Earthquake & Structural Dynamics
The Journal of the International Association for Earthquake Engineering

EARTHQUAKE ENGINEERING & STRUCTURAL DYNAMICS
Earthquake Engng Struct. Dyn. (2015)
Published online in Wiley Online Library (wileyonlinelibrary.com). DOI: 10.1002/eqe.2594

Advanced frame element for seismic analysis of masonry structures: model formulation and validation

Eva Raka, Enrico Spacone*,†, Vincenzo Sepe and Guido Camata

Department of Engineering and Geology, University 'G. D'Annunzio' of Chieti Pescara, viale Pindaro 42, I-65127 Pescara, Italy

SUMMARY

This paper presents a masonry panel model for the nonlinear static and dynamic analysis of masonry buildings suitable for the seismic assessment of new and existing structures. The model is based on an equivalent frame idealization of the structure and stems from previous research on force-based frame elements. The element formulation considers axial, bending, and shear deformations within the framework of the Timoshenko beam theory. A phenomenological cyclic section law that accounts for the shear panel response is coupled, through equilibrium between shear and bending forces along the element, with a fiber-section model that accounts for the axial and bending responses. The proposed panel model traces with a low computational burden and numerical stability the main aspects of the structural behavior of masonry panels and is suitable for analyses of multi-floor buildings with a relatively regular distribution of openings and with walls and floors organized to grant a box-like behavior under seismic loads. The model capabilities are validated though analyses of simple unreinforced masonry panels and comparisons with published experimental results. The model accuracy is strongly dependent on the fiber and shear constitutive laws used. However, the formulation is general, and laws different from those employed in this study are easily introduced without affecting the model formulation.

Received 23 September 2014; Revised 11 May 2015; Accepted 20 May 2015

KEY WORDS: masonry structures; nonlinear analyses; equivalent frame; fiber elements; force-based formulation; cyclic analysis