Orhan Sabah Abdullah. A Study of the Effects of Different Types of Reinforcements on Mechanical and Structural Properties of a Polymer Matrix Composite. University of Technology. Department of machine and equipment engineering. M.Sc. Supervisor: Dr. Ibtihal A. Mahmood and Dr. Wafa Abd Soud. 2013. 155p.

Abstract

This research aims to study the effects of different types of reinforcement materials on the mechanical and structural properties of a polymer matrix composite prepared by hand using lay-up method.

Epoxy resin type (Quickmast105) was used as a matrix material with 3:1 base to hardener mix ratio. The reinforcement material used in this research can be classified into two types; the first one is short fibers, this includes short carbon fibers (SCF) and short glass fibers (SGF) with (2.5, 5, 7.5, 10, 12.5, 15) volume fraction %. The second one is ceramic fillers that include granite, perlite and $CaCO_3$ particles with 10μm particles size, and having volume fraction of (1, 2.5, 4, 5) volume fraction%.

Specimens of matrix material and the eight groups of composite materials were subjected to compression, impact, wear, density and damping tests.

Experimental results indicate that the Young's modulus and compressive strength of the composite materials are significantly higher than those of the matrix material. It is found that enhancement in Young's modulus and compressive strength are directly proportional to the volume fraction of reinforcement material. The carbon fiber composites have higher modulus of elasticity and compressive strength than the glass fiber composites with equivalent volume fraction. The highest modulus of elasticity and compressive strength are that of the composite 15 % CF +

5 % granite particles, which are 150% and 50.25% higher than that of the matrix material respectively.

The results also indicate that the impact strength, fracture toughness and density of the composite material are significantly higher than those of the matrix material. The enhancement in those properties are found to be directly proportional to the volume fraction of reinforcement material. The carbon fiber composite have higher impact strength and fracture toughness and lower density than glass fiber composite. The highest impact strength and fracture toughness are that of composite 15 % CF +5 % granite particles, while the highest density is that of composite 15% GF +5 % granite particles.

Wear resistance of the composite material is significantly higher than that of the matrix material. It is directly proportional to the volume fraction of reinforcement material. The carbon fiber composite have higher wear resistance than glass fiber composite. the highest wear resistance is that of 15 % CF +5 % granite particles, which is 83.8% higher than that of the matrix material. The results also indicate that the wear rate increase with the increasing of load, time and sliding distance.

The damping ratio of the matrix material was found to be significantly higher than those of the composite materials and it decreases with increasing reinforcement material volume fraction.

Keywords: polymer matrix composite. Damping. Wear. Impact. Density. Compression strength. Granite. Perlite. $CaCO_3$ particles.