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OPTIMIZATION OF MICROSTRUCTURE IN MULTISCALE PROBLEMS WITH USE OF PARALLEL EVOLUTIONARY ALGORITHM

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ABSTRACT

The paper is devoted to application of parallel evolutionary computing [1,6] to optimization in multi-scale modelling. The computational homogenization [5,2] is used in solving the multi-scale problem. A composite made from two materials (matrix and fiber) is considered. The goal of the optimization is to obtain the composite which gives the best performance in macroscale for considered load case. The macro and micro structures are computed using the finite element method [7]. The optimal shape of the fiber in the composite material is obtained using evolutionary optimization [3].

The numerical example of optimization with a beam made from composite is considered (Fig. 1a). The fitness function is evaluated for each chromosome. The fitness function is expressed as a minimal value of maximal reduced displacement in the beam. The shape of the fiber is coded into chromosomes genes. The genes play role of coordinates of the NURBS control polygon points (Fig. 1b). A representative volume element (RVE) is used as the microstructure. The periodic boundary conditions are applied (the periodicity of displacement is used).

Numerical results of material identification are shown in Fig.2. The best microstructure after the first iteration is shown in Fig. 2a, and after optimization in Fig. 2b. The objective function changed value during optimization from 6.8 to 5.2.

The full paper contains more numerical examples and speedup measurements of the parallel evolutionary algorithm.

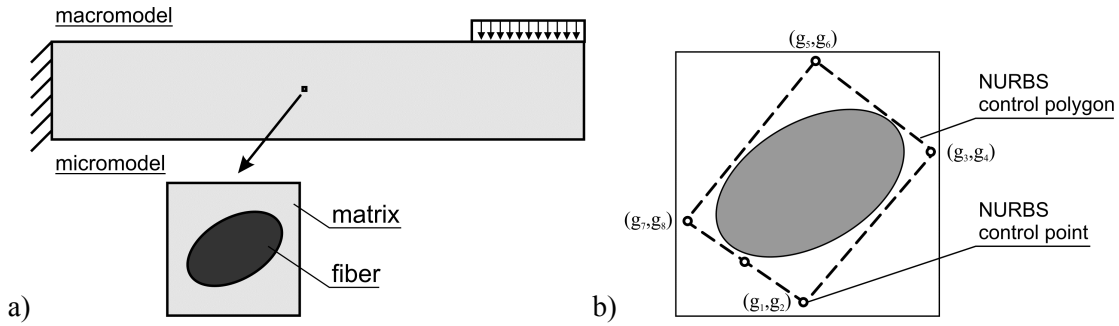

Figure: 1. a) The analyzed beam, macro and micro model,
b) the fiber shape definition using NURBS curve

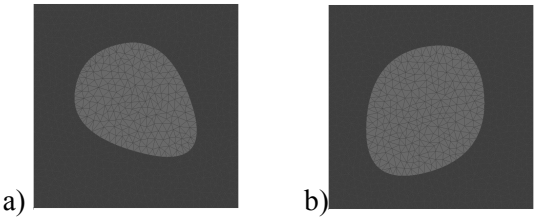

Figure: 2. The best result of optimization a) after first generation, b) after optimization

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