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A NOVEL MACRO-DISTINCT ELEMENT MODEL FOR THE IN-PLANE ANALYSIS OF UNREINFORCED MASONRY STRUCTURES

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Abstract

The use of Distinct Element Method (DEM) based micro-modeling strategies for simulating the response of unreinforced masonry (URM) structures has primarily focused on the analysis of local problems of arched and reduced-scale dry-joint assemblies, i.e. in cases where the number of degrees of freedom is limited and the effect of masonry material properties is usually not predominant. While DEM provides the possibility of explicitly representing damage patterns and failure mechanisms, as well as of accounting for the mechanical interaction among in-plane and out-of-plane loaded components, the computational cost is high. In this work, aimed at combining the efficiency of simplified modeling strategies with the accuracy of discontinuum-based micro-modeling approaches, the development of a novel macro distinct element model (M-DEM) for simulating the response of large-scale URM assemblies with mortared joints is presented and discussed. Shear and flexural failure modes are accounted for by zero-thickness interface spring layers, whose geometrical distribution is determined *a priori* as a function of the considered masonry bond pattern. The discretization scheme is conceived in such a way that the model can be used to simulate both in-plane and out-of-plane damage, as well as combined mechanisms. Simplified expressions are proposed for determining equivalent stiffness and strength properties of the interface spring layers that separate the macro blocks. Masonry crushing failure is modeled through homogenized Finite Element macro blocks. Further, to avoid mesh dependency, a linearized version of the Feenstra compression model, typically employed in the field of concrete fracture mechanics, was implemented. The use of the proposed modeling strategy is demonstrated through an initial application, involving comparisons against experimental static tests on full-scale URM components, subjected to in-plane shear-compression loading cycles. Preliminary results indicate that the model can satisfactorily reproduce the load-displacement curves and the in-plane hysteretic responses in a reasonable timeframe, as well as the experimentally-observed failure mechanisms.

Keywords: macroelement, Finite-Distinct Element Method, in-plane, cyclic, unreinforced masonry

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