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A homogenized model for the nonlinear analysis of masonry columns in compression

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Abstract

A homogenized model based on simplified kinematic assumptions for the analysis of masonry columns subjected to axial forces is presented. A Unit Cell (UC) characterized by different arrangements of clay bricks and mortar joints is modeled and analyzed. The kinematic unknown fields are approximated by cubic interpolation functions and the compatible strain fields are accordingly derived. Stresses in bricks and mortar are evaluated on the basis of a damage constitutive law, relying on a modified Willam-Warnke yield criterion and an exponential evolution for the damage variable. The equilibrium equations are consistently deduced via the virtual displacement principle. A numerical solution procedure is proposed and described in detail, using the collocation technique to solve the nonlinear evolution problem of damage variables in masonry constituents. Numerical applications are presented to validate the proposed model. The response of UCs characterized by different geometrical textures is numerically studied and the results are compared with those obtained by well assessed nonlinear nonlocal finite element (FE) modeling approaches. Finally, a parametric investigation on the effects of constituents mechanical properties on the overall UC response is performed and a comparison with experimental evidences is illustrated.

Keywords: Brick masonry, Micromechanical analysis, Homogenization, Damage law, Strength in compression, Collocation method.

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