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EXPERIMENTAL-THEORETICAL RESEARCH OF MECHANICAL PROPERTIES OF SMART-COMPOSITES

Aleksandr Anoshkin, Valerii Zuiko, Gleb Shipunov

Perm National Research Polytechnic University, Russia
aan-02@yandex.ru ; zuyko81@mail.ru ; gsshipunov@gmail.ru

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Summary: The present work is dedicated to experimental-theoretical research of the mechanical behavior of composite materials with optical fibers embedded into their structure - so-called self-diagnosable (SMART) composites.
Structural elements made of SMART-materials allow to measure the various parameters in the manufacturing process and to realize an uninterrupted non-destructive testing of construction parts in real time. Integrated study of this class of materials is required to carry out a series of experimental and theoretical researches related to the choice of sensor types and their location variants, registration and interpretation of receiving signals and the definition of effective mechanical properties.
The composites based on epoxy and polyester resins with carbon and glass fabrics as reinforcement were chosen for this research. First the fiberglass specimens based on polyester resin and glass fabric with embedded optical fiber PANDA were made with the help of vacuum infusion process (VIP). The results of the tensile and bending tests conducted according to ASTM D3039 and ASTM D790 showed that optical fibers slightly reduce the tensile and flexural properties of composite materials (less than 10%).
Another type of optical fibers - polyimide coated Fibercore SM 1500 (9/125)P with fiber Bragg gratings (FBG) - was used for manufacture of composite laminate with help of prepreg technology. The assay of possibility of strain registration in composite specimens by optical sensors was carried out using the ASTRO X 327 interrogator.
For numerical simulation of the mechanical behavior of SMART-composites the microsections of these specimens were analyzed by optical microscopy. The computer models were developed by obtained data for stress-strain analysis of the specimens under various conditions of loading using ANSYS software.
The results of this work allow us to estimate the impact of the basic technological factors of composite materials manufacture on the ability of the information registration by optical elements, and the accuracy of determination of strain fields in the specimens of composite materials for various mechanical tests.

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