AN EQUIVALENT TRUSS MODEL FOR NONLINEAR STATIC ANALYSIS OF URM BUILDINGS

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Keywords: Equivalent Truss Model, Nonlinear Static Analysis, Shear Wall, Unreinforced Masonry

According to the importance of seismic evaluation of existing unreinforced masonry buildings, researchers are mostly interested in numerical modelling of these types of structures and their components. Different numerical tools are applied in the proposed numerical modelling methods such as finite element method, discrete element method and equivalent frame method (Roca, 2005 and Lagomarsino et al., 2013).

On the other hand in seismic evaluation and retrofitting codes which are mostly based on Performance Based Seismic Design, different analysis methods such as linear and nonlinear, static and dynamic analyses are recommended. So, simple equivalent frame models with lower computational cost with compare to the complex finite element models are very useful for modelling and analysis of unreinforced masonry buildings.

In this paper at first, a simple equivalent truss model is proposed for modelling of an unreinforced masonry wall which sliding shear failure is the dominant in-plane failure in it. Next, the proposed model is applied for push over analysis of an unreinforced masonry building with appropriate nonlinear load-displacement behaviour.

The in-plane shear capacity corresponding to sliding shear failure is calculated with the general Mohr-Coulomb relationship:

$$\tau=C+\sigma\mu \qquad (1)$$

Where τ is the shear stress which causes sliding in mortar bedjoints, C is the brick-mortar bond shear cohesion, σ is the normal stress on mortar bedjoints and μ is the brick-mortal bond coefficient of friction.

Considerable number of seismic design and evaluation codes for unreinforced masonry buildings like FEMA356 or Eurocode6 use relationships with general form of equation 1 for calculation of in-plane shear capacity of URM walls. According to this relationship, the in-plane shear capacity of the wall depends on the normal stress on mortar bedjoints due to the gravity loads on the wall. This property causes some difficulties in nonlinear analysis of URM buildings.

The equivalent truss model for masonry shear walls proposed in this paper consists of 2 truss elements, one vertical element and another inclined one, (Figure 1). A plastic hinge is also assigned to the vertical element which models the failure of the wall due to sliding shear failure based on equation 1. The section properties and plastic hinge parameters of the truss elements are obtained with simple equilibrium equations and an analogy with the general equation for the in-plane shear capacity of the unreinforced masonry walls. The most prominent advantage of the proposed model is that it considers automatically the effect of gravity load on in-plane shear capacity of the wall which is very helpful in the next step of the research.

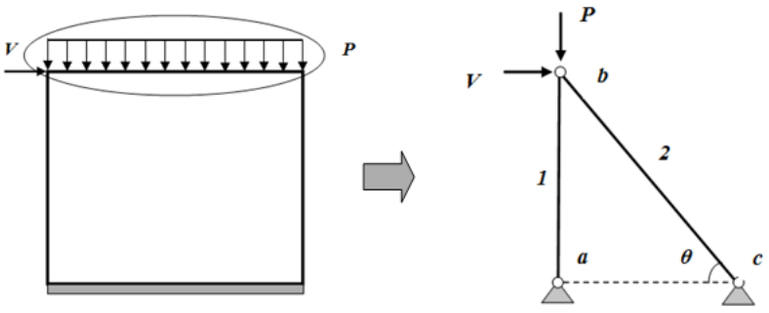

Figure 1. Equivalent truss model for unreinforced masonry wall

In the second part, the truss model is applied to do push over analysis of unreinforced masonry buildings with combination of several walls. For this purpose, the assembling procedures of the walls with different nonlinear behaviours in buildings with one, two and more stories are discussed completely. Then a push over analysis is performed on a building with current method as an example and the results are compared with other previous numerical methods.

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