Congress on Numerical Methods in Engineering
Lisboa, June 29 to July 02, 2015

RESUMO N° 338

COMPUTATIONAL STRATEGIES TO SPEED UP THE SOLUTION OF HOMOGENIZATION-BASED MULTI-SCALE PROBLEMS

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Keywords: Multi-Scale, Representative Volume Element, Parallel Computing, High Performance Computing

The modelling of heterogeneous multi-phase materials has been a topic of extensive research over recent years. An important class of computational homogenization techniques, which addresses both the influence of the microstructure and the coupling with the resulting macroscopic response, is known as multilevel finite element framework (ML-FEM) or FE2[1]. This method is based on the nested solution of two coupled problems, one at a macro-scale and other at the micro-scale, where a micro-scale computation is conducted over a statistically representative volume element in order to extract quantities required for the macro-scale. Therefore, as the size of the macroscopic and/or microscopic problem increases, memory storage and computational requirements can become excessive, making the solution of realistic problems extremely challenging. To overcome this issue, procedures like parallelization [1] and the use of reduced order models [2] have been used.

The present contribution proposes computational strategies to optimize the incremental boundary value problem at the micro-mechanical level. These strategies take into account modern computer architectures to increase the performance and to reduce memory usage. They include parallelism and optimized memory access patterns, from one side, and efficient storing approaches from the other side. The speed up and memory gains obtained with the proposed approaches are critically assessed through the solution of several micro-scale problems.

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