

Vulnerability curves for monumental buildings based on seismic damage observation

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Abstract

After the recent Italian seismic events, the damage assessment to monumental buildings proved the high seismic vulnerability of this kind of structures and the relevance of this topic for the management of the earthquake risk both from the economic and the cultural point of view.

Vulnerability and seismic risk analysis of monuments should be defined and implemented at territorial scale targeting multiple aims: 1) to make decision makers aware of the potential consequences of an earthquake to the cultural heritage, 2) to list the monuments by seismic vulnerability in order to prioritize preventive interventions for the risk mitigation; 3) to manage the emergency after a big earthquake, estimating in a short time, the potential damage occurred.

Due to the large number and the high density of monuments in a region or in a town, the seismic vulnerability of the cultural heritage may not be afforded by a detailed seismic analysis on each single building, nevertheless the importance and uniqueness of monuments.

The seismic behaviour of monumental typologies has been studied in Italy since 1994 (Doglioni et al.), on the basis of the observed damage and vulnerability on a wide number of buildings. From the statistical analysis of surveyed damage data, Lagomarsino and Podestà (2004a, 2004b) have defined a vulnerability method for churches.

In this paper vulnerability curves for other typologies of monumental buildings (castles, convents, monasteries and towers) are proposed. To this aim, the information gathered following Friuli (1976), Irpinia (1980), Umbria and the Marches (1997), Molise (2002) and Lombardy (2004) earthquakes have been re-elaborated, suitably re-processing the data available, in order to standardise the information to the assessment criteria proposed by the EMS- scale. The results obtained have permitted the definition of an instrument useful for a prevention policy at the national level, able to assess as a function of the building typology, the expected damage for areas depending on the seismic hazard. In this way, an overall knowledge of the seismic risk of the cultural heritage in a big town or in a region could be reached with the lowest possible level of information, without any specific data to be surveyed except for the typology.

In the framework of an Italian National research project "SAVE - Updated Instruments for the Seismic Vulnerability" (funded by the INGV-GNDT National Institute of Geophysics and Vulcanology and National Group for Earthquake Defence) 18.000 monumental buildings in the South Italy, have been assessed according to the proposed vulnerability curves. The results in terms of their inventory, vulnerability and seismic risk analysis are herein presented.

References:

- Doglioni, F., Moretti, A. and Petrini, V., (Lint), 1994, *Le chiese e il terremoto*, Trieste.
- Lagomarsino S., Podestà S., 2004a, "Seismic vulnerability of ancient churches. Part 1: damage assessment and emergency planning" *Earthquake spectra* 20, 377-394. ISSN: 8755-2930.
- Lagomarsino, S., Podestà S., 2004b, *Damage and vulnerability assessment of the churches after the 2002 Molise, Italy, earthquake*, *Earthquake Spectra* 20, (Special Issue 1, 2002 Molise Italy Earthquake Reconnaissance Report, edited by P. Bazzurro and J. Maffei), S271-S283. ISBN: 1-932884-03-3.

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