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Research article

Banana fiber and pet bottles waste reinforced polymer composites

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Abstract

In this study, polymer composite specimens were produced by using glass fiber and polyester reinforced waste banana fibers and PET bottle. Initially, a mold was prepared in order to produce the composite specimens. Predetermined amounts of glass fiber and polyester including waste banana and PET bottle were used to produce the composites. The produced composite specimens were subjected to tensile tests. Additionally, macrostructure of the composites were also examined. The obtained results are discussed in this study.

Keywords: *Polymer composite, banana fiber, PET bottle*

1. Introduction

Composite is a combination of at least two different materials. Composites offer superior properties when compared to their essential components. Three dimensional nature is obtained with combining components that any of the components does not exist this desired property alone. In other words, the intended purpose is producing a material which has superior properties that any of components does not have. Today, the use of composite materials is increasing very quickly. The desired properties of matrix element are work environment, strength, high stiffness, heat resistance and insulation. These superior properties strengthen composite materials to the fatigue life conditions. [1-3].

Since the early periods, the vegetable or animal fibers have been added to the brittle materials in order to increase their ductility and to reduce brittleness. One of the best examples of these attempts is known as mud-brick material. In the production of mud-brick, straw, clay, mud, branches of the vine stalks and fibers may be included to increase the strength during use. In practice, the composite materials are generally planned to develop one or more of the following features: mechanical properties (modulus of elasticity, yield strength, tensile and compressive strength, hardness and impact resistance) [4-6], fatigue resistance, wear resistance [7], corrosion resistance, fracture toughness, high temperature resistance, thermal conductivity or thermal resistance, electrical conductivity or electrical resistance, acoustic conductivity, sound conservatism

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or sound absorption, weight, appearance and some other properties [8-11]. Composites also have lower density. In addition, these properties indirectly reduce unit cost of the material [12]. Today, large number of studies are carried out on the production of natural fibers from green plants, using in many areas and especially in the production of bio-composite materials [13-15].

In this study, firstly a mold of appropriate size was manufactured to produce the composite test specimens. The halves of the mold glass fiber were laid by applying polyester. Filling materials which are branch of the banana fiber and extrusion of pet waste were also placed. Then in accordance with the mold, the halves were closed and the test materials were produced. The samples were kept in the mold at room temperature for 12 hours, and then the samples were taken through the mold, and the burrs were removed. The same process was repeated, so all test samples were obtained. The tests were performed with specimens. The test results are shown below. In addition the sample's macrostructure were examined under a microscope.

2. Materials and Method

2.1. Composite Production

There are three basic functions of the matrix of composite materials. The matrix holds together the fibers, distributes the load between the fibers and protects the fibers from the environmental effects. The presence of the matrix will provide an even distribution of the load between fibers. Under a tensile shear load, a good adhesion between the matrix and fibers is required and the matrix must show a high shear strength property. In addition to the properties of the matrix and reinforcing materials, the orientation of fibers and adhesion strength between the matrix and fiber are important factors in determining the strength of the composite structure [6].

In this study, CE 92 N8 general purpose polyester resin material, resin, hardener methyl ethyl ketone peroxide (MEK) and naftanat cobalt were used as catalysts. Polyester resin blend of polyester 1% by weight cobalt, and 1% MEK were used. Polyester resin materials were supplied by Glass Fiber Inc. E glass fiber was used as the reinforcement material and 300 gr/m^2 MAT 8 multi-faceted glass fiber was also supplied from Glass Fiber Inc. [16].

Branch-dried banana stalks laid collected, dried in the outer membrane for the separation of the fibers, after waiting 2 days in water, the fibers removed from the water, leaving the outer surface of lignin and pectin membranes spatula, re-laid to dry. Crumbled dry fibers are separated from the remaining parts of the outer membrane. The dried fibers brought into bundles of 6-10 mm to be cut with pruning shears, then eliminating the dust, and the removal of small pieces of 6 mm was achieved. Banana fiber thickness is 0.3-2 mm.

PET plastic bottles used in this study were taken in a mixture of polycarbonate. The used PET fibers were obtained by extrusion from the recycled waste plastic bottles, polycarbonate obtained by extrusion.

2.2. Preparation of Test Specimens

In order to prepare the samples, 2 g of each constituent was taken. The mating surfaces of the mold halves were applied vaseline for easy removal of the molded parts from the mold. After this operation, molding glass fiber were laid moiety, wetted with the above polyester. As a reinforcing element, banana fibers and a suitable amount of extrusion of PET fibers are placed in the same process applied to the other mold moiety. The molded composites were kept for 12 hours, and the halves of the mold were opened. The burrs were removed from the sample taken from the mold. The composites were ready for the tests. The operation was repeated with the other samples which were produced with the same amount and method. Then, tensile test specimens were prepared and the examination was performed under the microscope.

2.3. Mechanical Tests

Tensile test specimens were prepared according to the TS 1398, and the sample size is given in Fig. 1. Tensile test specimen photo is also given Fig. 2. The tensile tests were performed on SHIMADZU AG-IS brand unit having a capacity of 50 kN.

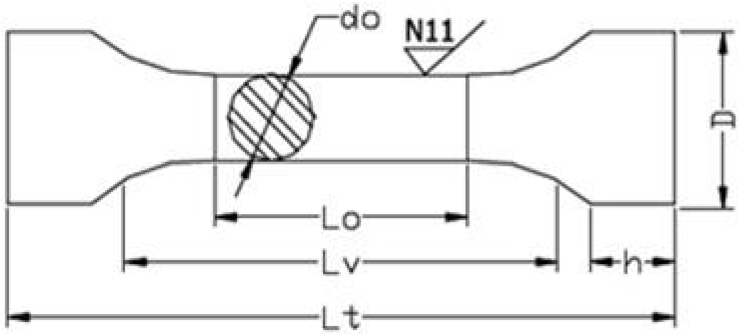

Fig. 1 Tensile test specimen dimensions

Tensile test specimen dimensions;

d_0= 10mm
D= 12mm
h= 15mm
L_0= 50mm
L_v= 70mm
L_t= 120mm

Fig. 2 Tensile test specimen

Impact testing was carried out using PENDULUM brand unit. Removing the pendulum arm 60°, the left is on the rise of free, high post-coup by the pointer appears as the difference between the first height, the material was calculated by the energy from the received pulse.

3. Results and Discussions

The prepared composites were subjected to tensile test and the tensile tests results were given in Table 1 and Fig. 3. As can be seen from both the Figure 3 and Table 1, the composite can withstand up to an average force of 0.65 kN tensile load. Average force strength will change depending on the molding pressure.

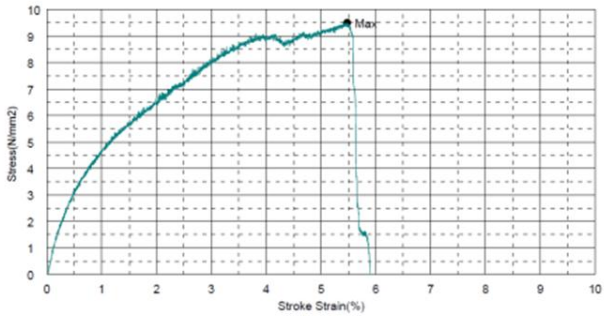

Fig. 3 Strain-stress curve for the composite

Table 1
Polymer composite strain-stress numeric data

Weight (g)	Diameter (mm)	Lenght (mm)	Max.extension (mm)	Max.stress (N/mm^2)	Max.strain %	Max.force (kN)
4	8	50	2.7	9.5	5.4	0.65

As a result of impact test, it was observed that the specimen made of polymer composite can withstand loads of up to 4 J (Table 2). Heterogeneously distributed within structure of the microscopic examination, the largest gap was observed between the pet and banana fiber. A good adhesion was seen between the banana and glass fibers. It was deduced that these parts began to break during the tests.

Table 2
Polymer composite impact test results

Diameter (mm)	Length (mm)	Weight (g)	Impact Energy (J)
8	100	4	4

The cross-sections of the samples (macrostructure) were analyzed by an optical microscope. If it is magnified 20 times, the-cross section was seen in Fig. 4 showed that the fibers of the composites cannot be differentiated. If it is magnified about 50 times, the cross-section of banana fibers was seen in Fig. 5 and the cross-section of PET fibers could be seen in Fig. 6.

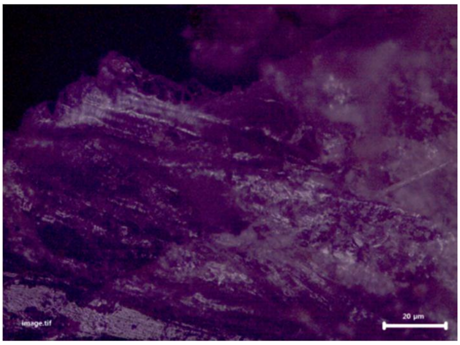

Fig. 4 Composite section

Fig. 5 Banana fibres in composite section

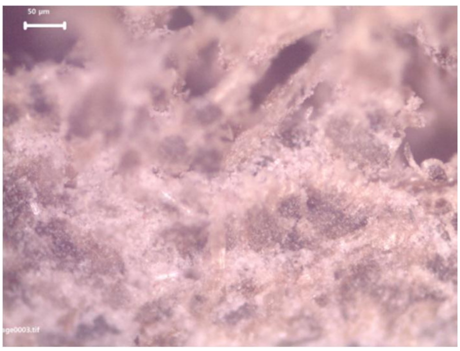

Fig. 6 Pet fibres in composite section

4. Conclusion

In this paper, recycled PET bottles were broken into pieces and mixed with polycarbonate polymer fibers which were produced by extrusion. Polymer fibers, glass fibers and banana fiber were used to produce polymer composite materials. Mechanical properties of polymer composite materials were determined by tensile and impact tests. In addition, cross-sectional (macrostructural) investigation was performed with an optical microscope. Fibers were made from plastic bottles with using a mixture of polycarbonate. Consequently, in the manufacture of polymer composites, waste plastic bottles polycarbonate blend and green materials can be used with the pulling operation and the polymer fiber production. In the light of obtained results, agricultural wastes offer a potential alternative raw material for the forest industry. In the production of polymer composites, agricultural wastes which are results of the burning of fields and forest fires can be used to prevent environmental pollution. If the dies is heated, the sections of the produced samples, plastic fibers and banana fibers will blend well with the expected same as glass fibers.

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