Two-scale Hydro-Thermo-Mechanical Analysis of Heterogeneous Materials and Structures Performed on Clusters of PC

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ABSTRACT

Coupled hydro-thermo-mechanical analysis of heterogeneous materials and structures is very time consuming. For example, the numerical solution of heat and moisture transport in masonry based on the finite element method usually leads to huge numbers of degrees of freedom. It is mainly caused by the situation that there are relatively thin layers of mortar in contrary to large bricks or stones. The mortar and stones have very different material parameters and the finite element mesh has to be able to describe the correct temperature and moisture fields in the thin layers of mortar and in their vicinity. This paper is devoted to the utilization of parallel processor farms (clusters of PC) in such complicated coupled problems in order to reduce the total computational time.

The processor farming is used in a two-level approach (see [1]). The whole structure is described by a reasonably coarse finite element mesh, called the macro-scale problem, and the material parameters are obtained from the lower-level problems, called the meso-scale problem. This method differs from the domain decomposition methods, e. g. in [2]. The two-level method assumes each macro-scopic integration point or each macro-scale finite element is connected with a certain meso-scopic problem represented by an appropriate representative volume element (periodic unit cell). The solution of a meso-scale problem provides effective properties needed on the macro-scale. The macro-problem is assigned to the master processor while the homogenization at the meso-level is carried out on slave processors. At each time step the current temperature, moisture and their gradients at a given macro-scopic integration point are passed to the slave processor (imposed onto the associated periodic cell), which, upon completing the meso-scale analysis, sends the homogenized data (effective conductivities, averaged storage terms and fluxes) back to the master processor.

The processor farming method with two-scale approach seem to be an efficient tool for coupled analysis of large or complicated structures such as masonry arch bridges. The significant reduction of computational time is obtained in comparison with the classical single processor solution.

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REFERENCES

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