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Multiscale computational first order homogenization of thick shells for the analysis of out-of-plane loaded masonry walls

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Abstract

This work presents a multiscale method based on computational homogenization for the analysis of general heterogeneous thick shell structures, with special focus on periodic brick-masonry walls. The proposed method is designed for the analysis of shells whose micro-structure is heterogeneous in the in-plane directions, but initially homogeneous in the shell-thickness direction, a structural topology that can be found in single-leaf brick masonry walls. Under this assumption, this work proposes an efficient homogenization scheme where both the macro-scale and the micro-scale are described by the same shell theory. The proposed method is then applied to the analysis of out-of-plane loaded brick-masonry walls, and compared to experimental and micro-modeling results.

Keywords: Computational Multiscale Homogenization, Representative Volume Element (RVE), Shell, Masonry, Periodic Micro-structure, Strain Localization

1. Introduction

Masonry is an ancient building material that have been extensively used throughout the history, and it is still used nowadays. Being the main building technique adopted in historical constructions, a deep understanding of masonry mechanical behavior is therefore of primary importance for the preservation of our cultural heritage. However, the formulation of phenomenological constitutive equations for heterogeneous materials such as masonry is still a challenge [1, 2, 3]. The evolution of the structural response strongly depends on complex micro-structural phenomena such as damaged-induced anisotropy and localization of deformation in the micro-structure. It is therefore difficult to account for the influence that this evolving micro-structure has on the overall macroscopic

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