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A HIERARCHICAL APPROACH FOR LOCAL ENRICHMENT OF THE FINITE CELL METHOD

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ABSTRACT

We present a hierarchical approach for local enrichment of the finite cell method applied to problems of solid mechanics involving discontinuities and singularities. In contrast to the standard eXtended finite element method (XFEM), where new degrees of freedom are introduced for all finite elements located in the enrichment zone, we define the enrichment on a so-called overlay mesh which is superimposed over the base mesh. The approximation on the base mesh is obtained by means of the finite cell method (FCM) [1] where the hp-d method [2] is employed to introduce the hierarchic extension on the overlay mesh. The FCM combines ideas from fictitious domain methods with the p-version of the finite element method. Besides supporting a fast and simple generation of meshes, it also allows for high convergence rates, provided the exact solution of the underlying mathematical problem is sufficiently smooth. In the case of discontinuities or singularities the FCM needs to be enriched, to maintain high-order convergence rates providing accurate results. To this end, we present two different strategies for defining the enrichment on the superimposed overlay mesh. In the first approach, the enrichment is based on a local h-, p- or hp-refinement utilizing the finite element method on the overlay mesh. Alternatively, the enrichment is constructed by means of the partition of unity method (PUM) introducing carefully selected enrichment functions suitable for the problem at hand. The proposed method is presented for problems with strongly heterogeneous materials, including pores and material interfaces. Several examples will be presented to discuss the basic characteristics of the proposed local enrichment strategy.

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