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UNIVERSITÀ DEGLI STUDI

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DEPARTMENT OF CIVIL, COMPUTER AND AERONAUTICAL ENGINEERING
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MSc Course in Civil Engineering for natural risk protection
Laurea Magistrale in ingegneria Civile per la protezione dai rischi naturali

MSc Degree Thesis
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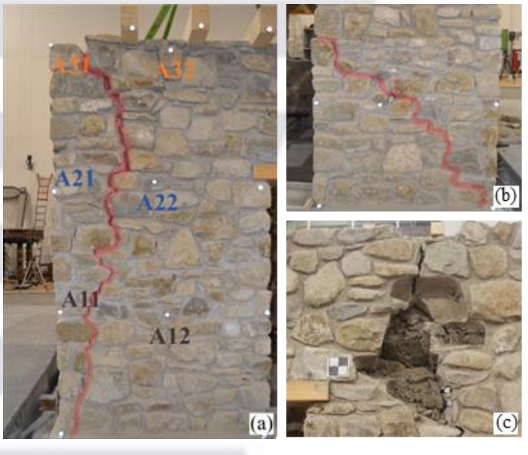
Shake table tests of a rubblestone large-scale masonry structure

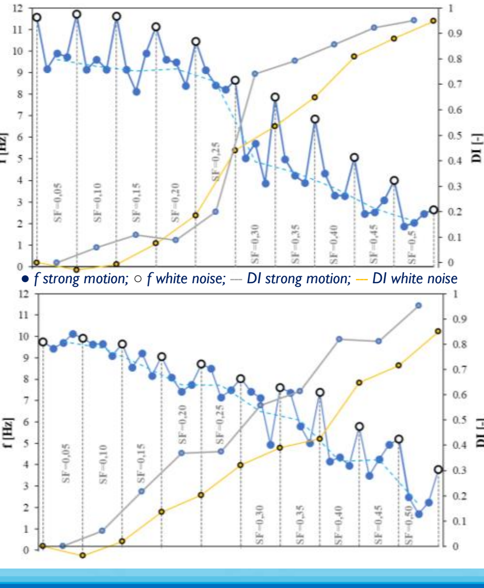
Motivations and aims

The traditional stone masonry architecture in central Italy, while emblematic of cultural heritage, demonstrated its dramatic seismic vulnerability during recent events, notably the 2016-2017 earthquake sequence. Disintegration emerged as the primary failure mode. This highligths the need of enhancing the understanding of the seismic behavior of rubble masonry constructions and of developing adequate retrofitting technologies, pivotal for preserving structural integrity and architectural distinctiveness. Within RIPARA research project, funded by Regione Lazio, the seismic behavior of a large-scale masonry structure was investigated on the shake table. Tests were carried out at ENEA Casaccia Research Centre.

Methods and results



The prototype consisted of four walls with openings and a timber floor. It underwent three-axial seismic tests under three natural records (Norcia, August 24, 2016; Castelsantangelo sul Nera, October 26, 2016; and Amatrice, October 30, 2016) progressively scaled by 0.05g PGA. Instrumentation included a triaxial accelerometer and an opto-electronic motion capture system (3DVision) tracking the spatial displacements of 91 wireless retroreflecting spherical markers. Visual observations surveyed crack evolution and collapse modes. Collected data were processed to derive acceleration-displacement curves and deformed configurations. Dynamic identification used an experimental Multiple Input Multiple Output (MIMO) method to calculate fundamental frequency and damage index.



Conclusions and future developments

The shake table tests faithfully replicated real conditions observed in Lazio Apennine villages during the 2016-2017 seismic sequence, emphasizing the crucial role played by masonry disintegration. Thorough investigations and safeguarding interventions are pivotal to prevent catastrophic collapses, as standard rigid-body approaches might provide unconservative estimates of seismic capacity. The structure exhibited a linear behavior until PGA=0.20g, followed by a stiffness reduction and the initiation of failure, which took place at PGA=0.50g. Frequency reduction with increasing PGA agreed with surveyed damage. This work contributed to the understanding of the seismic behavior of rubble masonry structures, and provided an experimental benchmark for validating/calibrating structural analysis models and developing seismic retrofitting techniques.