Failure modeling in masonry structures using adaptive multiscale domain decomposition techniques

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ABSTRACT

Masonry is a highly heterogeneous composite consisting of two materials: bricks and mortar. These two constituents have different material properties, resulting in a complex composite behavior. An accurate masonry model in which both constituents are modeled explicitly, such as microscopic and mesoscopic models [1], requires an enormous amount of computational resources, especially when damage-induced nonlinearities are included. An alternative strategy to model masonry structures are macroscopic models, where homogenized elements are used which combine brick and mortar into one material element. This removes the upper bound on the element size, leading to a reduction in element numbers, but makes it hard to capture the inherent nonlinear composite behavior.

An underexplored solution in the analysis of masonry structures is the use of domain decomposition techniques [2,3]. This separates the composite material into regions of microscopic and macroscopic elements [4]. Doing this adaptively, one gains a large increase in computational efficiency [5], enabling the modelling of larger failing structures. While these techniques are being successfully applied in other parts of science and engineering [6], specific applications to the unique problem posed by masonry are scarce.

In this work, one develops a novel finite element based framework that formulates an adaptive domain decomposition technique with the goal of accurately, and efficiently, simulating large masonry structures. Particular focus is devoted to optimizing the choice of different RVE's (Representative Volume Elements) and refinement criteria. One demonstrates the accuracy and performance of the novel method by comparing it to more classical strategies on simple reference systems.

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