



**INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH
TECHNOLOGY**

**MECHANICAL BEHAVIOR OF NATURAL MATERIAL (ORANGE PEEL)
REINFORCED POLYESTER COMPOSITE**

Raghad Usama.Abass*

* Materials Engineering Department, University of Technology, Iraq

ABSTRACT

Over the last century, polymers have emerged as one of the most indispensable components used in everyday life, polyester one such example. Until recently, synthetic filler materials have been the preferred choice for reinforcement of polyester to improve its toughness. However, natural filler and fiber materials are emerging as suitable alternatives to synthetic materials for reinforcing polymers such as polyester due to their environment friendliness, high abundance, renewability, and cost effectiveness. Several research efforts have been put to study the effectiveness of natural fiber based materials on the mechanical behavior of polyester composites, focusing mainly on fibers and their weight percent's within the composites. The present experimental study aims at learning Mechanical behavior of orange peel (OP) reinforced polyester composites. Composites having 2, 4, 6, 8 and 10% weight fraction of orange peel were made using hand layup method. The fabricated composite samples were cut according to the ASTM standards for different experiments. Hardness test, Impact test, compression test and tensile test were carried out at the samples. The maximum hardness, impact, compression, and tensile are getting for the material prepared with the 10 % reinforced orange peel polyester composite.

KEYWORDS: Mechanical properties, impact, hardness, compression, tensile test, orange peel (Op), orange peel particulate.

INTRODUCTION

When two or more material with different properties is combined together they form a composite material [1]. The constituents are combined in such a way that they keep their individual physical phases and are non-soluble in each other or do not form a new chemical compound. That is why a composite is considered to be any multi-phase material system that exhibits a combination of properties that makes the composite superior to each of the constituent phases. This criterion has provided the main motivation for the research and development of composite material worldwide. There are basically two category of constituent material, one constituent is called reinforcing phase and one in which the reinforcing phase is embedded is called matrix. The primary function of matrix is to hold the fiber to form a certain shape. Besides, the functions of the matrix are also to transfer stress between the reinforcing fibers and to protect them from mechanical and environmental damage. The function of reinforcing phase in matrix is to improve the mechanical properties such as strength, stiffness etc. As per Berghezan [2-4] the composite material is to be designed in such a way that the individual component retain their characteristic are so incorporated that the composite take advantage of their

superior properties without compromising on the weakness of either. There are basically three major types of composite materials available designated as per the matrix material used. The matrix material can be metallic, polymeric or can even be ceramic. When the matrix is a polymer, the composite is called polymer matrix composite. Fiber reinforced polymer (FRP) composite are the most common advanced composites. These composites consist of a polymer matrix reinforced with thin diameter fibers. The reasons why they are the most common composite include low cost, high strength, and simple manufacturing processes. There are many polymer resin system used as matrices in FRP composites. They can be classified as thermo plastic (polyethylene, polypropylene, nylon etc.) and thermoset (epoxies, polyesters, vinyl ester etc.) polymer. Thermoplastic polymer can be repeatedly softened and formed by increasing the temperature or hardened by decreasing the temperature, while the thermoset polymers are insoluble and infusible after cure. Availability of natural fibers and easy of manufacturing is tempting researcher to try locally available inexpensive natural fibers as reinforcement material in polymer matrix. The other advantages associated with natural fibers are

non-abrasive nature, low energy consumption, biodegradability, light weight and low cost. Careful selection of reinforcement type enables finished product characteristics to be tailored to almost any specific engineering requirement. Whilst the use of composites will be a clear choice in many instances, material selection in others will depend on factors such as working lifetime requirements, number of items to be produced (run length), complexity of product shape, possible savings in assembly costs and on the experience & skills the designer in tapping the optimum potential of composites. In some instances, best results may be achieved through the use of composites in conjunction with traditional materials. Hemicellulose found in the natural fibers is believed to be a compatibilizer between cellulose and lignin [5-6]. The use of lignocellulose fibers as reinforcements for polymeric materials has been growing during the last decade or so to replace synthetic fibers, especially glass fibers in composites, for different industrial sectors, such as packaging, automobiles [7, 8] and even in the building sector [9]. This is mainly due to their unique characteristics, such as availability, biodegradability, and low density, non-toxic nature, less abrasiveness to plastic processing equipment, useful mechanical properties and low cost [10]. The chemical composition of natural fibers may differ with the growing condition and test methods even for the same kind of fiber. The physical mechanical properties of natural fibers are greatly influenced by their chemical compositions.

Natural fibers in general can be classified based on their origin, and the plant-based fibers can be further categorized based on part of the plant they are recovered from. An overview of natural fibers.

In this work, is to improve the mechanical properties of orange peel (OP) filled reinforced PMC. The composites were prepared through hand lay-up technique. The specimens were characterized by mechanical tests.

EXPERIMENTAL WORK

The composites slabs were prepared by hand layup method or contact mold method. A glass mold was prepared and the dimension of the mold was 40cm x 15cm and a depth or thickness of 0.3 Polyester resin (NYCIL 6043) belonging to ester family was used as the matrix material, methylethylketone peroxide (MEKP) introduced as the catalyst and combat derivative accelerator (CDA) was used as the hardener

.Polyester resin and the hardener were mixed in the ratio of 100:2 by volume and the catalyst methylethylketone peroxide added to effect the chemical reaction. Composites of five different bio filler compositions such as 2wt%4wt%, 6wt% and 8wt% and 10wt% also a neat counterpart produced as control. The casting was left for 24 hours for proper curing at room temperature. Specimens of suitable dimension were cut for test. Tensile, hardness, compression, and impact test were carried out on each sample specimen. This was done according to ASTM D 638-90 with the aid. Bio composite is a material formed by a matrix and a reinforcement of a plant derived fiber. It is needed to develop novel bio based products and other innovative technologies that can reduce widespread dependence on fossil fuels. Eco-friendly bio composites from plant derived fiber and crop-derived plastics, make a great importance to the environment and is also a solution to the uncertainty of petroleum supply. Bio polymers are now moving mainstream use, and the polymers that are biodegradable or based on renewable feedstock may soon be competing with commodity plastics, as result of the sales growth of more than 20-30% per year and improvement in the economics of sales. The best examples of biopolymers based on renewable resources are: Cellulosic plastics, polylactides (PLA), starch plastics and soy based plastics. Microbial synthesized biopolymers, i.e., polyhydroxy alkanooates (PHAs) polymers are also having attractive environment friendly properties.

The use of materials from renewable resources is being popular and the world's leading industries are looking forward to use more and more composite materials derived from natural fibers and bio-polymers in place of petrochemical based feedstock. Classification of Natural/Bio-fibers

Natural/bio-fibers can be broadly divided into two categories: non-wood fibers and wood fibers shown in the table 1.1. At present level of technology non wood fibers like hemp, kenaf, flax and sisal find commercial success in the design of bio-composites from polypropylene for automotive applications. Increase use of biopolymers would result in more eco-friendly bio composites for twenty first century green automotive parts applications. All the natural reinforcing fibers are lingo-cellulosic, having cellulose and lignin as principle components.

The reason for the application of natural fiber composites in the automotive industry includes:

1. Low density: This may lead to a weight reduction of 10 to 30%
2. Acceptable mechanical properties, good acoustic properties.
3. Favorable processing properties, for instance low wear on tools, etc.
4. Options for new production technologies and materials.
5. Favorable accident performance, high stability, less splintering.
6. Favorable eco balance for part production.
7. Favorable eco balance during vehicle operation due to weight savings.
8. Occupational health benefits compared to glass fibers during production.
9. No off-gassing of toxic compounds (in contrast to phenol resin bonded wood and recycled cotton fiber parts.)
10. Reduce fogging behavior.
11. Price advantage both for the fibers and the applied technologies

Orange is a citrus fruit mainly originated in Southeast Asia. It is the most commonly grown tree fruit in the world. Like all citrus fruits, the orange is acidic having pH range 2.9-4.0.

Orange peel, the outer cover part of an orange, mainly consists of cellulose, essential oils, proteins and some simple carbohydrates.

The orange peels were collected locally and were sun dried for 5 days. Sun drying was necessary to remove the moisture from the peels. The fibers were then grinded into fine powder as shown in figure (2) The collected powders were sieved and a particle size distribution in a sample is given in Table(1) Since the wt.% of 212+ microns was around 74.6grams, for the present.

RESULTS AND DISCUSSION

Impact test

From Fig. 2. it is observed that composite low optimum by (10% wt.) exhibited minimum ultimate strength (8MPa) when compared with other filled composites but high than the un-filled composite this may be due to good particle dispersion and strong polymer/filler interface adhesion for effective stress transfer but further increase in filler content (up to 15

% Vol.), the impact strength is found to be increase is due to more filler material distribution in the material.

Hardness test

The hardness values shown in Fig. 3 indicated that increase in filler content increases the hardness. The addition of filler content increases the hardness of composite material due to increase in the resistance strength of polymer to plastic deformation. In this case, the polymeric matrix phase and the solid filler phase would be pressed together and touch each other more tightly.

Tensile strength

The tensile strength of the composite materials depends upon the strength and chemical stability of the matrix with the filler.

From Figure 4. it is observed that composite high optimum by (10% wt.) exhibited maximum ultimate strength (24MPa) when compared with other filled composites but lower than the un-filled composite this may be due to good particle dispersion and strong polymer/filler interface adhesion for effective stress transfer but further increase in filler content (up to 15 % Vol.), the tensile strength is found to be less this is due to more filler material distribution in the material.

Compression test

The compression test is simply the opposite of the tension test with respect to the direction of loading. In some materials such as brittle and fibrous ones, the tensile strength is considerably different from compressive strength. Therefore, it is necessary to test them under tension and compression separately. Compression tests results in mechanical properties that include the compressive yield strength, compressive ultimate strength, and compressive modulus of elasticity in compression, % reduction in length etc. All the compression tests of casted hybrid composites are conducted on 100 KN servo hydraulic UTM machine. Specimen configuration is shown in figure 5. All tests are conducted aspect ratio of 2.0. All tests are conducted under displacement mode of control. The displacement rate is 1mm/min and all tests conducted at room temperature. Compressive strength is also a very important mechanical property required for bearing compressive load. Compressive properties of Composite with 10%wt of orange peels particles shows very good ultimate strength and good modulus of elasticity in compressive zone in

comparison to other 0wt% reinforcement of particles as shown in figure 5.

CONCLUSION

The present work deals with the preparation of characterization of waste orange fiber reinforced polyester composite. The mechanical behavior of the composite lead to the following conclusions:

1. With the successful fabrication of a new class of polyester based composites reinforced with orange fiber.
2. The impact test of the composite is found to be maximum with 10% weight percent of orange fiber.
3. The hardness value of the composite increases with increasing of the fiber content.
4. The tensile strength of the composite is found to be maximum for the 10 % weight percentage of the orange fiber.
5. The compression test of the composite is found to be maximum with 10%weight percent of orange fiber

REFERENCES

1. Herakovich, C.T., "Mechanics of fibrous composites". New York: Wiley; (1998). p. 1–27.
2. Berghezan, A., "Nucleus", 8(5), 1966, (Nucleus an Editeur, 1, rhe, Chalgrin, Paris,)16(e).
3. Mallick P.K. 1993. Fiber Reinforced Composite: Materials, Manufacturing And Design, Second Edition, 18, Marcel Dekker Inc, Newyork,
4. Abdul Khalil M., Abu Bakar A., Mariatti M., Jannah, H. P. S. 2008. Properties of Banana and Pandanus Woven Fabric Reinforced Unsaturated, Polyester Composites, Journal of Composite Materials, 42 (9), pp.931-941
5. Santos C.J.E. 2009. Development of Fiber Reinforced Composite for Structural Applications, Submitted in partial fulfillment of course requirements for MatE 198B.
6. Rong, M.Z., Zhang, M.Q., Liu, Y., Yang, G.C. and Zeng, H.M., 2001, "The effect of fiber treatment on the mechanical properties of unidirectional sisal-reinforced epoxy composites," Compos. Sci. Technol., 61; pp. 1437–1447.
7. Wambua P., Ivens J, Verpoest I., 2003, "Natural fibers: can they replace glass in fiber

- reinforced plastics, Compos Science Technology"; 63: 1259–64.
8. Schuh TG., "Renewable materials for automotive applications". Http // www. Ienica. net / fibers seminar/schuh.pdf (Accessed in February 2006).
9. Khedari J., Charoemvai S., Hiruanlabh J., "New insulating particle boards from durian peel and coconut coir. Build Environ"; 38: 2003, 435–441
10. Bledzki A K., Gassan J., "Composites reinforced with cellulose based fibres". Progress in Polymer Science, Volume 24, (1999): p. 221-274.
11. Frank, R.R., "Bast and other plant fibers", 2005. Cambridge: woodhead publishing limited.
12. Z. Zhikai, Z. Sixun, H. Jinyu C. Xingguo, G. Qipeng, and W. Jun, Phase Behavior and Mechanical Properties of Epoxy Resin Containing Phenolphthalein Poly ether ether Ketone, Journal of Polymer, 39 (5), (1997), pp. 1075–1080.
13. H. Shangjin, S. Keyu, B. Jie, Z. Zengkun, L. Liang, D. Zongjie and Z. Baolong, "Studies on the Properties of Epoxy Resins Modified with Chain-Extended Ureas" , Journal of Polymer, 42 (2001), pp. 9641–9647.
14. W. G. Potter, Epoxide Resins, New York: Springer, 1970.
15. C. A. May and G. Y. Tanaka, "Epoxy Resin Chemistry and Technology". New York: Marcel Dekker, 1973.
16. R. S. Bauer (ed.), "Epoxy Resin Chemistry I", ACS Symposium Series, no. 114. Washington, DC: American Chemical Society, 1979.
17. R. S. Bauer (ed.), "Epoxy Resin Chemistry II", ACS Symposium Series, no. 201. Washington, DC: American Chemical Society, 1983.
18. R. S. Drake, D. R. Egan, and W. T. Murphy in "Epoxy Resin Chemistry II", (ed. R. S. Bauer), ACS Symposium Series no. 221. Washington, DC: American Chemical Society, 1982, p.
19. E. M. Yorkitis, in "Rubber-Modified Thermoset Resins", (ed. K. Riew and J. K. Gillham), Advances in Chemistry Series no. 208. Washington, DC: American Chemical Society, 1984, p. 137.

20. J. S. Riffle, I. Yilgor, A. K. Banthia, C. Tran, G. L. Wilkes, and J. E. McGrath in "Epoxy resin chemistry", (ed. R. S. Bauer), ACS

Symposium Series no. 201. Washington, DC: American Chemical Society, 1983, p. 13

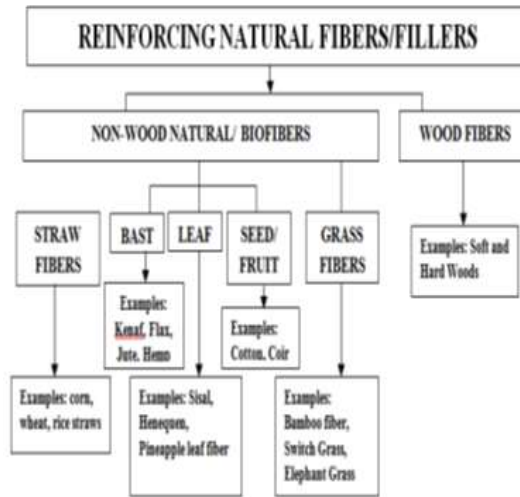


Table 1.1 Classification of Natural fibers



Figure (1) (a) Orange peels



(b) Sun dried orange peels



(c) Powdered orange peels

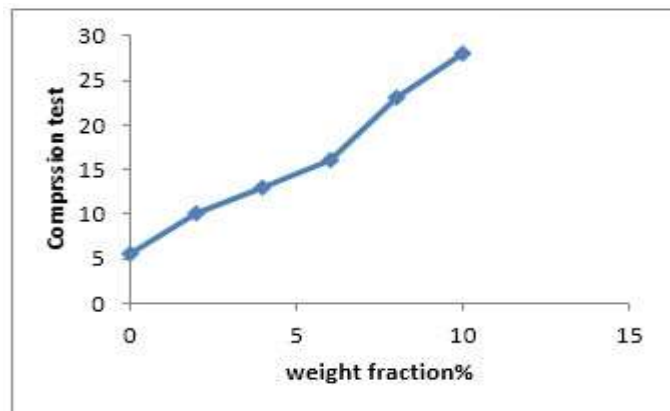


Figure (2) Variation of impact test with different composition of composite/

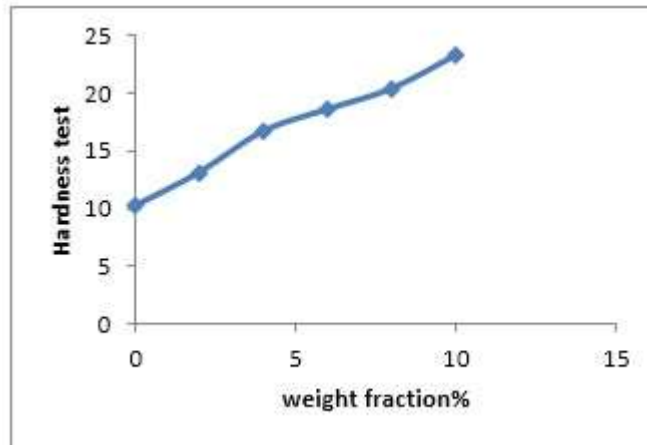


Figure (3) Variation of hardness test with different composition of composite.

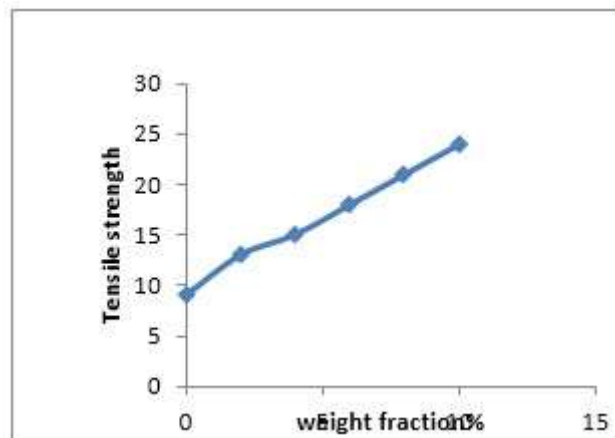


Figure (4) Variation of Tensile strength with different composition of composite.