THE EFFECT OF NATURAL MATERIALS ON MECHANICAL PROPERTIES OF COMPOSITE MATERIALS

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ABSTRACT

This research studied the mechanical properties of orange and pomegranate shells powders reinforced unsaturated polyester with different weight fractions %Wf. The composite specimens were prepared by hand lay-up technique and sectioned according to (ASTM) for tensile, impact, bending and compression tests to obtain modulus of elasticity, ultimate tensile strength, elongation percentage, compression strength, impact energy and fracture toughness of the composite specimens. The results showed that the composite specimens reinforced with pomegranate shells powder give high mechanical properties compared with composites specimens reinforced with orange shells powder.

KEY WORDS : **Composite materials, mechanical properties, orange shells, pomegranate shells, polyester.**

دراسة تأثير المواد الطبيعية على الخواص الميكانيكية للمواد المتراكبة

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الخلاصة

في هذا البحث تم دراسة الخواص الميكانيكية للبولي استر الغير مشبع المقوى بمسحوق قشور البرتقال والرمان عند كسور وزنية مختلفة. حضرت العينات المركبة بطريقة يدوية وقطعت وفق المواصفات الامريكية لفحص الشد، فحص الصدمة، فحص الانحناء وفحص الانضغاط للحصول على معامل المرونة، اقصى مقاومة شد. نسبة الاستطالة، مقاومة الانضغاط، الطاقة الممتصة ومتانة الكسر للعينات المركبة . النتائج بينت ان العينات المركبة المقوات بمسحوق قشور الرمان تمتلك خواص ميكانيكية اعلى من العينات المركبة المقوبات بمسحوق قشور البرتقال .

الكلمات الدالة : المواد المتراكبة ، الخواص الميكانيكية ، قشور البرتقال ، قشور الرمان ، بولي أستر.

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INTRODUCTION

The use of natural fibers as additives for composite materials presents a great potential for improving their performance and technological application due to their low cost, richness and high specific strength. Additionally, due to their low density of natural fibers, reduce the mass of the composite. This is especially important if such fibers are rests of agro industrial processes and if their raw properties are suitable for composites (Garcia, 2004).
These waste fibers could be profitably used in the manufacture of fiber or particulates polymer reinforced composites because they posses attractive physical and mechanical properties (Cazaurang, 1991). Over a past few decades composites, plastics, ceramics and metals have been the dominant engineering materials. The areas of applications of composite materials have grown rapidly and have even found new markets. New polymer resin matrix materials and high performance fibers of glass, carbon and aramid which have been introduced recently have resulted in steady expansion in uses and volume of composites. Which possesses superior properties that are not obtainable with any of the constituent materials acting alone (Verma, 2013). Due to increase in population, natural resources are being exploited substantially as an alternative to synthetic materials (Saxena, 2012). Kumar (2012) studied mechanical and physical properties of composite materials made from orange peel reinforced epoxy resin were made using hand layup method. It has been shown that the maximum hardness, density, tensile and flexural are getting for the material prepared with the 20 % reinforced orange peel epoxy composite . Hashim,(2013) studied the optical properties of composite materials consisting of polyvinyl alcohol- polyacrylamide and pomegranate peel were prepared by using the casting method. They showed that the optical properties of polymer matrix are changed with the increase of the pomegranate peel concentrations (Hashim, 2013). Chadramonhan,(2014) investigated the mechanical properties of hybrid materials made from powder of natural fibers such as (sisal, banana, and roselle) and resin polymer such as (epoxy and polyester). In his study, roselle and banana (hybrid) and roselle and sisal (hybrid) are fabricated with polymer using molding method. The all types of fibers were chemical treatment with 6% NaOH. The results showed that the properties obtained without fibers treated gives higher properties than fibers treated, and higher value of all properties happened at the composite materials made from hybrid fibers reinforced epoxy resin than fibers reinforced polyester resin (Chadramonhan, 2014) .
Anoopisan et al (2015) studied the interfacial behavior of material composites made from epoxy matrix reinforced with orange peel at different particle sizes (100, 170 and 240)mesh. The interfacial behavior of these composites was investigated by tensile test, short beam test, and rockwell hardness test. The results showed that the tensile strength, hardness and short beam strength increased with increased weight fraction of reinforced while density of composites decreased with increased reinforced (Anoopisan, 2015).
The aim of this research was to study the influence of adding different weight fractions of orange and pomegranate pells powders on the mechanical properties of unsaturated polyester.

EXPERIMENTAL WORK

The orange and pomegranate shells were collected locally were washed by distill water to remove impurities and sun dried for 7days. Sun drying was necessary to remove the moisture from the shells. The fibers were then grinded into fine powder and the collected powders were sieved to the required particle size (53µm). Then the composite material was preparation by combining the unsaturated polyester with orange and pomegranate shell powder with different powder weight fraction (0, 4, 8 & 11Wt%). The mechanical test carried out to determine the characteristics of the studied composite. The usage of unsaturated polyester resin as a matrix was chosen because it is the standard economic resin commonly used, preferred material in industry and besides, it yields highly rigid products with a low heat resistance property. The resin was prepared by mixing unsaturated polyester with 2% hardener. The hardener type used is the Methyl Etheyl Keton Peroxide (MEKP) . The composite specimens were fabricated by using hand lay-up technique. Composites having different powder content were prepared by varying the type, Weight fraction. In the first process of preparing the composite specimens' preparation process is to set the percentage of powder content in the composite. The amount of resin needed for each category of composite material was calculated after that. Then the resin was mixed uniformly with hardener, the mixture was poured carefully into the moulds and left in the mould for 24 hours. After the composites were fully dried, they were separated off from the moulds, and then put the specimens in oven at (55 ºC) for (1 hour) (Flex, 2012). Specimens are prepared after the composites are ready. Specimens are prepared after the composites are ready. The geometry of the specimens is set by referring to (ASTM D- 638) at room temperature as shown in Figure (1) (ASTM, 1988) .

Tensile test is done by using universal testing machine type (LARYEE) with capacity (50 KN) applied load and strain rate (0.5 mm/min).

Izod impact test machine was used for testing polymeric materials. This test is performed according to standard (ISO-180) at room temperature as shown in Figure (1) (ASTM, 2006).

Bending test is performed according to (ASTM D790) as shown in Figure (1) at room temperature (ASTM, 1997). Compressive test is performed according to (ASTM D695-85) at room temperature as shown in Figure (1) (ASTM, 2002).

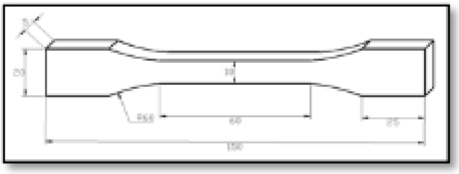
RESULTS & DISCUSSIONS

Figures (2&3) show the relationship between stress and strain for composite specimens. It was clearly from these figures the initial part of the (stress-strain) curve is a linear where the specimen behaves in an elastic manner and eventually develops into non-linear due to the deformation of specimen in plastic manner. It can also be notice that the increasing stress and decrease strain with increasing weight fraction of particles. The reason behind such behavior is because that increasing weight fraction might lead to reduction in the inter-particles spacing that does not allow forming internal defects (cracks) in quick manner and in turn the composite material will have high stress. Figures (4&5) show the relationship between ultimate tensile strength, modulus of elasticity and weight fraction for composite specimens reinforced with two type of particles. It can be seen from these figures the increase of weight fraction of particles lead to increase the ultimate tensile strength and modulus of elasticity due to the restriction of the mobility and deformability of the matrix with introduction of mechanical restraint. Also may be attributed the improved interfacial bonding between the particles and matrix resulted in good improved the ultimate tensile strength and modulus of elasticity. Figure (6) shows the relationship between bending modulus and weight fraction of particles for composite specimens reinforced with two type of particles. It can be show that the bending modulus increased with increased weight fraction of particles this may be due to the particles improves the load bearing capacity and the ability to withstand bending of the composites. Also may be attributed to enhanced compatibilization between particles and matrix. Figure (7) shows the relationship between compression strength and weight fraction of particles for composite specimens reinforced with two type of particles. It was observed from this figures the compressive strength increased with increased weight fraction of particles because of that can explain fillers particulate work at the outset on impeding the cracks movement, where that lead to increase in compression strength value. Figures (8&9) show the relationship between impact energy, fracture toughness and weight fraction of particles for composite specimens. It can be seen from these figures the impact energy and fracture toughness increased with increased with increased weight fraction of particles. The enhancement of this properties could be attributed to The good adhesion between the matrix and particles is behind the improved values of impact energy and fracture toughness for composites.

CONCLUSIONS

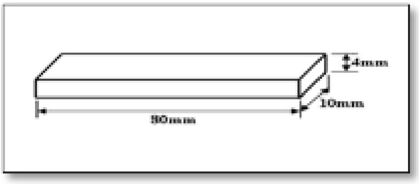
The previous discussions lead to the following conclusions :

1. The composite specimens reinforced with pomegranate powder gives higher mechanical properties than composites specimens reinforced with orange powder.
2. Higher value of all mechanical properties were obtained when the unsaturated polyester was reinforced by (11 wt%) for two types of powder.



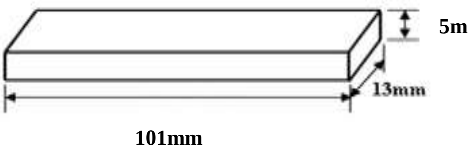
A) Standard specimen B) specimens for test

Tensile Test Specimens



A) Standard specimen B) specimen for test

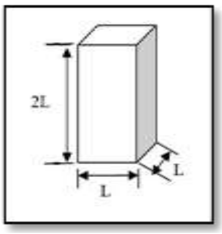
Impact Test Specimens



) Test

A) Standard specimen B)specimen for test

Bending Test Specimens



A) Standard specimen B) specimen for test

Compression Test Specimens

Figure (1): Mechanical Tests Specimens.

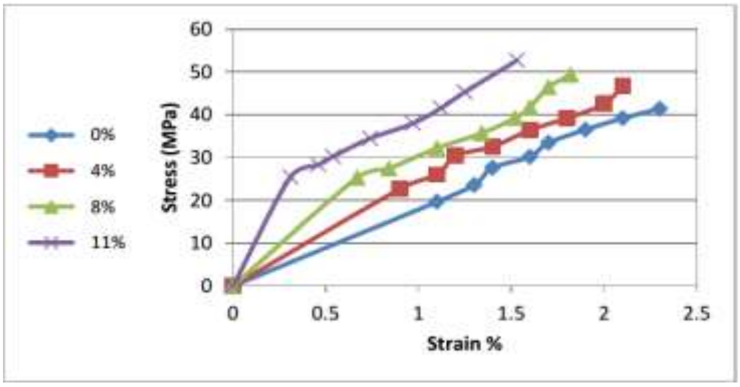


Fig. (2): stress- strain curve of composite materials reinforced with orange peel.

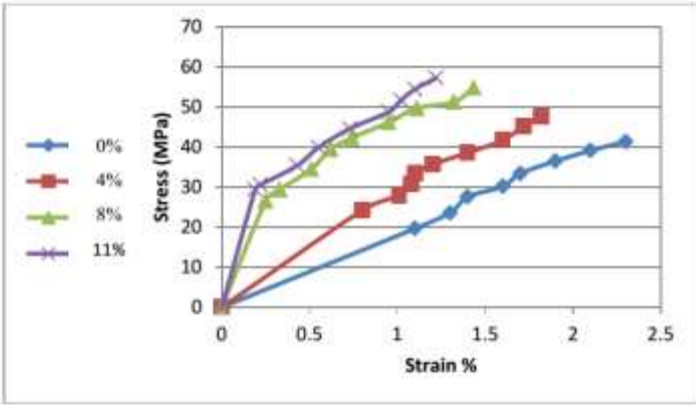
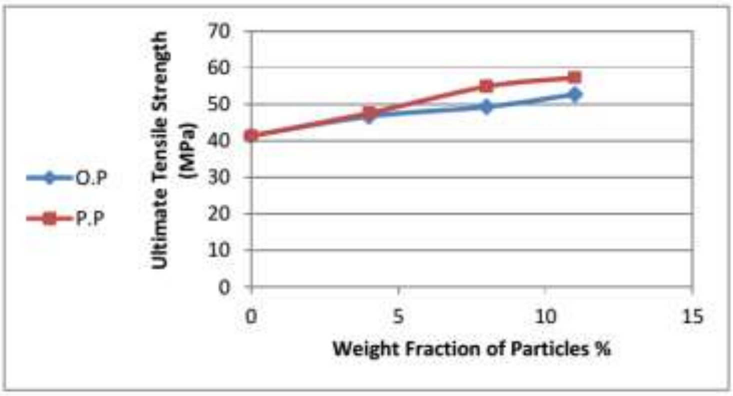


Fig. (3): stress -strain curve of composite materials reinforced with pomegranate peel .



. (4): the relationship between ultimate tensile strength & weight fraction of particles for composite materials.

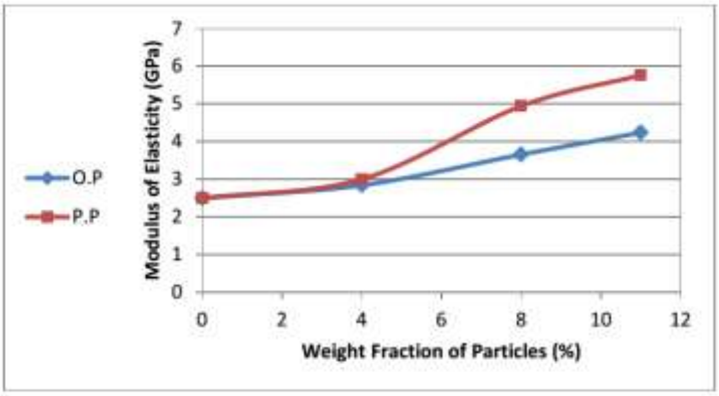


Fig. (5): the relationship between modulus of elasticity & weight fraction of particles for composite materials .

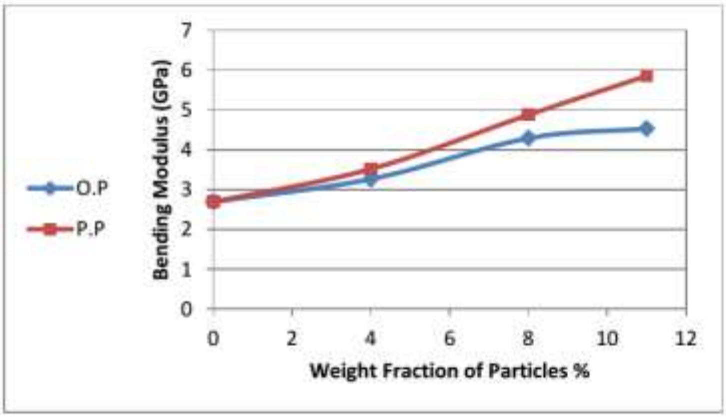


Fig. (6): the relationship between bending modulus & weight fraction of particles for composite materials .

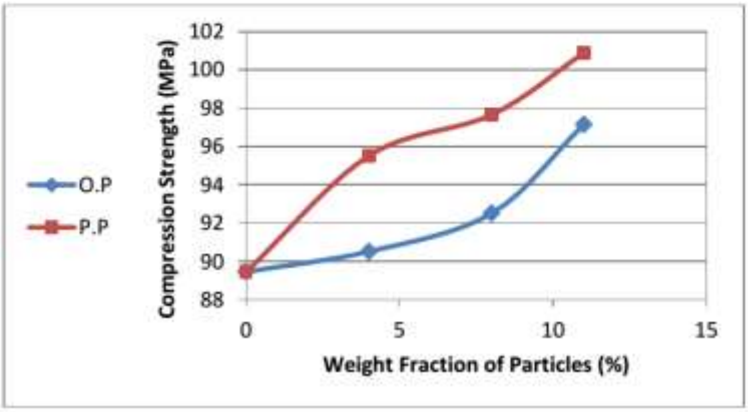


Fig. (7): the relationship between compression strength& weight fraction of particles for composite materials.

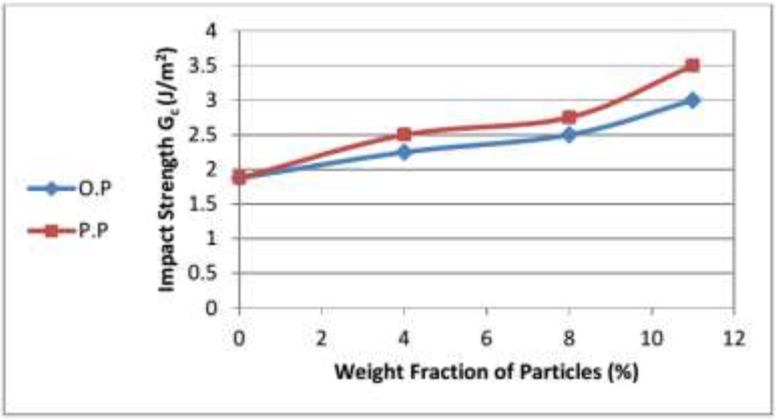


Fig. (8): the relationship between impact strength & weight fraction of particles for composite materials .

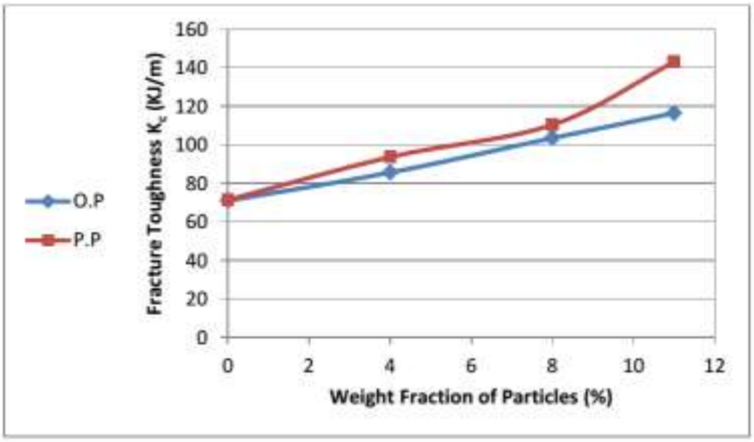


Fig. (9): the relationship between fracture toughness & weight fraction of particles for composite materials.

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