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COMPLEX SYSTEM OF IDENTIFICATION OF MATERIAL PROPERTIES OF MICROSTRUCTURE USING BIOINSPIRED METHOD

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Abstract: The paper is devoted to identification of a microstructure distribution of materials using artificial immune system (AIS). The identification is performed on the basis of homogenized material properties. The coefficients of homogenized elastic matrix are used in the objective function. The goal of the identification is to obtain the material distribution in the microstructure which gives the same homogenized elastic material coefficients as the reference material. The objective function value in the identification process is evaluated with use of the FEM. Due to symmetry of the stiffness and compliance matrices, the 9 variables are independent in the fully orthotropic elastic material. The material coefficients in the case of linear problems can be obtained once for each microstructure. The six analyses should be performed for each microstructure to obtain the 9 independent orthotropic material coefficients. The distribution of the materials depends on the function depending on vector of design variables playing role of control points and coordinates. The level set of the function determines the topology of the structure. The material properties for each element of the RVE mesh depend on belonging to the sub or superlevel set of function. The artificial immune system is a computational adaptive system inspired by the principles, processes and mechanisms of biological immune systems. The algorithms typically use the characteristics of the immune systems like learning and memory to simulate and solve a problem in a computational manner. In this algorithm clonal selection mechanism was used. In the first stage of artificial immune algorithm the memory cells are created randomly. Next cells are proliferated and mutated creating new cells. The number of clones created by each memory cell is determined by the memory cells objective function value. The objective functions for each cell is evaluated. The selection process exchanges some memory cells for better cells. The selection is performed on the basis of the geometrical distance between each memory cell and its mutated cells (measured by using design variables). The crowding mechanism removes similar memory cells. The similarity is also determined as the geometrical distance between memory cells. The process is iteratively repeated until the stop condition is fulfilled. The stop condition can be expressed as the maximum number of iterations. Acknowledgment. The scientific research was partially funded by National Science Centre, Poland, grant no.2015/19/B/ST8/02629 and from the statute subvention of Silesian University of Technology, Faculty of Mechanical Engineering.