Parallel Computational Models for Composites Reinforced by Short Fibers

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The aspect ratio of the short fibres reinforcing composite material is often 10^3:1-10^6:1, or even more. Method of Continuous Source Functions (MCSF) developed by authors using 1D continuous source functions distributed along the fibre axis enables to simulate the interaction of fibre with the matrix and also with other fibres. 1D source functions serve as Trefftz (T-) functions, which satisfy the governing equations inside the domain (matrix) and boundary conditions on the fibre-matrix boundaries are satisfied in collocation points in the least square (LS) sense along the fibre boundaries. The source functions are defined by Non-Uniform Rational B-Splines (NURBS). Because of large gradients, large number of collocation points and many NURBS shape functions are necessary to simulate the interaction. Moreover, the matrices solving the problem numerically are full. In our model, only the interactions of each two fibres is solved by elimination and then the complex interaction of all fibres in a patch of fibres and the matrix is completed by iteration steps in order to increase efficiency of computations. For heat problem, material of fibres is supposed to be super-conductive in the first steps. The energy balance condition in each fibre enables to find temperature change of each fibre by the interaction with the other fibre in the first iteration steps. The next iteration steps enable to correct the temperature changes of the fibres by complex interaction of all fibres and the matrix and distribution of the source functions inside the fibres are obtained. Temperatures and heat flows in the control volume enable then to define homogenized material properties for corresponding patch of the composite material.

Keywords: Computational mechanics, composite materials, short fibers, 1D continuous Trefftz functions, LS collocation.