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AN ADAPTIVE FE^2 APPROACH FOR THE SIMULATION OF A MATRIX-SMA-FIBER COMPOUND

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The contribution deals with an adaptive FE^2 approach for the analysis of a fiber-matrix composite, where the fibers are randomly distributed shape-memory alloys in a linear-elastic matrix, see [1] . The standard FE^2 approach can be found in e.g.[2] and has the disadvantage of a high computational effort. The adaptive approach depends on the idea, that an accompanying homogenization is only necessary in case of the nonlinear behavior on the lower scale. The goal of the adaptive approach is to predict the nonlinear regime of the fibers. Therefore an indicator is developed, which makes use of different homogenization strategies. The boundary value problem of the lower scale is solved by applying traction boundary conditions (tbc) and displacement boundary conditions (dbc). The tbc problem is solved by following [3] and leads to an underestimation of the effective material tangent modulus. It is used as the initial homogenization for the adaptive approach and leads to an overestimation of the displacement response and thus the strain state on the macro-scale . The prediction of the nonlinear behavior is performed via the reformulation of the phase transition condition in terms of a critical strain state and is used as an indicator for FE^2. A multiscale analysis is only performed if the indicator is violated. This procedure results in a computational saving due to the lower number of equations in the complete problem. Since shape memory alloys are very temperature sensitive a thermal homogenization is performed to get the effective heat conductivity tensor. On the macro-scale the weak form of equilibrium and the transient heat equation are solved to determine the deformation and the temperature state. Some numerical examples demonstrate the capability of the formulation.

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