Numerical simulation of composite material thermal expansion by homogenization method

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The article considers a variant of the asymptotic homogenization method for calculation of effective thermal expansion coefficients of composite materials with thermoelastic properties. We formulate problems of local thermoelasticity over a periodicity cell of composites. A variational formulation of the thermoelasticity problem over a periodicity cell is proposed. A finite element method for computational solving of these problems of thermoelasticity is applied. For software implementation of the finite element method we use the software package developed by the Scientific and Educational Center of the BMSTU. We also give examples of numerical solution of the local problems of thermoelasticity for composites based on ceramic fibers and the polymer matrix. Effective coefficients of thermal expansion for composite materials with spatial arrangement of ceramic fibers and a polymer matrix were calculated for different temperatures. We show that processes of thermal decomposition of polymer matrix result in nonmonotonic dependence of the thermal expansion coefficient on temperature. The proposed algorithm allows to calculate the thermal expansion coefficients for composites with almost any structures of fiber reinforced matrices undergoing physicochemical transformations at high temperatures. Unlike a large number of the well-known approximate methods for calculating thermal expansion coefficients the proposed method allows to obtain the mathematically accurate values for these coefficients.

Ключевые слова: *multilayer thin shell, asymptotic homogenization method, asymptotic theory of shells*.

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