APPLICATION OF THE ASYMPTOTIC HOMOGENIZATION IN PARAMETRIC SPACE TO THE MODELING OF STRUCTURALLY HETEROGENEOUS MATERIALS

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In the work structurally heterogeneous materials (including industrial composites, nanocomposites and soils, as composites of natural formation) which have changing effective mechanical, thermophysical and filtration characteristics that depend on temperature and spatial coordinates are considered. The materials class can also have smoothly changing internal microstructure (i.e. materials with functional-gradient properties).

The asymptotic homogenization method [1] in the parametric space [2, 3] is applied to the considered above equations, and it is shown that from the position of asymptotic homogenization, smooth nonperiodic dependences are resolved parametrically in the fast variables functions. As a result, for the problems in structurally heterogeneous materials a two-level scheme for the solution is formulated, and an algorithm for correct calculation of the effective characteristics including the functional-gradient properties is found.

For solution of low-level problems (it is a cell problem for fast variable functions that determine the effective characteristics of a materials), a block analytical-numerically approach develops that allows to construct effective approximations for an inclusion of arbitrary geometrical form on the basis of a generalized Papkovich-Neuber representation. Separately the class of inclusions of a spherical and cylindrical shape with an intermediate interphase layer is considered. For them complete systems of functions are constructed in the framework of the generalized Eshelby problem, which accurately take into account contact conditions on the interface boundaries. With help of these functions, the problem of material homogenization using the block analytic-numerical method is effectively solved. Accordingly, for solution of top-level problems (with effective characteristics), the finite-element approaches are developed based on existing software package, also on the basis of the Uway finite element software developed by the authors.

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