Fayoum University
Faculty of Engineering
Industrial Engineering Dept.

Characterization of Glass-Fiber Reinforced Polymers at Different Strain Rates

By
Samar Esam Mohamed Salem

A thesis submitted in partial fulfillment
Of
The requirements for the degree of
Master of Science

In
Industrial Engineering

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FAYOUM UNIVERSITY
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Under the Supervision of

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جـــامعة الفـــيوم
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Degree: Master Degree
Title of Thesis: Characterization of Glass-Fiber Reinforced Polymers at Different Strain Rates
Supervisors: 1-Assoc.Prof. Mohamed Fahmy Aly
2- Dr. Abdallah Shokry Mahmoud

Department: Industrial Engineering

Approval:

ABSTRACT

Many of our modern technologies require materials with unusual combinations of properties that cannot be met by the conventional metal alloys, ceramics, and polymeric materials. This is especially true for materials that are needed for aerospace, underwater, and transportation applications. Among these materials, composite materials have been recently used in many different applications.

The effect of strain rate on the mechanical properties of glass fiber reinforced polyester with and without Zinc Oxide (ZnO) nano-filler is studied. A woven roving glass fiber reinforced polyester resin composite is fabricated by hand lay-up method and tested under four different strain rates 0.01, 0.1, 1 and 6 s^{-1} with four different ZnO percentages 0, 1, 2 and 3 wt.%. In addition, the fractured samples are examined using Scanning Electron Microscope (SEM) to study the fractured surface and fracture mechanism. Furthermore, finite element analysis is implemented to analyze the experimental findings at different ZnO weight ratios and different strain rates.

The results indicate an increase in the tensile stress with the increasing of strain rates. The tensile strength of the glass fiber reinforced polyester composite also increases with adding filler content up to 3 wt.%. In which the stress increases by 27% as the strain rate increases from 0.01 s^{-1} to 6 s^{-1} for 0% ZnO, 11.5% for 1% ZnO, 40.5% for 2% ZnO, and 36% for 3 % ZnO. The SEM images show an improvement on the fiber/matrix interfacial bonding at the highest strain rate and with adding ZnO nano-filler with 3 wt.%. Also, the fracture mechanism changes from delamination to fiber pull-out with increasing strain rate and filler content in which the composite becomes more coherent. Furthermore, the finite element results give good

The summary not more than 500 words

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agreement compared to the experimental work results. In addition, design of experiments confirms that both adding ZnO and strain rates have significant effect on tensile stress of GFRP composite.

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