Volume-4, Issue-9, Sept-2015 • ISSN No 2277 - 8160

Research Paper | Engineering

Study The Effect of Weight Fraction of Coconut Coir Fiber for Composites Reinforced with Glass Fiber

Rafah A.Nasif | Applied Science Department, University of Technology, Baghdad, Iraq

ABSTRACT

This search was carried out to study the effect of weight fraction of coconut coir fiber (0,5,10,15,20 wt%) on the mechanical properties of unsaturated polyester composites reinforced with glass fiber (with constant weight fraction 25%) . the coir fibers were treated with NaOH and both treated ad untreated coir fibers were characterized by Fourier Transform Infrared (FTIR) spectroscopic analysis.

Some mechanical tests were carried out like: tensile strength, impact strength and flexural strength. The results show that when the weight fraction of coconut coir fiber increased, the values of impact and flexural strength increased, while the values of tensile strength decreased.

KEYWORDS : coconut coir fiber, glass fiber, composites materials, mechanical properties.

Introduction

The term composite can be defined as a material composed of two or more different materials, with the properties of the resultant material being superior to the properties of the individual materials being superior to the properties of individual material that make up the composite. A composite material consists of two phases. It consists of one or more discontinuous phases embedded in a continuous phase. The discontinuous phase is usually harder and stronger than the continuous phase and is called the "reinforcement" or "reinforcing material", whereas the continuous phase is termed as the "matrix". The matrix is usually more ductile and less hard. "Matrix" is composed of any of the three basic material type that is, polymers, metals or ceramics.

Glass Fiber Reinforced Polymers (GFRPs) is a fiber reinforced polymer made of a plastic matrix reinforced by fine fibers of glass. Fiber glass is a lightweight, strong, and robust material used in different industries due to their excellent properties [1,2]. Among all reinforcing fibers, natural fibers have gained great significance as reinforcements in polymer matrix composites. Depending upon the source of origin, natural fibers are classified as plant, animal and mineral fibers. Recently, due to the growing global energy crisis and ecological risks, natural fibers reinforced polymer composites have attracted more research interests. The main advantages of natural fibers are their availability, biodegradable, renewable, environmental friendly, low cost, low density, high specific properties, good thermal properties and enhanced the energy recovery, low energy consumption, non-abrasive nature and low cost. A great deal of work has been carried out to measure the potential of natural fiber as reinforcement in polymer such as jute, coir, bamboo ,sisal, banana and wood fibers have been reported. Among the natural fibers, coir could be used as reinforcement, because of its hard-wearing quality, durability and other advantages, for any type of the polymer matrix[3,4].

Processing & characterization of jute/glass Fiber reinforced epoxy based hybrid composites was analyzed by Janaki [5]. Thew and Liao [6] investigated the characterization of bamboo-glass fiber reinforced polymer matrix hybrid composite. Verma etal [7] examined the composites of glass/modified jute fabric and unsaturated polyester resin. Studies on mechanical performance of biofiber/glass reinforced polyester hybrid composites were analyzed by Mishra , etal [8]. Sreekala etal [9] studied the mechanical performance of hybrid phenol-formaldehyde-based composites reinforced with glass and oil palm fibers. Mechanical properties of palmyra/glass fiber hybrid composites was investigated by Velmurugan and .banana-glass hybrid fiber reinforced polyester composites.

The main goal of this work is to study the effect of coir fiber content on the mechanical properties of the unsaturated polyester composites reinforced with glass fiber for different weight fraction.

Experimental Work

1-Materials

The unsaturated polyester (UP) resin was used, the curing of (UP) was done at room temperature (25C°) by the incorporation of 2 volume percent methyl ethyl ketone peroxide (MEKP). A 1% (volume percent) cobalt naphenate was added as a catalyst to accelerate the hardening process (molecular formula $C_{22}H_{14}O_4Co$, density: 0.921g/ml, melting point: 140 C°, boiling point >150 C°).

The coir fibers were obtained from the coconut husks abstracted from the coconut fruits naturally grown in Thailand. The chemical composition and mechanical properties of the coir fiber are presented in tables 1 and 2 respectevily.

Glass fiber fabrics were used as reinforcement in composites preparation; the woven fabric was supplied by TeximpiantiS.p.a. with thickness of 0.22 mm and weight of 290 g /cm^2.

2- Preparation of coir fibers

The fibers were washed with distilled water and then dried at 80 for several hours to get rid of the moisture. They were treated with 5% of NaOH to achieve a good adhesion with the matrix. They were washed again with distilled water and dried at 80 for several hours. Finally, they were cutted to about 10mm (whickers).

3- Sample preparation

The composites materials samples were prepared by conventional hand lay- up technique. Hardener and catalyst were added to unsaturated polyester for getting the sample as fast as possible. Contents were mixed very well to avoid bubbles. These contents were reinforced with coir fibers with different weight fractions (5, 10, 15 and 20%). A glass mould having demotions of 150*150*10mm is used for composite fabrication. The mixture was pured into mold slowly in order to avoid air trapping. The mixture was left for some time so that it becomes a little tacky. After that, the woven glass fiber was laid on the matrix layer, which was covered by another layer of matrix by puring the matrix slowly onto the surface of the glass fiber. Three layered composite was cured at room temperature at constant load (4 kg) for 24 hours until it was dried.

Tests

Tensile measurement

The tensile strength was carried out at room temperature by INSTRON tester (1195) testing machine with gage length of (32mm), applied load of (50Kg) with speed of (12.5mm/min). Measurements dimensions of tensile bar were: length 32mm; width 7.8mm and thickness 3.2 mm according to ASTM-D638.

Flexural test

This test was carried out with the hydraulic piston, its type is ley Bold Harris, No. 36110. The measurement dimensions of Flexural specimen was: length 15 cm and width: 3 cm based on ASTM-D790.

Impact strength

The charpy impact test on unnotched specimens was determined using (5 Jules) pendulum impact testing machine. The measurements dimensions of impact specimen was: length 55mm and width 10 mm according to ISO-179.

Infrared spectroscopy (FTIR)

The prepared untreated and treated coir fibers were analyzed with SHIMADZU spectrophotometer. To obtain FTIR spectra, 10 scans were collected for wave number

ranging from 4000 to 400 cm^{-1}.

Results and Discussions

Tensile strength

The influence of fiber loading on tensile strength of composites is shown in Figure (1).It is evident from the Figure the tensile strength of composites decreases with increase in fiber loading. This is because the brittleness of the fibers which contributed to low mechanical strength because higher fibers contain higher possibilities of the fibers to sustain higher loads. This result reflects the lack of interfacial adhesion between matrix and fibers which behave like voids in the continuous phase. However this behavior make the structure become more flexible [14] This agrees with the conclusion of earlier work Rao and Rao [15]and Janaki D.[5] that coir fibers do not enhance the tensile strength of composite.

Flexural strength

Flexural strength for all composites were reported in Figure 2. It can be seen that flexural strength increases with increasing fiber content for all composites. This is behavior is similar to a result reported by Prakash T. [16] that it clearly indicates that inclusion of glass fiber improves the load bearing capacity and the ability to withstand bending of the composites. Also, the treatment leads to the removal of impurities from the fiber surface after treatment which leads to the better adhesion of the fiber with the matrix [17].

Impact strength

Figure (3) shows the variation of impact strength with coconut coir fiber load. It can be seen that impact strength values increases with increasing fiber content for all composites**.** It is because that the impact energy level of the composites depends upon several factors such as natural of the component, geometry, fiber arrangement and fiber matrix interface. Presence of the fiber in the matrix requires high energy to initiate crack and hence there is increase in impact strength [16] . Similar observations have been reported by Velmurngan R. and Manikandan V.[10] and Goud G.and Rao R.[18].

FTIR analysis

Figures (4) and (5) show the FTIR spectra of untreated and alkali treated coconut coir fibers. In spectra of untreated coir fibers Figure (4), the peak at 3313.82 cm^{-1} was due to hydrogen bonded O-H stretching and this group increases to 3362.04 cm^{-1} I the case of alkali treated coir fibers. In both spectra of untreated and alkali treated coconut coir fibers, there was no change in the peak at 2935.76 which is related to the (C-H) in aromatic and alkanes. In the spectra of alkali treated coir fibers, there was disappearance peak at 1726.35 cm^{-1} associated with (C=O). This was due to the removal of hemicelluloses found o the fiber surface. This phenomenon has been verified by BrigidaA. etal .In the case of treated fibers peak position 1365.65(C-O), for untreated fiber peak position at 1263.42(C-OH), here shifting of bonds accure.

Conclusions

The hybrid composites of coconut coir fibers and glass fibers were fabricated by conventional hand-lay-up technique. The results have shown that values of impact and flexural strength increased as the weight fraction of coir fiber increased, while values of tensile strength decreased. Due to the removal of the surface impurities and cementing material like lignin and hemicelluloses, separation of the ultimate cells has increased. This leads to the increase in effective surface area of the fiber to become more compatible with the matrix.

Table 1. Chemical composition of the coir fiber [12]

Chemical composition and microfibrillar angle of the coir fiber	Unit (weight %)
Lignin	40-45
Cellulose	32-43
Hemi cellulose	0.15-0.25
Pectin	3-4
Water soluble	5
Ash	2
Micro angle(degree)	30-49

Table 2. Mechanical properties of the coir fiber [13]

Mechanical properties	Coconut coir fiber
Density g/cm^3	1.2
Elongation at break %	30
Tensile strength MPa	175
Young modulus GPa	4-6
Water absorption %	130-180

Figure 1 The tensile strength of the composites

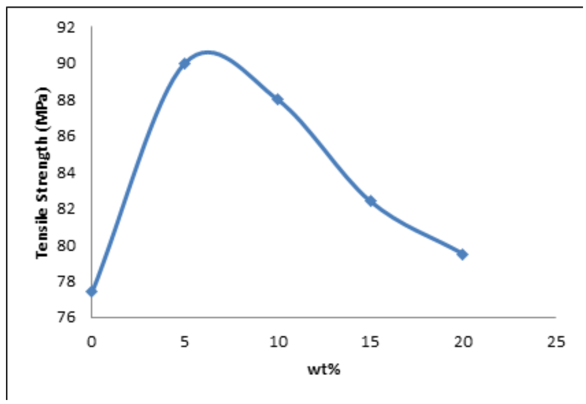

Figure 2 The flexural strength of the composites

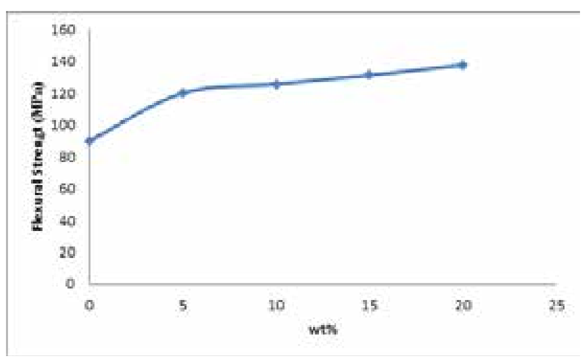

Figure 3 the impact strength of the composites

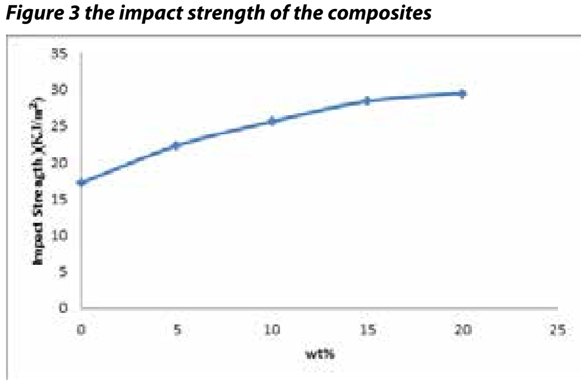

Figure 4 FTIR for untreated coconut fiber

Figure 5 FTIR for NaOH treated coconut fiber

REFERENCES

1- K.Alagarraja,A.Dhamodharan ,K.Gopinathan,R.Mathan Raj , and K.Ram Kuma: J. Mech. Civil Eng. 12(2010) 27. | 2- S. Das : M.Cs. Thesis, Physics Science, National Institute Of Technology, Rourkela ,Republic of India (2012). | 3- M.John, M. J., & R.D.Anandjiwala: J.Poly. comp.29 (2008) No.2,187 | | 4- I.Siva I, J.T.Winowlin Jappes, I. Sankar,S.C. Amico and D.Ravindran : J.Manu.Eng. 8 (2013) No.1,060. | | 5- J. Dehury: M.Cs. Thesis, National Institute Of Technology, Rourkela ,Republic of India (2013) | 6- M.M.Thwe& K. Liao: J. Mat.Sci. Let.19 (2000) 1873. | | 7- I.K.Varma, S.R. Anantha Krishnan &S. Krishnamoorthy: J.Comp. 20 (1989) No.4, 383. | | 8- S. Mishra, A.K. Mohanty, L.T.Drzal, M., Misra, S.Parija, S.K.Nayak, & S.Tripathy: J.Comp. Sci. Tech.36 (2003) No.10,1377 . | | 9- M.S.Sreekala, ,J. George, M.G.Kumaran& S.Thomas: J.Comp. Sci. Tech.62 (2002) No.3,339 . | | 10- R.Velmurugan& V.Manikandan: J. App.Sci.Manu. 38 (2007) No.10, 2216. | | 11- L.A. Pothan,C.N. George, M.J.John& S.Thomas:J.Rein.Plas.Comp.29 (2010) No.8, 1131. | | 12- N.Ayrilmis, S.Jarusombuti, V.Fueangvivat, P. Bauchongkol, and R. White: J. Fib. Polym. 12(2011) No.7, 919. | | 13- L.A. Pothana,Z. Oommenb and S.Thomasc:: J.Comp. Sci. Tech.63 (2003) No.3,283 . | | | 14 - P. N. Naveen1 and M Yasaswi1: : J.Mech.. Eng. Rob.Res. 2 (2013) No.1. | | 15- S.M.Sapuan,M. Harimi and M.A.Maleque : : Arabian J. Sci. Eng..28 (2003) 171 . | | 16- P. Tudu: M.Cs. Thesis, Physics Science, National Institute Of Technology, Rourkela ,Republic of India (2009). | | 17 - V.Vinay : M.Cs. Thesis, Physics Science, National Institute Of Technology, Rourkela ,Republic of India (2013) | | 18-G. Goud &R. Rao:Bull. Mat.Sci. 35 (2012) No.4, 595. | | 19- A.I.S. Brígida a, V.M.A. Calado b, L.R.B. Gonçalves c, M.A.Z. Coelho:.J.Carb.Poly .79 (2010) 832. | | |