ESTABLISHING THE CAUSES OF PREMATURE FAILURE OF COMPOSITE REINFORCEMENT WITH UNIDIRECTIONAL DISCRETE FIBERS

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The structure and properties of reinforcement made of composite material is analyzed. The structure and elemental composition of the studied material was examined by the optical and electron microscopy. It has been established that the basis of the studied reinforcement is a composition consisting of $CaCO_3$ and SiO_2. The elemental composition of reinforcing fibers includes SiO_2, Al_2O_3, $CaSiO_3$ and pure Si. The presence of cracks in the fiberglass composite was also found. The strength of reinforcement under static tension has been studied. A quantitative assessment of the structure of the studied composite material has been carried out. Based on the results of the analysis, it was found that the distribution of fibers along the Feret diameter is uniform. The causes of premature destruction of composite reinforcement are established and recommendations are given for changing the reinforcement mechanism to improve operational properties.

Keywords: composite, reinforcement, mictostructure, fibers

Introduction. Composite materials with fibrous fillers according to the mechanism of reinforcing action are divided into discrete, in which the ratio of fiber length to diameter is relatively small, and with continuous fiber. Discrete fibers are placed randomly in the matrix. Fiber diameter from particles to hundreds of micrometers. The greater the ratio of length to diameter of the fiber, the higher the degree of strengthening.

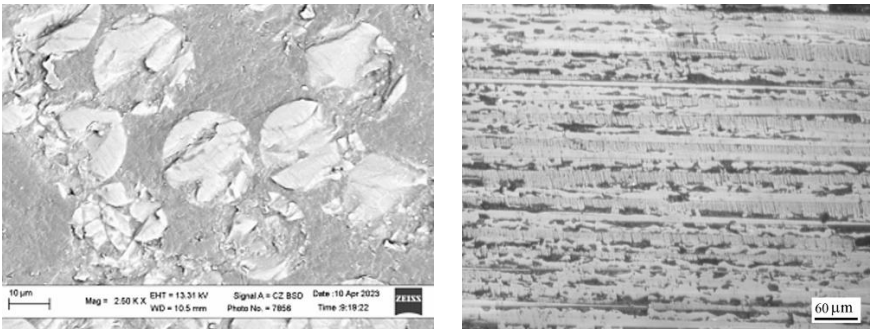
The use of composite materials for the manufacture of reinforcing building materials effectively increases the specific strength of structures. But there are a number of disadvantages of composite reinforcement due to the extensive anisotropy of properties.

Materials and method of investigation. The microstructure of the composite reinforcement was studied on transverse and longitudinal sections using metallographic analysis (MICROTECH MMT-14Ts) and electron microscopy (Zeiss EVO-40XVP). Quantitative analysis of the microstructure was carried out on the software product ImageJ. Elemental analysis was carried out by electron microscopy using an INCA Energy 350 energy dispersive X-ray spectrometer. Mechanical characteristics were determined by static tensile testing on a UIT STM 050 universal tensile testing machine.

Results and discussion. The distribution of structural components in the investigated composite material is somewhat uneven. There are places of depletion of reinforcing elements, and in some places, on the contrary, their

accumulation is observed. This may be due to non-compliance with the modes of production of reinforcement. By means of electron microscopy, it has been found that the fibers are preferably spherical in cross section (Fig. 1, a). When machining to produce a microsection, the surface of the fiber is damaged. Cracking, chipping and delamination are visible.

The study of the microstructure of the longitudinal section showed that the reinforcing elements of the studied material are fibers. They are discrete and located in parallel at a distance of 23-28 μm from each other (Fig. 1, b).



a b

Fig.1. Microstructure of composite reinforcement:
a – transverse microstructure; b – longitudinal microstructure.

According to the results of dispersed X-ray spectrometry, it was found that the basis of the studied reinforcement is a composition consisting of $CaCO_3$ and SiO_2. The elemental composition of reinforcing fibers includes SiO_2, Al_2O_3, $CaSiO_3$ and pure Si.

According to the results of computer processing of images of the microstructure in the ImageJ software complex, it was established that the distribution of fibers in terms of the Fere diameter is uniform. The cross-sectional diameter of the investigated fibers ranges from 1 to 8 μm, the predominant share belongs to fibers with a diameter of 3 μm.

During static stretching, the sample before cracking withstood a load of 6200 N. The tensile strength could not be established because cracking took place by a shear mechanism parallel to the reinforcing fibers in the places of fasteners.

Conclusions. A sample of composite reinforcement with unidirectional discrete fibers has a significant level of structure and property anisotropy. To improve the strength characteristics, it is recommended to reinforce the composite with discrete fibers in two or more directions.