

Seismic Assessment of Monumental Structures

The S. Vicente de Fora project

Preservation of the built cultural heritage is one of the challenging tasks of our society. In Europe, even more than in other continents, it should be a priority because of the large number of monuments having an inestimable cultural value. The recent Umbria/Marche, Italy earthquake events have shown how vulnerable are ancient constructions under seismic loading. Very important monuments (e.g.: Basilica of S. Francesco, Assisi) have suffered irreversible damages and very old villages have been seriously affected.

The JRC, the General Directorate for Monuments and the National Laboratory for Civil Engineering in Lisbon jointly developed a project dealing with the vulnerability assessment of historical structures and with the validation of retrofitting solutions and techniques. A full-scale model of part of the S. Vicente de Fora monastery in Lisbon [1] was constructed, tested and retrofitted at the ELSA laboratory. It was demonstrated that rather simple and economical retrofitting solutions, based on anchored ties with continuous bond, substantially increase their seismic performance. Furthermore, the proposed retrofitting techniques maintain the original architectonic and structural layouts of the construction.



Figure 1. S. Vicente de Fora: General view (top), Cloisters internal view (bottom)

In what concerns methods and tools for seismic assessment of monuments, the hybrid nature of the project is underlined, since it combines numerical modelling and testing of large-scale models representative of part of the monument. Detailed non-linear numerical models were developed and calibrated against experimental results to study local behaviour and stability [2]. Moreover, experimental parameters such as equivalent damping (~10%) and stability conditions up to 1.5% drift were identified and are now available for the global vulnerability analysis of stone-block monumental structures.

Project achievements and outcome have been presented in several scientific/technical conferences [2, 3 and 4] and a dedicated international workshop was organised [5]. The project was also a subject of interest for the Portuguese government (Visit of the Minister and Secretary of State), the press (television and newspapers) and Protection of Cultural Heritage policy makers.

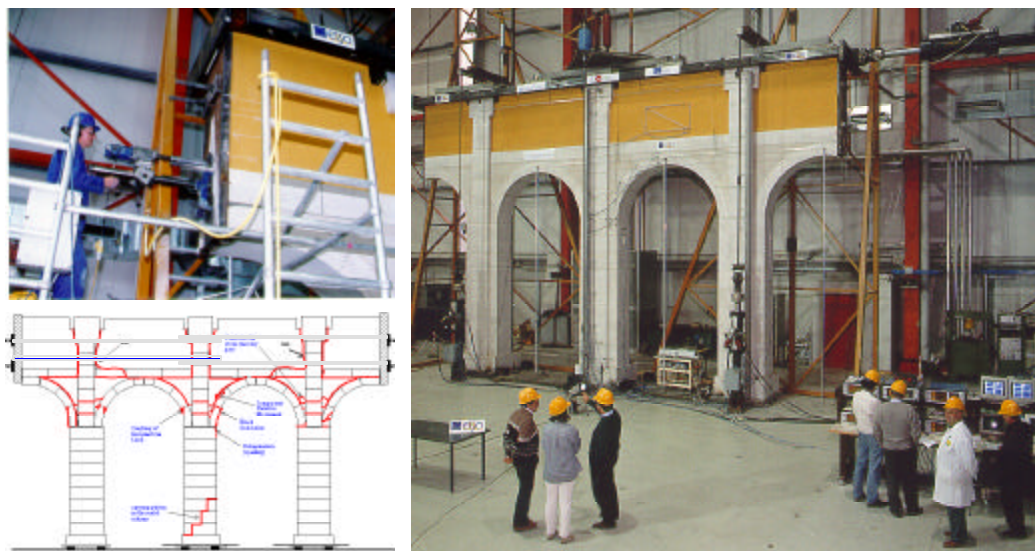


Figure 2. Façade full-scale model in the ELSA reaction wall laboratory and application of continuous-bond anchored ties

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