8th International Conference on Seismology & Earthquake Engineering
11-13 Nov. 2019, Tehran, Iran

QUASI-STATIC SHEAR-COMPRESSION TESTS ON SIX RUBBLE STONE MASONRY WALLS

Amir REZAIE
Ph.D. Candidate, EPFL, Lausanne, Switzerland
amir.rezaie@epfl.ch

Michele GODIO
Ph.D., EPFL, Lausanne, Switzerland
michele.godio@epfl.ch

Katrin BEYER
Associate Professor, EPFL, Lausanne, Switzerland
katrin.beyer@epfl.ch

Keywords: Stone-masonry wall, Shear-compression cyclic test, 3D displacement field, DIC

Stone-masonry works are among the most vulnerable structures to earthquakes, especially the typology A (MIT, 2009), which are the walls constructed with uncut stones and pebbles with irregular arrangement. Recently, a database of quasi-static cyclic tests on stone-masonry walls that were publicly available has been published (Vanin et al., 2017). In the database there are only a few results available for the typology A. To be more specific, there is only one data point from this typology in the database used to build the proposed empirical drift capacity model (Vanin et al., 2017). To contribute to the available database and to get a better understanding of the cyclic performance of stone-masonry walls of typology A with two leaves, six large scale shear-compression tests have been conducted at EPFL. The specimens have the same typology and dimensions (height = 1600 mm, length = 1600 mm and thickness = 40 mm). To represent old buildings, lime mortar with the aggregate/binder ratio of 3/1 is used. Figure 1 illustrates the specimens and the test setup.

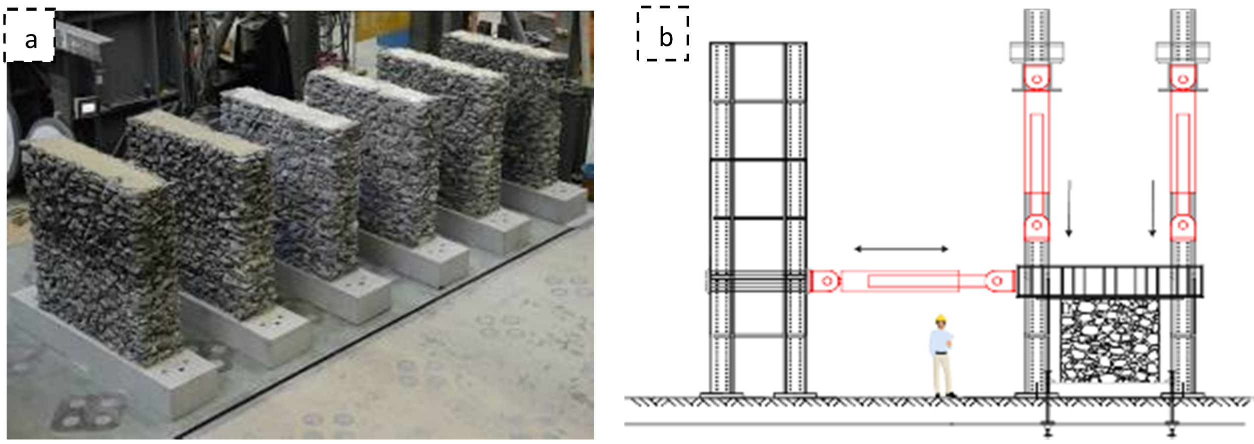

Figure 1. a) Six stone-masonry specimens, b) Test setup.

Different kinematic boundary conditions and pre-compression load has been applied to investigate the effect of each of which on drift limits, force capacity, and stiffness of walls. The 3D displacement field has been measured using two sets of pair of cameras on both sides of the walls. Table 1 shows the applied axial load ratio at the base (σ/fc, where σ is the vertical stress at the base and fc is the compression strength of masonry) and ratio between the height of zero-moment from the base (H0) to the height of the wall (H).

Table 1. Applied boundary condition and pre-compression level.

Wall Name	σ/fc	H0/H
RS1	0.13	0.5
RS2	0.30	0.5
RS3	0.22	0.5
RS4	0.30	1.0
RS5	0.30	1.5
RS6	0.22	1.0

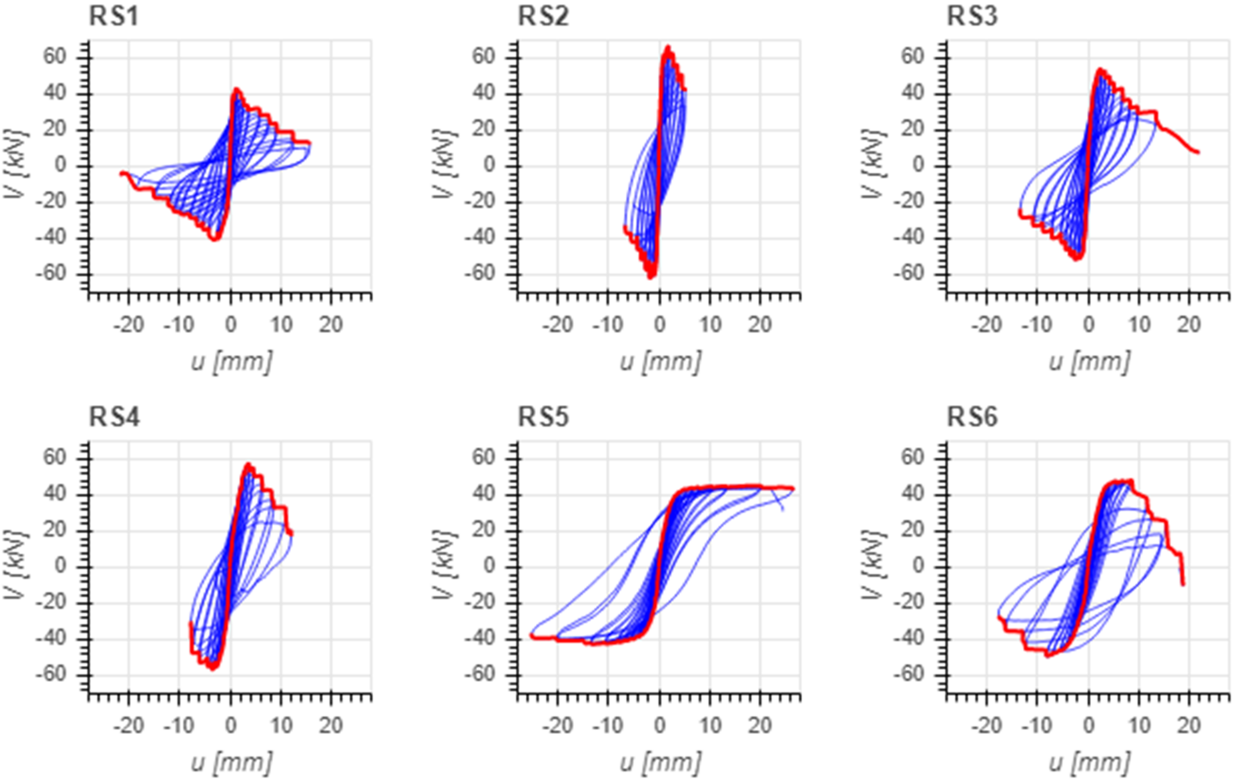

Figure 2. Cyclic and envelope response of shear-compression tests.

Figure 2 shows the horizontal force-displacement cyclic and envelope response of the walls. According to this figure and also the crack patterns (not shown here), the failure modes of the walls RS2, RS3 and RS4 are shear; wall RS1 and RS6 a hybrid failure and the wall RS5 rocking failure. Another important observation was opening of the leaves in which a splitting crack develops and continues propagating and widening as drift level increases.

It is observed that the force capacity of the walls increases as the axial load increases. Using the tensile strength proposed by the Italian code (MIT, 2009), and applying the Turnsek–Cacovic criteria results in an accurate prediction of peak force. Moreover, there is a negative correlation the peak force and the H0/H. The ultimate drift capacity decreases by the increase of axial load ratio. However, higher H0/H ratios result in the increase of the ultimate drift. The empirical equation proposed by (Vanin et al., 2017) could predict fairly well the ultimate drift.

REFERENCES

Vanin, F., Zaganelli, D., Penna, A., and Beyer, K. (2017). Estimates for the stiffness, strength and drift capacity of stone masonry walls based on 123 quasi-static cyclic tests reported in the literature. *Bull. Earthquake Eng.*, 1-37.

MIT (2009). Ministry of Infrastructures and Transportation, Circ. C.S.Ll.Pp. No. 617 of 2/2/2009. Istruzioni per l'applicazione delle nuove norme tecniche per le costruzioni di cui al Decreto Ministeriale 14 Gennaio 2008. G.U. S.O. n.27 of 26/2/2009, No. 47 (in Italian).