Structural health monitoring of ancient constructions within the framework of the MOSCARDO project.

G. Bartoli[†], M. Betti[†], M. Girardi[‡]*, C. Padovani[‡], D. Pellegrini[‡], B. Pintucchi[†], L. Robol[‡], G. Zini[†]

[†] Department of Civil and Environmental Engineering (DICEA)
University of Florence
Via di Santa Marta 3 – I - 50319, Florence, Italy
webpage: https://www.dicea.unifi.it/

[‡] Institute of Information Science and Technologies "A. Faedo"
CNR-ISTI
Via Moruzzi, 1 56126 Pisa, Italy
webpage: http://www.isti.cnr.it/
* Corresponding author: maria.girardi@isti.cnr.it;

ABSTRACT

Last decades have seen an increasing interest in the structural monitoring of historic constructions. Nowadays, monitoring procedures have a crucial role in the assessment of the structural health of the built heritage and in its maintenance [1], [2], [3], [4] since they provide an effective tool to support retrofitting and strengthening operations.

MOSCARDO (ICT technologies for structural monitoring of Ancient Constructions based on wireless sensor networks and drones) is a research project, ended in October 2018, funded by the Regional Administration of Tuscany (Italy) and developed by a consortium including the University of Florence (Department of Civil and Environmental Engineering), the National Italian Research Council (Institute of Information Science and Technologies "A. Faedo", ISTI-CNR) and two private companies (Infomobility srl – www.infomobility-italia.com - and Engineering Italy Solutions srl - www.eisolutions.it).

This paper describes some issues dealt with in the project, aimed at designing, developing and testing new ICT tools for structural health monitoring, among which networks of wireless sensors able to operate in both ordinary and emergency conditions, for long-term monitoring purposes. Three representative case studies in Italy have been selected to test the system developed in the project: two historic masonry towers (the "Torre Grossa" in San Gimignano and the "Mastio di Matilde" in Livorno) and the "Voltone" (a large vaulted masonry structure located beneath Repubblica Square in Livorno. The system installed on the buildings is still working.

Main results of the MOSCARDO project include the possibility: i) to check the structural health of the monitored structures at any time and from any location, and to real-time detect any potential damage that may compromise its habitual use; ii) to provide historical data sets that can be used to permanently monitor the tested structure and to develop predictions (and promptly act for repairing when needed); iii) to gain an in-depth and organic knowledge of historical constructions, from which new mathematical models and numerical methods can be developed ([5], [6], [7]); iv) to reduce management costs and security risks due both to environmental factors and anthropic activities (such as vibrations due to vehicular and pedestrian traffic), i.e. the system can be used as a tool to support building maintenance and safeguard.

REFERENCES

[1] L.F. Ramos, L. Marques, P.B. Lourenco, G. De Roeck, A. Campos-Costa. *Monitoring historic masonry structures with operational modal analysis: two case studies*, Mechanical Systems and Signal Processing 24: 1291–1305, (2010).

[2] A. Saisi, C. Gentile, M. Guidobaldi. *Continuous monitoring of a challenging heritage tower in*

Monza, Italy, Journal of Civil Structural Health Monitoring 8:77–90, (2018).

[3] A. D'Alessandro, G. Vitale, S. Scudero, R. D'anna, G. Passafiume, L. Greco, S. Speciale, D. Patanè, O. Torrisi, S. Di Prima, S. Magiagli, G. Tusa. *Real-time urban seismic network and structural monitoring by means of accelerometric sensors: Application to the historic buildings of Catania (Italy)*. IEEE International Conference on Environmental Engineering EE2108. Proceedings. p. 1-5. (2018).

[4] F. Ubertini, N. Cavalagli, A. Kita, G. Comanducci. *Assessment of a monumental masonry bell-tower after 2016 Central Italy seismic sequence by long-term SHM*. Bulletin of Earthquake Engineering, 16(2), 775-801, (2018).

[5] M. Girardi, C. Padovani, D. Pellegrini, L. Robol. *NOSA-ITACA: a free FE program for historic masonry buildings*. In: Proceedings of 2nd International Conference on Recent Advances in Nonlinear Models, Design and Rehabilitation of Structures CoRASS2017, http://www.eccomas.org/spacehome/1/10, (2017).

[6] D. Pellegrini, M. Girardi, P.B. Lourenço, M.G. Masciotta, N. Mendes, C. Padovani, L.F. Ramos. *Modal analysis of historical masonry structures: Linear perturbation and software benchmarking*. Construction and Building Materials, 189(20), 1232-1250, (2018).

[7] G. Zini, M. Betti, G. Bartoli, S. Chiostrini. *Frequency vs time domain identification of heritage structures*. In: Proceedings of the XIV International Conference on Building Pathology and Constructions Repair CINPAR2018, https://doi.org/10.1016/j.prostr.2018.11.115, (2018).