SEISMIC BEHAVIOR FACTOR FOR UNREINFORCED CONCRETE BLOCK MASONRY WALLS

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During moderate to high seismic events, inelastic deformations are expected to occur in shear wall buildings which result in a significant reduction in the building's seismic demand. Nowadays, seismic design guidelines for buildings, such as ASCE-7, NBCC, Eurocode-8 (EC-8), assume nonlinear response in selected components when subjected to an earthquake of the design intensity level. However, these codes and guidelines do not explicitly incorporate the inelastic response of a structure in the design methodology. These designs are usually based on force-based elastic analyses rather than displacement-based methods. The equivalent static lateral force method, which has been used since the early days of seismic design, is still the most preferable method for a structural design engineer, because it is conceptually simple and less demanding from a computational point of view. Most seismic design codes use the concept of response reduction to account for the nonlinear response of a structure. In this approach, the design base shear (V_d) is derived by dividing the elastic base shear demand (V_e), which is obtained using an elastic analysis considering the elastic spectral response acceleration (for 5% damping, S_a), by a factor R:

$$V_d = \frac{V_e}{R} = \frac{S_a W}{R} \tag{1}$$

where, W is the effective seismic weight of the structure and R is termed "seismic behavior factor" in the Iranian Seismic Code (Standard No. 2800) and in the Eurocode 8 and "response modification coefficient" in ASCE 7. There are differences in the way the seismic behavior factor (R) is specified in different codes for different types of structural systems.

The studies reported in the literature on seismic behavior factor, R, have concentrated on reinforced masonry constructions (Shedid et al., 2010; Shedid et al., 2011). Recently, Khajeheian and Maheri (2017) have carried out work on assessment of R-factor for URCBM walls retrofitted by one-sided and two-sided RC layer. In addition, Maheri et al. (2019) evaluated the in-plane seismic strength and performance of full-scale hollow concrete block masonry walls retrofitted by RC layers. Due to little available research data on the R-factor of unreinforced concrete block masonry (URCBM) walls, the main goal of the present paper is to obtain R-factor for these structural walls.

The work presented in this paper focuses on determination of the R-factor for URCBM walls with two limiting boundary conditions; (i) restrained in vertical direction, resulting in a primarily shear behavior for the wall and (ii) free in vertical direction, in which the top of the wall is allowed to move in the vertical direction, hence allowing flexural cantilever behavior. This objective is achieved in four phases; (i) considering limited available information, in-plane pushover tests are first conducted on small-scale walls; (ii) results of the tests are then used to develop and calibrate appropriate numerical models of URCBM walls; (iii) nonlinear pushover analyses are then conducted on different full-scale numerical models with different aspect ratios (height/length) of 0.5, 1.0 and 2.0, having two different boundary conditions, to investigate the effects of some problem variables, and finally; (iv) results of the full-scale analyses are used to calculate and compare the seismic behavior factor, R, of these masonry structural walls. The force-displacement curves of full-scale walls with different aspect ratios, obtained from the analyses, are compared in Figure 1. It is found that R-value of block masonry shear wall increases with an increase in the aspect ratio of the wall. Besides, based on the findings, R-values of 2.0 and 3.0 are proposed for restrained and cantilever URCBM shear wall construction, respectively.

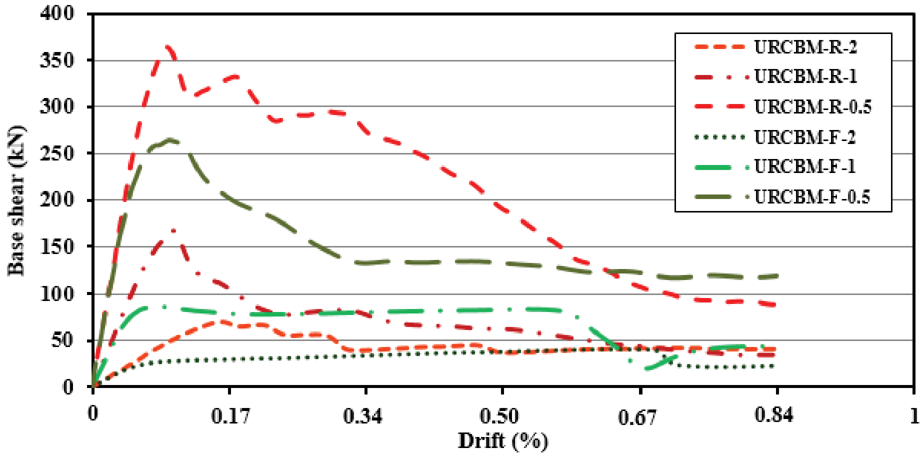

Figure 1. Force-displacement response curves of full-scale URCBM walls (Maheri et al., 2019).

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