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NONLINEAR CYCLIC STATIC ANALYSIS OF CONFINED MASONRY WALLS USING STRUT-AND-TIE MODEL

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Confined masonry buildings (CMBs) are often used as an earthquake resistant system even in high seismicity areas, particularly in villages and towns. This system consists of some structural masonry walls (consisting of units and mortar bands) accompanied by horizontal and vertical reinforced concrete tie/bond beams. The behavior of confined masonry buildings under seismic loading is very complicated and the correct prediction of their response depends on the accurate simulation of their components (i.e. masonry walls and RC confining tie beams) interaction. For the analysis and design of structures, macro-modelling strategy is generally adopted in common practice. However, in such a way, it should be kept in mind that in addition to the simplicity and efficiency of the strategy, it should also have a reasonable accuracy.

Since masonry materials play a major role in masonry buildings, identification of their mechanical properties is an important initial step in understanding the behavior, analysis, and simulation of masonry buildings. Mechanical properties of masonry materials can be studied from two perspectives; the first view is determining the mechanical properties of masonry components which is carried out by testing small samples of masonry units and mortar, and the second view is the mechanical characteristics of masonry prisms (a specimen of a specified dimensions consisting of several masonry units and mortar) that represent the properties of masonry material in a larger aspect. In numerical modelling of confined masonry walls using the strut-and-tie model and Mann and Müller [1982] theory, mechanical properties of masonry materials are required based on both the above-mentioned views. In the SeismoStruct software, similar to the strut-and-tie approach, masonry wall modelling can be done using a pair of inclined compression/tension struts by the infill element in a textual environment. Of course, in this software, the compression/tensile struts also accompany with a shear strut in the middle of them as illustrated in Figure 1. This model was originally developed by Crisafulli [1997] and implemented in the SeismoStruct software by Blandon [2005] to be used for modelling the behavior of framed masonry walls with the infill panel element. In this paper, by omitting the shear strut and ignoring its effects, the purpose is to evaluate and select the appropriate previously proposed relationships for the mechanical parameters of the compression/tensile struts to predict the overall response of confined masonry walls. In addition to defining the mechanical properties of the compression/tensile struts, there is also a set of empirical parameters that their values are important and must be estimated appropriately. On the other hand, these empirical parameters which affect the accuracy of the hysteresis response curves obtained from time-history analysis, themselves depend on many other factors. In this study, the values of these parameter were assumed as proposed by Crisafulli [1997] for masonry materials.

In this paper, first, it is tried to study the behavior of confined masonry buildings' materials and components and the mathematical relations to define the required mechanical properties to be used in their macro-modelling. Besides, existing macro-modelling strategies for the analysis of masonry walls such as strut-and-tie model are described. Then, the validity of the strut-and-tie based model proposed for the nonlinear analysis of infilled frames (Crisafulli, 1997) and implemented in SeismoStruct (2016) software is investigated using the results of available experiments on confined masonry walls in the literature.

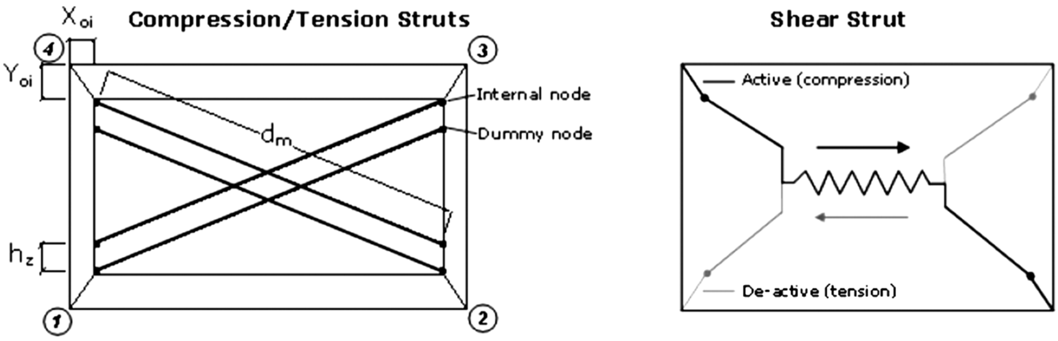

Figure 1. Infill element struts configuration in SeismoStruct Software (2016).

The considered experimented specimens consist of two 2/3-scale confined brick masonry walls (CBW1 and CBW2) designed and constructed according to the IS2800 specifications and tested by Tasnimi (2005) in BHRC. Figure 2 illustrates the comparison between the hysteresis curves diagrams of the experimented specimen CBW1, and that of the numerical analysis, up to a deformation in which the failure mechanism is formed. Comparing the results of numerical modelling analyses with the experimental results indicate that the adopted numerical modelling strategy with SeismoStruct software predicts appropriately the overall response of the confined brick walls and can be considered as a simple solution along with laboratory tests. Therefore, it is possible to estimate the behavior of confined masonry buildings in a wide range of conditions without the need for extensive laboratory works.

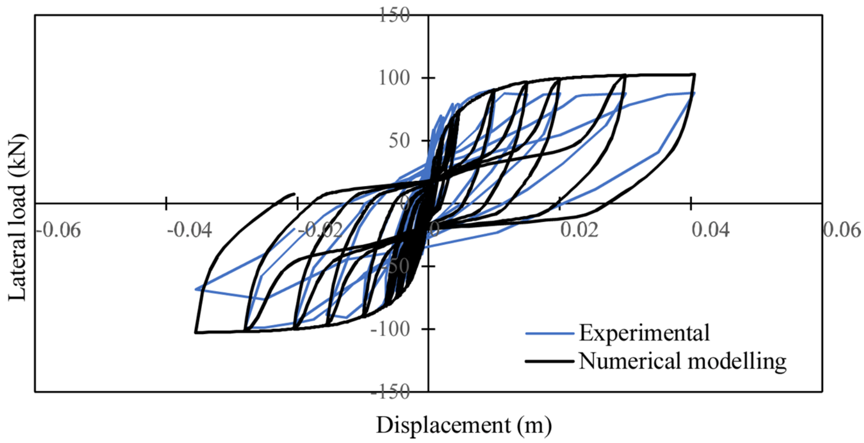

Figure 2. Comparison of numerical and experimental hysteresis curves of specimen CBW1.

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