Nonlinear Behaviour of Two-Whyte Stone Walls– SAHC2020

Burcu Dinç*, Yasin Murat Hothot†, Bilge Doran† and Nabi Yüzer†

* Department of Civil Engineering
Yildiz Technical University
Davutpasa Campus, 34220 Istanbul, Turkey
Email: bdinc@yildiz.edu.tr - Web page: http://avesis.yildiz.edu.tr/bdinc/

† Department of Civil Engineering
Yildiz Technical University
Davutpasa Campus, 34220 Istanbul, Turkey
Email: yasinmurathothot@gmail.com

† Department of Civil Engineering
Yildiz Technical University
Davutpasa Campus, 34220 Istanbul, Turkey
Email: doran@yildiz.edu.tr - Web page: http://avesis.yildiz.edu.tr/doran/

† Department of Civil Engineering
Yildiz Technical University
Davutpasa Campus, 34220 Istanbul, Turkey
Email: nyuzer@yildiz.edu.tr - Web page: http://avesis.yildiz.edu.tr/nyuzer/

ABSTRACT

Masonry historic structures represent architectural cultural heritage of great historical importance in Turkey. They have been used for public and residential buildings in the past several thousand years. A great number of well-preserved old masonry structures still exist proving that this form of construction can successfully resist loads and environmental impact. Conventionally, most major buildings were solid walled structures with the walls bearing directly on the ground. Engineers work hard to convert the highly uncertain and nonlinear behavior of historic masonry structures into something that can be understood with mathematical certainty. Therefore, practical and also accurate structural analysis techniques are still needed for the preserve the historical monuments as a huge cultural heritage. In this context, determining the mechanical properties of historical walls under in-plane and out-of-plane lateral loadings is one of the most important aim [1]. Since there is the limited knowledge on the traditional masonry stone walls and masonry constituents of the historical structures, new experimental and analytical studies are essential for the development of a thorough assessment and intervention procedures [2]. This study primarily focuses on the developing experimental and theoretical data in the literature for three dimensional (3D) nonlinear behaviour of two-whyte stone masonry walls. For this purpose, in the first part of this study, the properties of stone and mortar samples provided from a historical masonry structure in Turkey have been determined in terms of mechanical, chemical, mineralogical, physical at laboratory conditions. Then, the two-whyte stone walls have been constructed in accordance with the original material characteristics derived from the experimental studies. Elastic parameters such as modulus of elasticity and Poisson's ratios and plastic parameters such as compressive and tensile strengths have been determined using a universal testing machine. In order to evaluate the nonlinear behaviour of two-wyhte stone walls, these walls have been tested under shear-compression. In the second part of this study, a simple micro modeling approach has been proposed for the 3D nonlinear finite element analysis (NLFEA) of two-whyte stone walls subjected to a combination of lateral and vertical loads [3]. An original meshing procedure is improved to consider the orthotropy along the two natural directions of the masonry while the material is still assumed to be isotropic. These walls are successively modeled using the proposed approach in ABAQUS finite element analysis software. Finally, numerical results of non-linear finite element analysis and experimental results of walls were compared. It was observed that the numerical analysis results compatible with the experimental ones.

REFERENCES

[1] B. Doran, N. Yuzer, S. Aktan, D. Oktay, and S. Ulukaya, "Numerical Modeling of Traditional Masonry Walls Strengthened with Grout Injection," *Int. J. Archit. Herit.*, vol. 0, no. 0, pp. 1–16, 2019.

[2] C. Demir, "Seismic Behaviour of Historical Stone Masonry Multi-Leaf Walls," PhD Thesis, Istanbul Technical University, Istanbul, 2012.

[3] B. Doran, H. Orhun Koksal, S. Aktan, S. Ulukaya, D. Oktay, and N. Yuzer, "In-Plane Shear Behavior of Traditional Masonry Walls," *Int. J. Archit. Herit.*, vol. 11, no. 2, pp. 278–291, 2017.