A simplified modelling approach for the practical engineering assessment of unreinforced masonry structures using layered shell elements

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ABSTRACT

Unreinforced Masonry (URM) had been extensively used as a construction material in mass structures with predominant compression load paths. Despite its reasonably established performance under gravity actions, it can be quite vulnerable to seismic loading, predominantly due to its limited tensile strength and associated quasi-brittle failure modes. Therefore, a reliable seismic assessment of URM structures, including heritage buildings, is vital to ensure life safety and minimise their risk of collapse. This can assist in implementing effective remedial measures, if required, to ensure desirable performance level in future events. Despite significant advancements in masonry research, practical assessment of URM has always been a challenge for structural engineers due to the complexity of the mechanics and geometry involved. Different modelling approaches have been trialled so far, which are typically based on equivalent frame, discrete and continuum elements in 2D/3D domains. In this paper, a simplified nonlinear model is introduced within the framework of conventional layered shell elements, which can be easily implemented in commonly used FE packages, e.g. ETABS and OpenSEES. In this model, the URM shell element comprises three layers accounting for cohesion and axial-frictional behaviour parallel and perpendicular to the bed joints, where the mechanical properties can be adjusted for various masonry configurations. The performance of the proposed model is validated against several experimental tests available in the literature, where a good correlation with test data is achieved across various design scenarios and loading conditions.