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PROBABILISTIC DESCRIPTION OF STOCHASTIC PROCESSES OF STRUCTURAL FAILURE IN ADVANCED POLYDISPERSE COMPOSITES

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The failure probability analysis of advanced composites is based on development of multi-scale mathematical models for solution of micromechanical problems for characterization of nonlinear deformation processes. Parameters of these processes depend on specific details of the microstructural stress and strain fields.

The aim of this research is to develop new theoretical models and simulation tools for analysis of such fields in components of composites with complex stochastic geometry and for prediction of macroscopic behaviour of considered materials during deformation processes.

For non-periodic randomly reinforced composites stochastic methods based on random functions theory are used [1, 2]. According to such methods, deformation processes are described with multipoint statistical moments of stochastic stress and strain fields in components of composites. These moments are determined analytically from solution of stochastic boundary value problems or with finite-elements analysis based on statistical properties of the microstructure and loading conditions. The solution of boundary value problems in elastic and elastoplastic cases were obtained in the first and second approximations with the Green functions method.

Though there are many approaches for simulation of microstructures composites have emerged [3], the question of description of component interaction at a micro-scale is open. Statistical information about geometry of microscopic structure of materials is characterized with high-order multipoint correlation functions using the concept of a Representative Volume Element (RVE). These functions up to fifth order have been built for synthesized 3D RVE models. The structural function of damageability was introduced to describe failure parameters on a micro-scale.

New analytical expressions for failure probability and statistical characteristics in components of composites were derived. The algorithms for establishing link between failure on micro and macro-scale were introduced. The numerical results for parameters of deformation and failure process in components were calculated for several types of composites with different types of structural parameters and properties in some specific cases of macroscopic states of strain.

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