Proceedings, ICCES, vol.23, no.1

Tech Science Press

Coupling VEM and BEM for computational homogenization of composite materials

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Abstract: The Virtual Element Method (VEM) [1] is a recent numerical technique that is capable of dealing with very general polygonal and polyhedral mesh elements, including irregular or non-convex ones. Because of this feature, the VEM ensures noticeable simplification in the data preparation stage of the analysis, especially for problems whose analysis domain features complex geometries, as in the case of computational micromechanics problems [2]. The Boundary Element Method (BEM) [3] is a well-known, extensively used and efficient numerical technique that has been successfully employed for the computational homogenization of materials with complex morphologies [4]. Due to its underlying formulation, the BEM allows reducing the dimensionality of the problem, resulting in substantial simplification of the preprocessing stage and in the reduction of the computational effort, without jeopardizing the solution accuracy. In this contribution, we explore the capabilities of a coupled VEM and BEM approach for computational homogenization of heterogeneous materials with complex microstructures. The test morphologies consist of unit cells with irregularly shaped inclusions, representative e.g. of a fibre-reinforced polymer composite. BEM is used to model the inclusions, while the VEM is used to model the surrounding matrix material. Benchmark analytical and finite element solutions are used to validate the analysis results.

Keywords: Virtual Element Method, Boundary Element Method, Micromechanics, Computational homogenization

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DOI: 10.32604/icces.2021.08335