic fibre.

Keywords: Bamboo, Coir fibre, E-Glass fibre, Polyester, Mechanical properties, and SEM

1. INTRODUCTION

The growing demand for low-cost materials from renewable sources [1,2,3] that can replace traditional ones has increased interest in biocomposite development. In addition, a significant amount of research and development on natural composites has also been generated in response to certification and legal entity requirements on the use and final destination of synthetic fibres and resins derived from petroleum. Furthermore, the high cost of synthetic fibres and public awareness and sensitivity to environmental preservation contribute to the development of new research activities in this area [1]. A fiber-reinforced polymer (FRP) is a composite material consisting of a polymer matrix embedded with high-strength fibers, such as glass, aramid, and carbon. Natural fibers have recently become attractive to researchers, engineers, and scientists as an alternative reinforcement for fiber-reinforced polymer (FRP) composites. Due to their low cost, reasonably good mechanical properties, high specific strength, non-abrasive, eco-friendly, and bio-degradability characteristics, they are exploited as a replacement for the conventional fiber, such as glass, aramid, and carbon [4,5].

The glass/carbon mat thermoplastic (GCMT) composite was developed to replace the traditional glass mat thermoplastic (GMT) to reduce the weight of the bumper beam [6]. Bamboo fibre has several advantages over other natural plant fibres, including high growth rate, strength, and carbon dioxide fixation. In addition, it is comparable to glass fibre due to

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its light weight, biodegradability, and low cost. The structure and behaviour of bamboo fibres have been studied using SEM, and the following conclusions have been drawn. The industry could use SEM to resolve contamination issues, investigate the component failure, identify unknown particulates, and study the interaction of substances with their substrates [7].

Coir has resistance to chemical and microbial attacks. In addition, because of its high impact strength, low density, low cost, and biodegradability, it can be used as a reinforcing material in place of traditional reinforcing materials such as glass fibres, talc, and mica [8].

On alkali treatment, it was clear that the fiber's mass decreased and its surface area increased until all impurities were eliminated from the fiber's surface. The alkali treatment improves the mechanical and physical properties of the fibre and allows it to be used in composite structures [9]. The fibres were alkali treated, which removed hemicelluloses, lignin, and other impurities from the fibre surface and smoothed it. As a result, the fibre matrix interface, fibre wetting characteristics, and bonding were improved.

Chemically modifying kenaf fibres revealed that alkalization improved mechanical properties. A morphological study was also conducted to evaluate structural changes [10]. The SEM micrographs of untreated and sodium hydroxide (NaOH) treated betel nut fibres show some gaps between the fibre and matrix, indicating that no bonding occurred between the fibre and matrix. In addition, the fibre matrix adhesion of the sodium hydroxide-treated fibre composites was improved. The chemical modification and its influence on the morphological aspects of fibres were confirmed by SEM micrographs [11]. This study aimed to compare the E-GFRP composite and alkaline treated Bamboo & coir fibre composites on the mechanical properties and SEM micrograph.

2. MATERIALS

Polyester has a higher fracture strain than standard polyesters, resulting in composites with superior mechanical properties, impact resistance, and fatigue life [12,14].

Table 1. Properties of polylester Thermoplastic [13]

Properties	**Polyester**
Density (g/cm3)	1.2-1.4
Elastic modulus (GPa)	3.1-3.8
Tensile strength (MPa)	69-83
Compressive strength (MPa)	100
Elongation (%)	4-7
Cure Shrinkage (%)	-

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Water absorption (24h@20°C)	0.1
Cure temperature (°C)	25-150
Izod impact strength (J/m)	2.5
Cost (US $/kg)	3.2-6.4

E-glass fibres are used as a reinforcing material in many polymer products to develop glass fibre reinforced plastic (GFRP), a very strong and lightweight composite material.

Fig 1. E-Glass Fibre, Bamboo fibre and Coconut Coir

Table 2. Chemical Composition of Cellulosic Fibres [13]

Cellulosic fibres	**Cellulose (%)**	**Hemi-cellulose (%)**	**Pectin (%)**	**Lignin (%)**	**Wax (%)**
Bamboo	34.5	20.5	-	26	-
Coir	46	0.3	4	45	-

Table 3. Physical properties of Cellulosic fibres [10]

Cellulosic fibres	**Diameter (mm)**	**Length (mm)**	**Density (kg/m³)**	**Moisture gain (%)**	**Micro fibril angle (degree)**
Bamboo	12-30	2	1500	-	-
Coir	10-460	1.3	1250	13	44

Table 4. Mechanical properties of Natural and synthetic fibres [10]

Fibre type	**Relative density (g/cm³)**	**Tensile strength (MPa)**	**Elastic modulus (GPa)**	**Specific modulus (GPa-cm³/g)**	**Elongation at failure (%)**
Bamboo	0.3-1.1	140-800	11-32	25	2.5-3.7
Coir	1.15-1.46	95-230	2.8-6	4	15-51.4
E-Glass	2.5	1000-3500	70-76	29	0.5

3. FABRICATION METHODOLOGY AND TESTING

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E-Glass fibre reinforced composite specimen, and hybrid natural fibre (bamboo & coir fibre) reinforced composite specimen were prepared layer by layer process (first layer rein then second layer fibre up to our required thickness was achieved) in an autoclave moulding machine[15,16,17,18,19]. A square specimen of 100mm Length*100mm Width*4mm Thickness was moulded by autoclave moulding Technique.

Table 5. Composition of E-GFRP composites

Factors	polyester resin (gram)	E-Glass fibre (gram)	Sic (gram)	Temperature (°C)	Time (min)
Level (Quantity)	120	40	5	70	10

Table 6. Composition of Natural Fibre Composites (NFCs)

Factors	polyester resin (gram)	Bamboo& Coir fibre (gram)	Sic (gram)	Temperature (°C)	Time (min)
Level (Quantity)	120	40	5	70	10

The specimens are cut based on testing standards for Hardness, Flexural, and Impact Strength. In addition, SEM micrographs were studied for GFRP and Bamboo & Coir fibre composites and compared[20-26].

4. RESULT AND DISCUSSION

Because of chemical treatment, the mechanical properties strength conceivably improved. As a result of alkali treatment, the dust and impurities are removed from the fiber surface. Alkaline treatment helps fibres are getting separated from the fiber strands, and the separated fibres create an excellent interfacial adhesion between fibre and matrix resin. Better Interfacial adhesion provides higher mechanical strength to the composites. It showed in SEM micrographs.

Table 7. Mechanical properties of E-GFRP and NFCs

Properties	**E-GFRP**	**Bamboo & Coir fibre**
Hardness (BHN)	58.251	42.724
Flexural strength (MPa)	61.25	55.32
Impact Strength (MPa)	17	15

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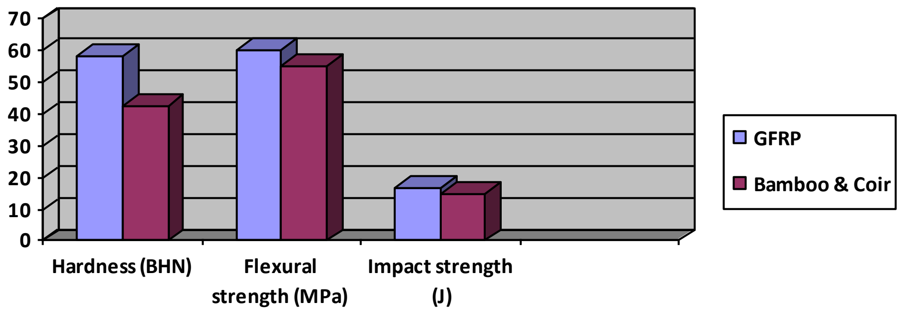


Fig 2. Mechanical Properties Vs. Strength Values

The above results show that E-GFRP composites have higher strength compared to natural fibre composites. But obtained Flexural and Impact strength of natural fibres were close to that of E-GFRP composites.

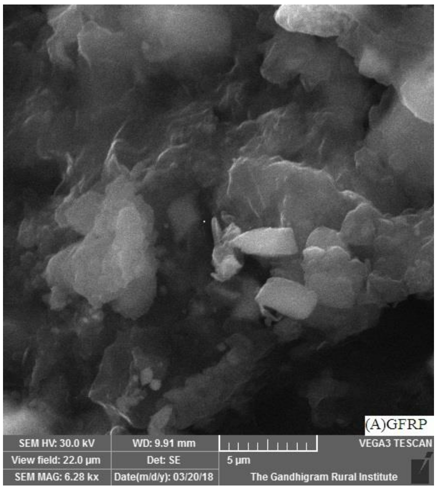
5. MICROGRAPH (SEM)

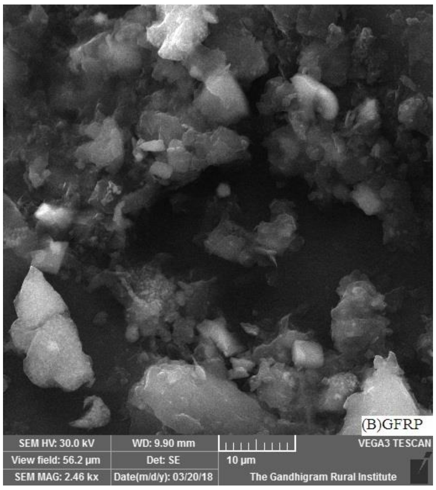
SEM image was taken using a VEGA3 TESCAN SEM machine at The Gandhigram Rural Institute in Dindigul. The surface micrograph was studied for E-GFRP composites and natural fibre composites by changing the view field and image magnification.

Nature of Sample: dry condition

Sample Size : 1 cubic cm & thin film 1*1 cm

5.1 GFRP Micrographs





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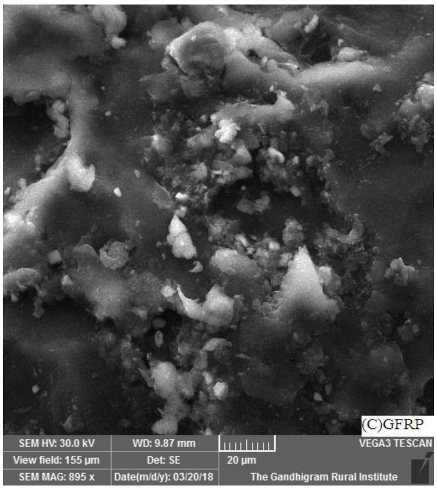
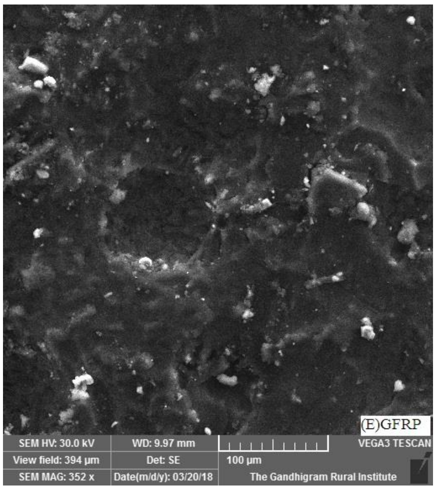




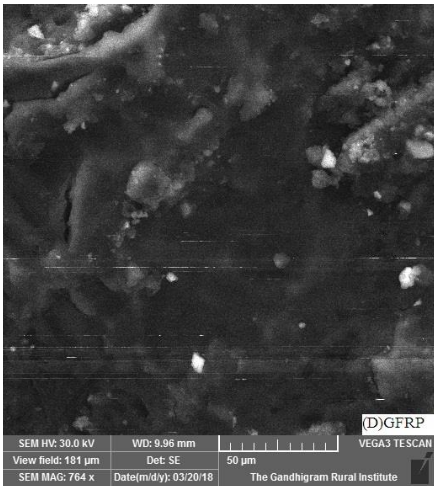
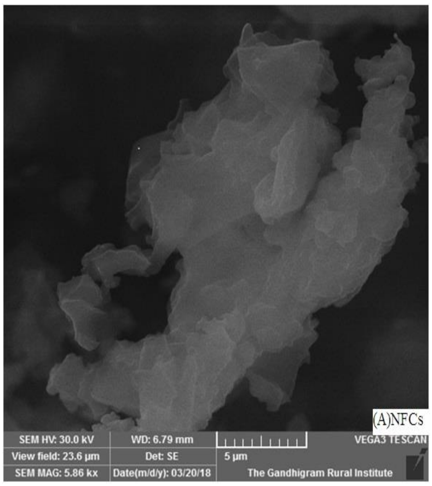
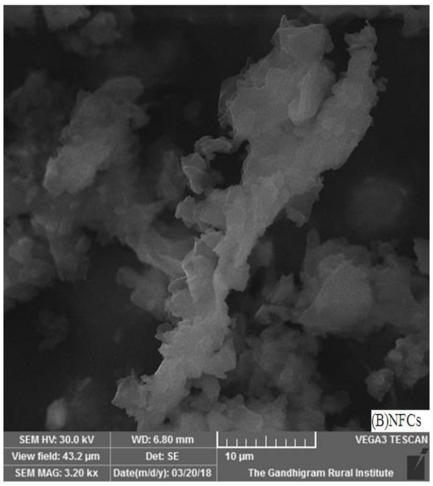


Fig 3. SEM micrograph images showing the top surface of specimens at various magnification: (A) 5µm (B) 10µm (C) 20µm (D) 50µm (E) 100µm

The surface micrograph's SEM image shows a uniform mixture and distribution of resin (polyester), silicon carbide, and glass fibre throughout the sample. Thus it results in better bonding and coherence between glass fibre and resin.

5.2 Hybrid Natural fibre Micrographs





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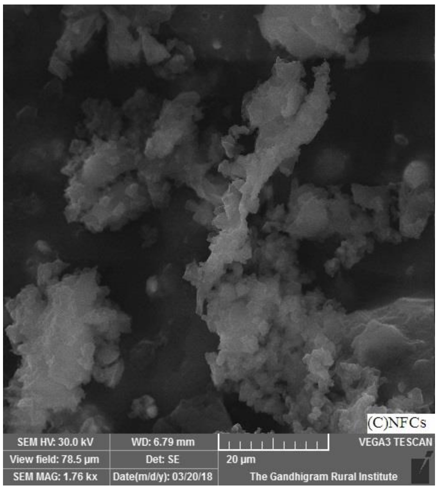

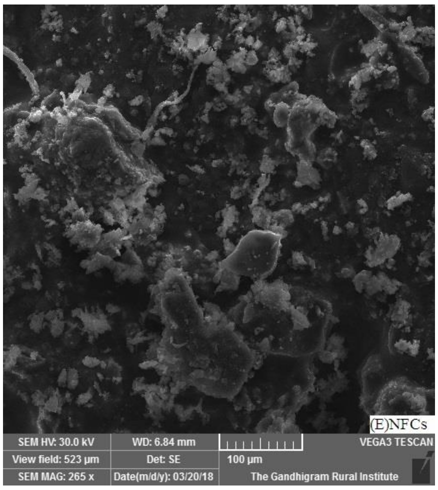

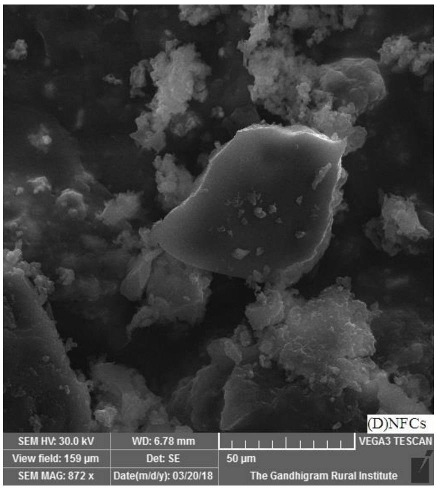

Fig 4. SEM micrograph images showing the top surface of specimens at various magnification: (A) 5μm (B) 10μm (C) 20μm (D) 50μm (E) 100μm

Figure 4 illustrates the surface morphology of the composites. It has significantly more excellent interfacial adhesion between the fibre and matrix. In our observations from fig 3(C) & fig 4 (C), mechanical interlocking occurs between E-GFRP composites as well as natural fibre composites. The SEM image reveals no crack and blows a hole in the sample specimen.

It reveals that the better interfacial interactions improve the hardness, Impact, and Flexural strength of the E-GFRP and NFCs composites.

6. CONCLUSION

Much Investigation has recently developed in the mechanical & microstructure characterization of hybrid composites. This study has evaluated the work that has concentrated on comparing betterment strength and microstructure performance of E-GFRP and hybrid natural fibre composites.

Comparison of hardness between E-GFRP and Hybrid natural fibre composite was 26.66% decreased. Similarly, Flexural strength and impact strength were decreased by 9.70% and 11.76%.

SEM images show that Interfacial bonding is good in these two various composites

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From our overall observation, Hybrid Natural Fibre Composite now compares fairly with E-GFRP in premises of strength, cost, and Biodegradable nature. Furthermore, our results revealed that Hybrid Natural Fibre Composite Flexural and Impact strength percentage variations are nearer that of E-GFRP composites.

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