International Journal of Disaster Recovery and Business Continuity
Vol. 12, No. 1, (2021), pp. 533-538

Effect of Fiber Loading on Tensile and Hardness Behaviors of Turkey Feather Fiber Reinforced Polyester Composites

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Abstract

This work presents an influence of various fiber loadings on tensile properties and hardness of turkey feather fiber reinforced polymer (TFFRP) composites. The composites were fabricated using a compression moulding technique and a varying weight percentage of 20, 30 and 40 fiber. The composite plates were cut into test samples according to ASTM standard methods for tensile and hardness behaviors. From the results obtained, 30wt% TFFRP composite sample recorded better tensile strength, when compared with other counterparts. This was attributed to a better fiber-matrix interfacial adhesion. The TFFRP composite recorded increased hardness value when fiber loading was increased from 20 to 40 wt%.

Keywords: Turkey feather fibers (TFF); Polyester resin; Tensile strength; Tensile modulus; Hardness.

Introduction

Government of various countries have taken effort to implement strong rules and regulation to protect the environment, and by providing freedom to environment friendly composite materials. The composite material is mostly developed by synthetic fibers, the other best alternative synthetic fiber is natural fiber, to improve the mechanical properties for low load application [1]. Some of natural fibers are banana, sisal, coconut sheath and jute are used as reinforcement for the application of automobile, aerospace, consumer products, building structures etc., Natural fibers are having many advantages over synthetic fibers like light weight, low density, high strength, good thermal and insulation material, low pollutant emissions, cost effective, easy availability and biodegradable.

Jowar, sisal and bamboo fiber reinforced polyester composites have been fabricated and their modulus properties compared. It was observed that jowar (sorgum) reinforced polyester composite was superior to the other two in terms of strength and rigidity [2]. Composites have been fabricated by randomly placed coir fiber in polyester resin. From the results obtained, better flexural properties than the pure polyester were recorded [3]. The fiber loading concentration between the matrix and fibers possessed a better property with shorter fibers when compared with longer fibers [4]. Jute fiber with nanoclay filled hybrid polyester composites recorded a better mechanical strength at optimum volume fraction of 15 and 5 wt% of jute fiber and nanoclay [5].

Animal fibers specifically contains proteins such as sheep wool, bird feathers and human hair. Natural fiber reinforced composite possess many mechanical properties such as

ISSN: 2005-4289 IJDRBC

fiber length, fiber weight fraction, fiber strength, modulus and the strength of interfacial bond between fiber and matrix. Feather fibers are having some unique characteristics as soft, durable, high mechanical strength, resilience and thermal resistance properties [6]. Feather fibers are used to reinforcing it with different type of polymer materials for various applications. Polymethyl methacrylate based composites was fabricated using chicken feather fiber as reinforcement which enhanced the properties of tensile strength and modulus due to uniform distribution of chicken feature fibers in the matrix material. It was reported through the morphological studies and it suggested to implementing the composite for dental applications [7].

In this present work, an attempt was made to fabricate the composite using a compression moulding technique, turkey feather fiber and polyester resin as reinforcement and matrix materials. The tensile properties and hardness of the fabricated composite samples with different weight fraction of fiber were studied.

Materials and Methods

The turkey feather fiber reinforced polymer (TFFRP) composites were fabricated, using polyester resin reinforced with TFF. The tensile properties and hardness of the fabricated composite samples were studied.

Materials

Indian TFF and isophthalic unsaturated polyester resin were used as reinforcement and matrix materials, respectively. The turkey's feather fiber was collected from local areas in/around Virudhunagar region, India. Dust and water-solubles were washed out with normal water. The turkey's feather fiber is washing and rinsing in a normal tap water and its temperature is around 25^{o}C. The thoroughly washed reinforcement material was dried at room temperature. It was cut into similar lengths of approximately 20 mm. The TFF is chopped for 20mm length and its shown in Figure 1. Polyester resin and its additional ingredients: catalyst (MEKP) and accelerator (CN), were used to fabricate the TFFRP composites, and were obtained from M/s VB Pvt. Ltd, Madras, TN, India.

Fig. 1. TFF used as a reinforcement.

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Fabrication of composites

The compression moulding technique was employed to prepare the composite plates. Initially, the steel mould of 300 x 125 x 3 mm was cleaned manually, using cloth material. Wax was applied on the interior face of the mould to allow demoulding of the fabricated composites without any damage. The TFF were randomly arranged in the mould cavity. The polyester resin, 2% MEKP and 2% CN as catalyst and accelerator respectively, were manually mixed by stirring in a glass beaker and poured over the fibers in the mould cavity. The mould was closed manually and compressed with the pressure of 16MPa by using a universal testing machine. The compressed mould was kept in a universal testing machine for the next 24 hours at a constant load and room temperature. The prepared composites were cut into appropriate dimensions required or recommended to study the tensile properties in accordance to the ASTM standards [8]. The TFFRP composites of three different fiber loadings of 20, 30 and 40 wt% were prepared by combining the TFF and the polyester resin, using the same procedures. A typical fabricated composite plate is shown in Figure 2.

Fig. 2. Fabricated TFFRP composite plate.

Tensile and Hardness testing of the composite

ASTM-D3039 standard is used to perform the tensile test by UTM (universal testing machine) (INSTRON Series 3382). The size of the specimen is 200mm × 20mm × 3mm as shown in Figure 3. The cross head speed is kept at 5 mm/min with the load cell capability of 400 kN [9]. For each situation, five samples were tested and average reading was tabulated. Testing of tensile specimen gives more knowledge like final strength and elongation at break. These properties bring up the behavior of materials under loading in tension. Tensile take a look at determines the strength of the given sample. During a tensile test the sample is placed between the grippers and load is given gradually to pulled the sample apart till the breaking point. Hardness of the composite was measured as per ASTM D-2240 using Shore D hardness tester. Hardness measuring instrumentation employing a sharp needle that was intended directly onto the surface of sample to determine the hardness. Information were found over five completely different positions. Information revealed during this work are computed as averages of the activity performed for five samples.

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Fig. 3. TFFRP composite samples before tensile test.

Results and Discussion

Tensile strengths

The tensile strength measurements were conducted for 20, 30 and 40 wt% turkey feather fiber reinforced polyester composites samples. Five samples were tested for each category and the average values were reported. The tensile strengths of the 20, 30 and 40 wt% TFFRP composites were 11.07, 15.6 and 11.3 MPa, and their corresponding tensile moduli were 1.79, 2.09 and 2.4 GPa, respectively. From Figure 4(a), it was observed that the highest tensile strength was obtained with 30 wt% TFFRP composites due to better interfacial bonding between the 30 wt% SWF and the polyester polymer matrix with best load transfer from the matrix to fibers. The tensile moduli of the TFFRP composites were gradually increases from a lower fiber content to higher wt% TFFRP composites, as shown in Figure 4(b). This trend was observed due to the strain variation of the TFFRP composites.

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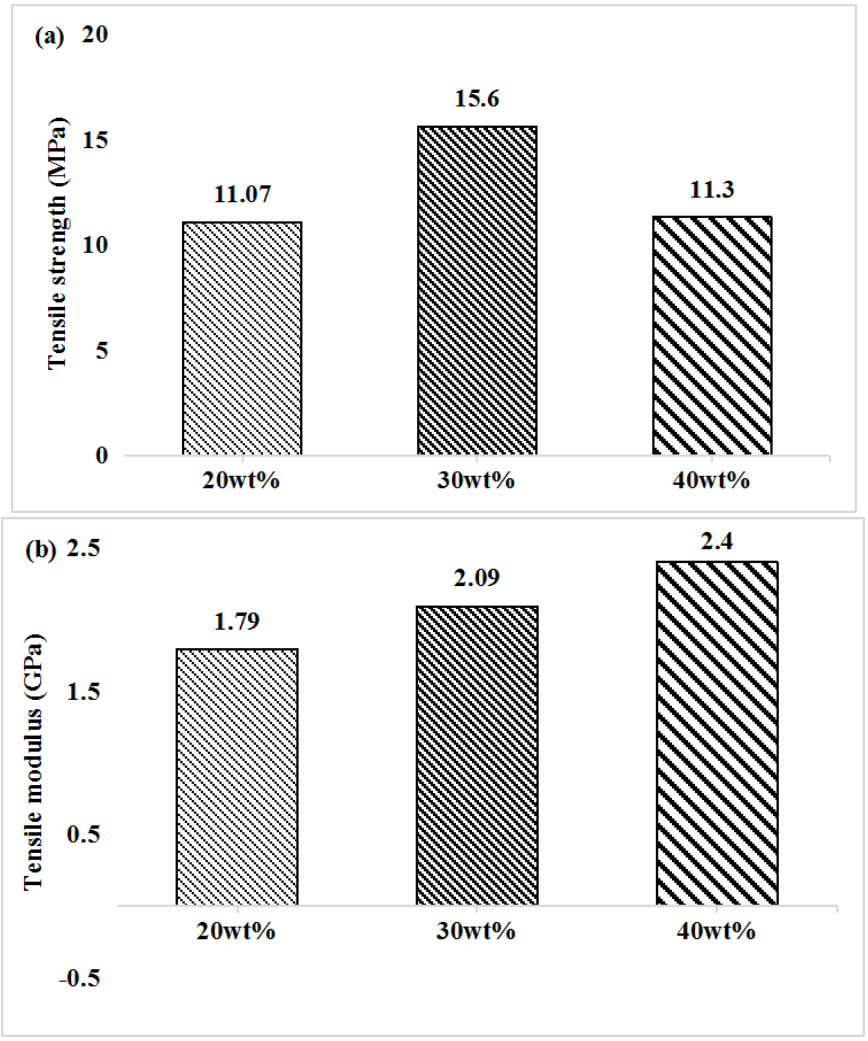

Fig. 4. Tensile properties of the various fiber loaded TFFRP composite samples, showing their tensile. (a) strengths and (b) moduli.

Hardness value

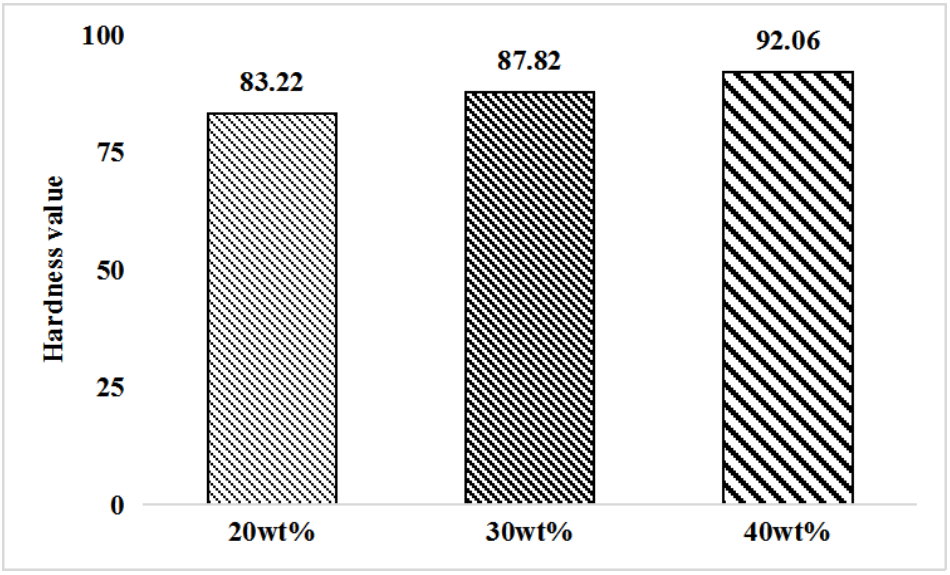

Fig. 5. Hardness value of the various fiber loaded TFFRP composite samples.

ISSN: 2005-4289 IJDRBC

The hardness measurements were conducted for 20, 30 and 40wt% of turkey feather fiber reinforced polyester composites samples. Five different locations were taken to measure the value of hardness on each category and the average values were reported. From Figure 5. it was observed that, hardness value of TFFRP composites were gradually increased from lower fiber content to higher wt% of fiber loading. It shows that increase in fiber loading increases the hardness of composites, and also the nature of composites was more brittle.

Conclusions

From the above experimental results the following conclusions were made.

- The turkey feather fiber reinforced polymer composites were successfully fabricated using compression moulding technique with varying fiber weight percentage.
- The highest tensile strength was obtained on 30 wt% TFFRP composites due to better interfacial bonding and load transfer between the matrix to fibers.
- The hardness value of TFFRP composites were increased when the fiber loading was increased from 20 to 40 wt% .
- The turkey feather fiber is a better alternative to synthetic fiber for low load applications and it's easy to biodegradable and eco-friendly to nature compare to synthetic fiber.

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ISSN: 2005-4289 IJDRBC