DEM-FEM Multi-scale modelling: overcoming numerical issues

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ABSTRACT

The multi-scale FEM-DEM approach is an innovative numerical method for geotechnical problems, using at the same time the Finite Element Method (FEM) at the engineering macro-scale and the Discrete Element Method (DEM) at the scale of the microstructure of the material. The link between scales is made via computational homogenization. In this way, the continuum numerical constitutive law and the corresponding tangent matrix are obtained directly from the discrete response of the microstructure [1,2,3].

In the proposed paper, a variety of operators, rather than the tangent consistent for the Newton-Raphson method, is tested in a challenging attempt to improve the poor convergence performance observed. The independence of the DEM computations is exploited to develop a parallelized code. The non-uniqueness of the solution is an already well known phenomenon in softening materials, but in this case the non-uniqueness results in a loss of objectivity due to the parallelization, this phenomenon is presented and discussed. At the macro level, a second gradient constitutive relation is implemented in order to enrich the first gradient Cauchy relation bringing mesh-independency to the model.

Some results are given exhibiting the above findings with emphasis on aspects related to strain localisation.

REFERENCES

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