AVERAGING OF THE MAGNETIC PROPERTIES OF FIBROUS FERROMAGNETIC COMPOSITES

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Within the framework of the model of regular structures, we average the magnetic properties of fibrous ferromagnetic composites with biperiodic structure. For the general case of packing of the fibers in any cross section, the problem is reduced to finding certain functionals determined from the solutions of a regular integral equation of the corresponding boundary-value problem of magnetostatics for the structure. For a special case of packing of the fibers with circular cross section, the solution is constructed in the form of a series in elliptic functions. As a result, we obtain approximate formulas for the macroparameters of the composites with perfect cells.

Keywords: ferromagnetic fibrous composite, averaging, macroparameters, method of integral equations, method of regular structures.

In finding the physical fields in structural elements, it is customary to replace composite materials with homogeneous materials equivalent to the medium with microstructure. In the investigation of fibrous composites with ferromagnetic matrix, we encounter the problem of averaging of the magnetic properties of these materials. These problems are of interest due to the fact that they connected with the possibility of control over the magnetic properties of these materials. Moreover, they serve as a basis for the solution of more complicated problems of averaging of the physicomechanical properties of piezomagnetic composites [1].

The stochastic methods aimed at the determination of the averaged physical properties of the composites were considered in [2–4]. The construction of a macroscopic model of fibrous composites with anisotropic and piezoelectric components within the framework of the model of regular structures was realized in [5, 6]. In what follows, by using the concepts from [5], we propose a procedure of determination of the macroparameters of fibrous ferromagnetic composites with biperiodic packing of fibers based on the method of integral equations and the method of regular structures. It should be emphasized that, in the design of structures made of composite materials, it is important not only to know their effective characteristics but also have information about the distribution of field quantities in the actual structure of the inhomogeneous material, which is necessary for the strength, reliability, and durability analyses. The method of regular structures, together with the construction of the macromodel of a composite, gives comprehensive information about local fields in the vicinity of inhomogeneities [5, 6].

Thus, we can conclude that the procedure of averaging consists of the following two steps:

(i) solution of the boundary-value problem of magnetostatics aimed at the determination of magnetic fields in the structure of the fibrous composite material;

(ii) evaluation of the effective characteristics of the composite.

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