

High-performance model order reduction in non-linear multiscale modelling of cementitious materials

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ABSTRACT

Multi-scale computational homogenization methods (FE²) offer a huge potential to incorporate, to macroscopic non-linear modelling in concrete-like materials, the complexity of the material meso/micro-structure morphology, through simple and physically realistic models. However, they presently suffer the burden of their enormous computational cost, since the computational complexity (number of the involved operations) has a multiplicative character in terms of the involved sampling points at every scale.

In this context, a powerful, and conceptually simple but efficient, multiscale computational model for fracture of cementitious materials has been recently presented by the authors in [1] and successfully applied to a number of 2D benchmarks. In this work, two combined techniques are explored and applied to that model: 1) low-dimension-space projection of the solution (reduced order modeling, ROM) and 2) reduced optimal quadrature (ROQ). They lead to a high performance reduced order model (HPROM) of the original high fidelity (HF) multiscale fracture problem [2], which dramatically diminish the computational demand, at the cost of a very small additional error. A number of representative simulations in 2D problems show high resulting speedups and linear scalability in terms of the problem complexity, which make think of the HPROM techniques as a possible way to make computational multi-scale computational fracture available for daily-life engineering problems.

REFERENCES

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