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EXPERIMENTAL INVESTIGATION OF MECHANICAL PROPERTIES OF UNTREATED NEW AGAVE ANGUSTIFOLIA MARGINATA FIBER REINFORCED EPOXY POLYMER MATRIX BIO-COMPOSITE MATERIAL

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ABSTRACT

In recent years, the natural fibers playing a vital role in worldwide. The main purpose of using natural fiber is biodegradable, cost wise low, easily available and at the same time strength to weight ratio is high. In this work, the Agave Angustifolia Marginata fibers (AAMFs) reinforced composite were made by compression molding machine (CMM) with various proportions of epoxy resin. The manufactured composite laminates were tested through the tensile, flexural, Impact and compression test according to ASTM standards. The results indicated that the composite with 35 weight percentage of the fibers having superior mechanical properties. The compression properties were improved in the 60:40 ratios. The surface morphology shows the great attachment or bonding was not seen between the fibers and epoxy as appeared in 60:40 proportion of composite. The strength of the fiber and composites will definitely improve after the best chemical treatment process.

Keywords

Untreated AAMFs, Epoxy Resin, CMM, Mechanical Tests, SEM, Bio-Composite

Academic Discipline And Sub-Disciplines

Mechanical Engineering- Materials- Natural fiber composite

SUBJECT CLASSIFICATION

Polymer Matrix composite

TYPE (METHOD/APPROACH)

Experimental investigation and analysis

1. INTRODUCTION

Fiber reinforced rubber composites are important both in the end use applications and in the area of research and development. Because of the massive degree in the field of composites, the need to locate a contrasting option to the glass fiber strengthened composites is fast approaching because of its non-biodegrading property. Development of a high-performance composite using natural fibers has been a major area of concern. So, the utilization of natural fibers as reinforcements in composite materials has finding extended applications over the last few years. The attractive characteristics of natural fibers have been their low cost, light weight, high specific modulus and health hazards of composites reinforced with synthetic fibers such as glass, carbon and aramid fibers. These advantages set the natural fiber composites amongst the high-performance composites having economical and eco-friendly [1–3]. The literature of many types of natural fibers including sisal, coir, flax, etc., for use in plastics. They reported that the natural fibers had an advantage of being renewable and also had marketing appeal as well [4]. The kenaf fiber 30wt% reinforced with polypropylene depicted high tensile and flexural modulus. For the jute fiber, reinforced composites, a fiber fraction of 40wt% seems to be an optimum value [5]. The coir fiber content in the composite was optimized and 20% coir content showed higher mechanical properties [6]. In this work, the tensile and flexural behavior of untreated New Zealand flax (Phormium Tenax) fiber reinforced epoxy composite using quasi-unidirectional fibers showed higher modulus and strength both in tensile and flexural loading, when compared to neat epoxy resin [7]. The treated coconut sheath fiber strengthened epoxy composite (TCSE) forces higher mechanical quality and thermal stability contrasted with untreated (crude) coconut sheath fiber fortified epoxy composite (UTCSE) [8]. Mechanical Properties of different length of coir fiber epoxy reinforced composite results was indicate that coir can be used as a potential reinforcing material for much structural and non-structural application [9]. The alkali treated fiber improved the crystallinity index and thermal stability than untreated Alfa fiber [10]. The epoxy based natural fiber reinforced polymer matrix composite were improved the mechanical properties [11-13]. Chemical modification of the fiber has gradually increased the bonding between the resin and fiber. The mechanical properties were increased after the chemical treatment of the fiber than the untreated fiber [14-15].The AAM fiber was treated by alkali (NaoH) and improved properties were gotten in 5 Wt.% of NaoH treated fiber and 65:35 Composites gives better mechanical properties[16-17].

In this research work, the Agave Angustifolia Marginata fiber reinforced composites were manufactured by compression molding machine and mechanical properties (Tensile, Flexural, impact and Compression) were studied different fiber weight fraction and fiber length.

2. EXPERIMENTAL

2.1. Natural fiber materials

Agave Angustifolia Marginata' (AAM) filaments were gathered from Coimbatore, Tamilnadu, India. Greenish-yellow to white in terminal panicles and roughly 5 cm long. The blossom stalks will reach up to 2.5 m in tallness. The Fig. 1. a and Fig. 1.b Shows the AAMFs plant and leaves.

2.2 Extraction procedure of AAMFs

The AAMFs were isolated from the Agave Angustifolia leaves, which were gathered from ranches around the city of Coimbatore in Tamil Nadu, India. Utilizing a mechanical procedure called decortication. In this process, the Agave Angustifolia Marginata leaves were encouraged into a fiber-removing machine called a mechanical decorticator. A schematic chart of a mechanical decorticator appears in Fig. 1.c the machine comprises of a couple of food rollers and a mixer. The leaves were held into the mixer through the foot rollers between a crushing roller and a scrapper roller. The strands were taken away, and the pulps were kept apart. The decorticated strands were dried in the daylight to evacuate the dampness substance, and machine searched for detachment. In this study, the washed AAMFs were dried for 24 h in daylight. The Fig. 1. d shows the untreated AAM fiber

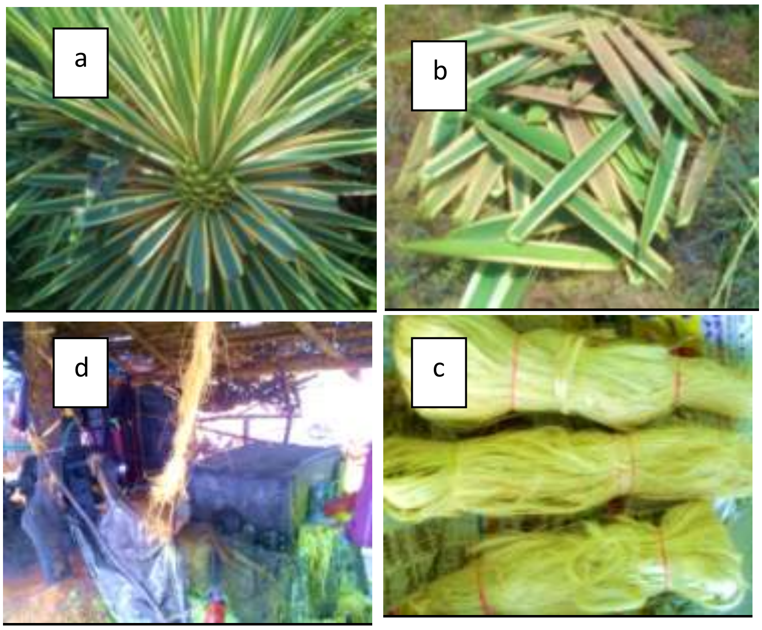

Figure 1. The pictures show that (a) The plant Agave Angustifolia Marginata (b) leaves of Agave anqustifolia Marginata (c) Fiber extracting machine (d) Extracted fiber from the machine (untreated fiber)

2.3 Epoxy resin

Epoxy offers phenomenal attachment, low shrinkage and no unstable matters exist amid curing. Consequently, epoxy resin was utilized as a framework material. Indeed, even at lifted temperatures, they offer the best execution. The resin was arranged with a blended mix of epoxy LY556 and hardener HY951.

2.5 Preparation of composite specimen

The compression molding process was employed for the preparation of composites. The cleansed and dried AAMFs were slashed into various lengths of 1cm, 3cm and 5cm.A known weight of AAMFs of unmistakable length was arbitrarily spread between two steel plates. Caution was taken to get a uniform distribution of fibers. A calculated amount of fiber and resin was taken and hydraulic pressure was applied to molded plates to structure a composite sheet. The shut mold was kept under load condition for 24h.The composite plates were made in the size of 300mm×150mm×3mm in different ratios of the matrix (60:40, 65:35 & 70:30).

2.6 Mechanical properties of composites

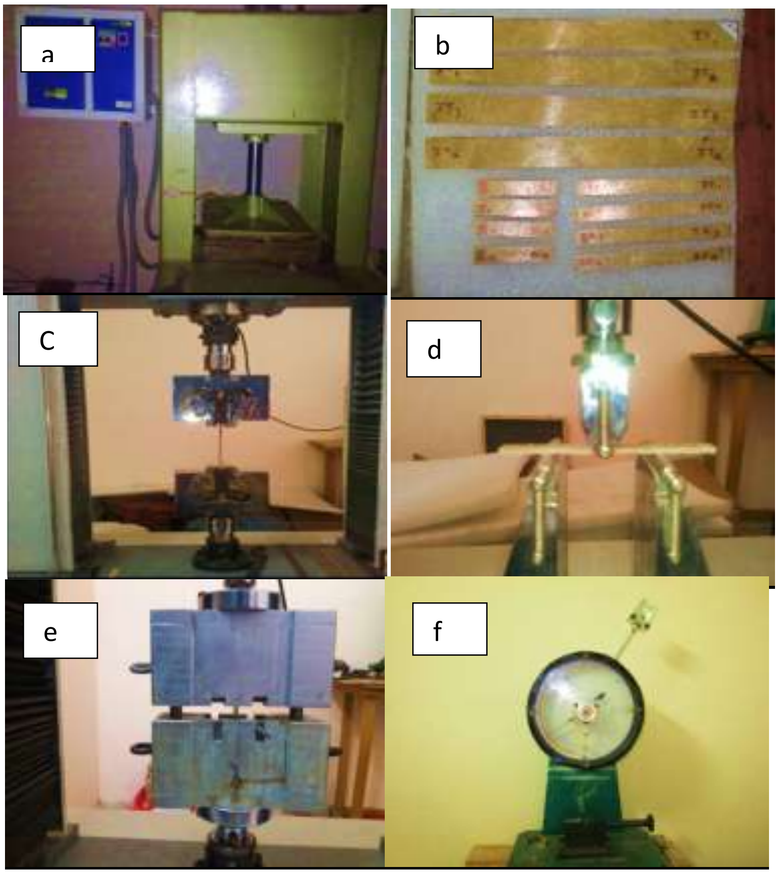

Figure 2. The pictures show that (a) Compression Molding machine (b) ASTM standard Testing Specimens (Tensile, Flexural & Impact) (c) Tensile Test (d) Flexural testing (e) Compression testing (f) Testing the impact

2.6.1. Tensile testing of the composite

The tensile test samples were produced using the composite plate as per the ASTM D 638-03 - Type I standard. Elastic test specimens were tried KALPAK UTM KIC-2-1000-C worked with a 100KN load cell with advanced load control. The cross head rate was 2 mm/min and the gage length kept up was 50 mm. The tensile test was conducted at 28 °C and at a relative moistness of 50 ± 2%. The loads and the relating strains were noted. The Fig. 2. b shows the specimens for tensile, flexural and impact testing. The Fig. 2. c shows the tensile testing system.

2.6.2. Flexural Testing of the Composite

The flexural test specimens were produced using the composite plate as per the ASTM D 790-03 standard. The KALPAK UTM KIC-2-1000-C 100 KN was utilized for directing the flexural test at 28 °C and at a relative dampness of 50 ± 2%. The cross head rate was 2 mm/min. The flexural modulus values were determined. Five specimens were sampled for every creative activity and the average quality was accounted. Fig. 2. d shows the flexural testing arrangement.

2.6.3. Compressive testing of the composite

The compressive strength test specimens were produced using the composite plates according to the ASTM D3410 standard. The extent of the specimen was 25 mm x 3 mm x 150. The test was led by 28 °C, at relative stickiness of 50 ± 2% and at a crosshead velocity of 2 mm/minute. The load cells and the strain gage values for the comparing loads and strains were noted. Five specimens were sampled for every testing. The Fig. 2. e shows the compression testing system.

2.6.4. Impact testing of the composite

The Impact test models were produced using the composite plates as per the ASTM D 256-05 standard. The Izod impact analyzer was utilized for directing the effect test at room temperature. Five specimens were tried for every test and the mean quality was accounted. The Fig. 2.f shows the arrangements for impact testing.

3. RESULTS AND DISCUSSION

3.1. Tensile properties of untreated Agave Angustifolia Marginata (AAMFs) fiber

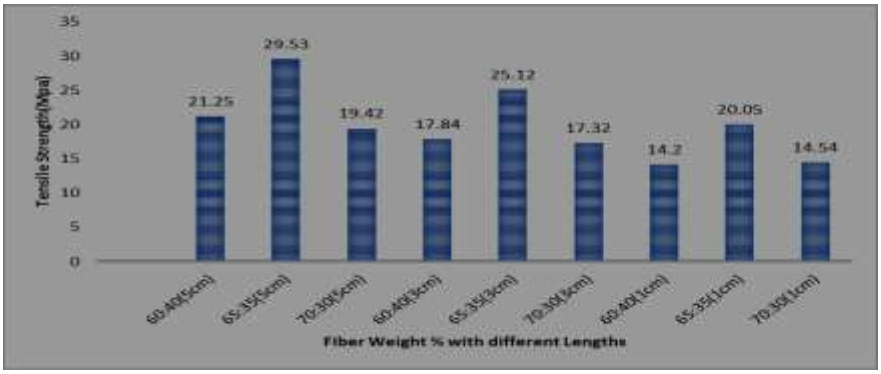

Figure 3. Fiber weight % with Different lengths in cm Vs Tensile strength in Mpa

Tensile Strength of a different weight % of the fibers with various lengths was inspected. The Fig. 3 shows the plot between Fiber weight rate and tensile quality. It indicates that composite produced with 35 fiber wt% and 5 cm length and 3cm length exhibit the higher strength of 29.53 Mpa and 25.12 Mpa. The force was diminished when fiber weight % was increased than 35%, this is because of lessening in the resin content.

3.2. Flexural properties of untreated Agave Angustifolia Marginata (AAMFs) fiber

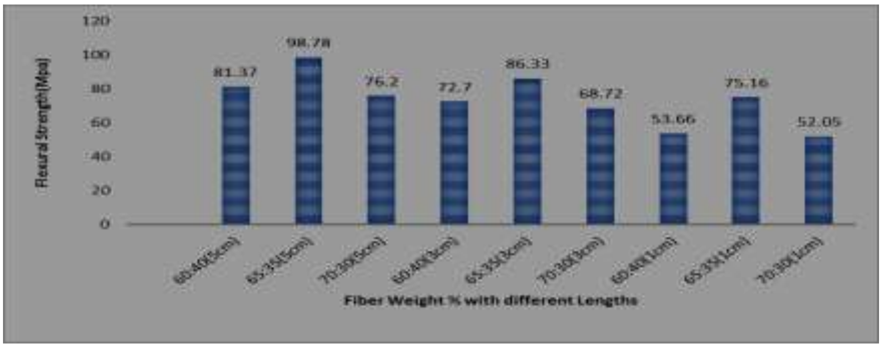

Figure 4. Fiber weight % with Different lengths in cm Vs Flexural strength in Mpa

The variation of flexural strength with the distinctive weight percent of Agave Angustifolia fiber composites with various fiber lengths appear in Fig 4. The flexural strength estimations of Agave Angustifolia Marginata fiber composites have increased by expanding fiber length up to 5cm and fiber weight up to 35 %. The Past which the flexural strength was diluted. At a low fiber weight rate (30%) and for 1cm long fiber, the flexural strength of composites was observed to be more depressed. It can be seen that the most extreme flexural strength was 98.78 Mpa. Agave Angustifolia Marginata fiber composites having 5cm (basic fiber length) fiber and 35% (ideal fiber weight percent) fiber weight represented the greatest flexural property**.**

3.3. Impact properties of untreated Agave Angustifolia Marginata (AAMFs) fiber

The impact strength of the composites was found in various weight% of fibers and various fiber lengths and the results are shown in the Fig.5. The most extreme impact strength was 15.12 J/cm^2. It was attained for a 35% fiber weight and 5cm long fiber. At the period when the fiber weight percent of the composites increased more than 35%, a slight falling in impact strength was kept.

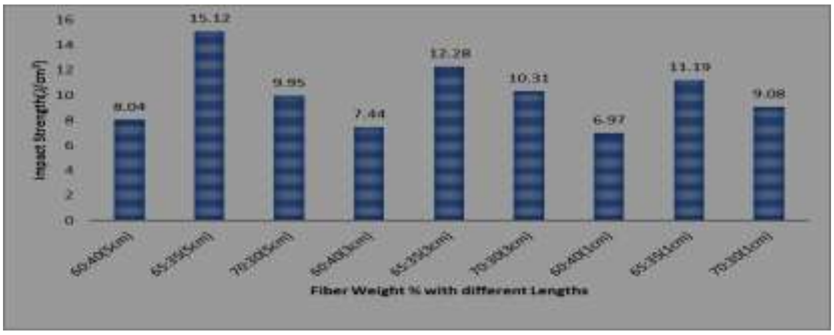

Figure 5. Fiber weight % with Different lengths in cm Vs impact strength in J/cm^2

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3.4. Compressive properties of untreated Agave Angustifolia Marginata (AAMFs) fiber

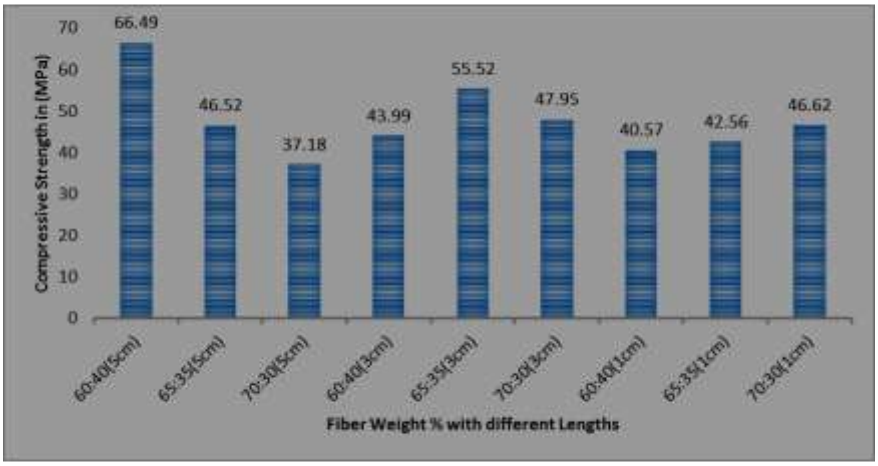

Figure 6. Fiber weight % with Different lengths in cm Vs Compressive strength in Mpa

The Fig.6 shows the variation of compressive strength against fiber weight percentage and fiber length. The compressive strength of the composites was found to increase with the development in the weight % of fibers and the highest compressive strength was 66.49 Mpa, which was acquired for a 40% fiber weight and 5cm long fiber. Exactly, when the fiber weight percent of the composites decreased than 40%, a slight reduction in compressive strength was appeared.

4. SCANNING ELECTRON MICROSCOPE ANALYSIS

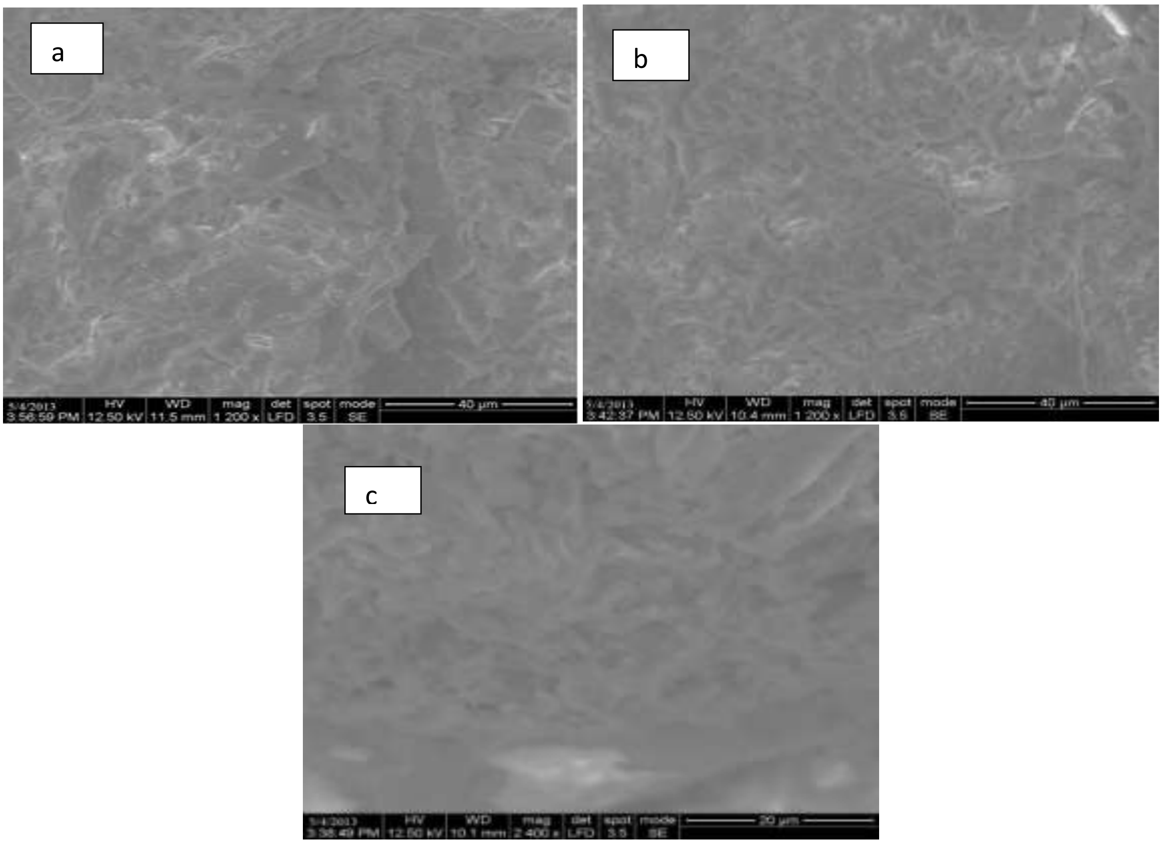

Figure 7. SEM Micrographs of the Fiber reinforced composites (a) 60:40Insufficient bonding (b) 65:35 Rich matrix bond (c) 70:30 more resin and pitiable bonding

Fig.7 shows the SEM Micrographs of the composites containing 60:40, 65:35 and 70:30 wt. percentage fiber reinforced composites. The Poor interfacial bonding was observed in 60:40 and 70:30 samples, but good bonding were observed in 65:35 composite sample.

5. CONCLUSION

The work plainly demonstrated that the Agave Angustifolia Marginata fiber (AAMF) will do in the future as the option material for alternate unadventurous materials because of its better mechanical properties.

The following are the important conclusions derived from this probe.

- The epoxy reinforced with Agave Angustifolia fiber composite was examined in various proportions and the 65:35 weight percentage fiber reinforced composite with 5cm fiber length was giving critical change in mechanical properties of tensile, flexural and impact.
- The 60:40 proportions strongly indicate the good compressive strength. The outcome prescribes that the Agave Angustifolia Marginata raw fiber has tremendous plausibility to fabricate the fiber reinforced polymer matrix composites and it is delivering more applications in different areas and it was one of the biodegradable stuff.
- SEM Image was demonstrating virtuous matrix seen in the 60:35 ratios and a poor holding between the fiber and resin seen in all other proportions. At the stage when the interface holding is poor, the mechanical properties of the composites will be the second rate. To increase the mechanical properties, the raw fibers recommended for chemical treatment to improve the bonding between fiber and resin.

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