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MULTISCALE FINITE ELEMENT MODELING LINKING SHELL ELEMENTS TO 3D CONTINUUM

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Multiscale approach represents an efficient tool to study the response of heterogeneous materials, as this allows for the detailed geometric/mechanical modeling. In this framework, many models were developed for masonry [1]. Indeed, the composite nature of the material, made of bricks/blocks and mortar joints, plays a significant role on the structural behavior, making the global failure mechanisms strongly affected by arrangement and mechanical properties of the constituent materials. Thus, multiscale formulations, developed within finite element codes, are suitable to study masonry constructions and, when properly formulated, can limit the computational effort required.

This work explores the response of flat and curved masonry structural elements with periodic texture by using the multiscale model recently presented in [2]. At the macroscopic level the real heterogeneous masonry material is modeled as an equivalent homogenized shell, whose constitutive response is derived by the detailed analysis of a three-dimensional representative unit cell, made of elastic bricks and nonlinear interfaces. A Transformation Field Analysis-based procedure is used to link the two scales, thus resorting to a reduced order model with indubitable computational advantages. Finite element numerical applications are performed to investigate the effects of texture, boundary and loading conditions on the ultimate strength and failure mode of masonry walls in-plane and out-of-plane loaded. Moreover, behavior of curved elements, like arches, domes and vaults, is investigated exploiting the advantages of the adopted computational tool, that is, following the damaging paths evolving in the structure up to the collapse. Results obtained with the proposed model are compared with both micromechanical and experimental outcomes.

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