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PROBABILISTIC STRENGTH ANALYSIS OF FILLED POLYMERIC COMPOSITE MATERIALS AND OF PRODUCTS BASED ON THEM

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Polymeric composite materials and compounds on its basis are characterized by considerable dispersion of stress-strain properties. This dispersion depends on properties dispersion of matrix material, filling ratio, size and distribution of inclusions, etc. Properties variation range can be estimated by statistical characteristic: mathematical expectation and standard deviation.

Numerical experiments give a set of data referred to stress-strain state parameters, which are statistically analizable. In particular, effective Young's modulus mean value and standard deviation dependence on compound filling ratio was obtained. Filling ratio increase simultaneously leads to both effective Young's modulus rising and its standard deviation. First of these effects is familiar and easily explainable. The second is connected with the fact that the reduction of matrix fraction in compound makes properties variations defined in matrix more considerable in general.

Local strength reliability evaluation is based on the determination of stress-strain parameters in isolated points or elements of object. Increase of these parameters leads to failure. Criteria, which determine strength of product element, are in general random variables. Stress occurring in product element also depends on many variables (elastic, strain, dilatometric characteristics), which have dispersion. It is connected with peculiarity of material structure,

amount of defects, size difference, stability of loading conditions, etc. As a result, stress in the element becomes a random variable.

Assessment of construction reliability in considered approach lies in calculation of probability of failure-free operation of material in each point of a product. It also can be demonstrated by fields of probability of failure-free operation over all construction volume. Transition from local strength evaluation to construction strength in general can be made by means of criteria depending on material fraction in a product where failure condition was satisfied.

The proposed method is illustrated by fields of probability of failure-free operation plotting for ventilators propeller made of polimeric material. Propeller has a double-sided key slot. Stress state in the propeller occurs due to initial tension caused by seating on a shaft and due to electromotor operation in sub-zero temperatures.

Increase of the probability of failure-free operation can be achieved by changing the geometry of structure parameters (for example, size and shape of key slot, liner diameter), by choosing a material with other characteristics, etc. In this case calculations are carried out by means of statistics of numerical experiments.

Described approach considers random character of different parameters defining effective material properties, stress-strain state of construction and also strength criteria. The approach helps to avoid additional experiments and obtain numerical value of probability by making a numerical experiment.

The proposed method of fields of probability of failure-free operation plotting is applicable in products design for optimal materials and construction selection.

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