

Multiscale modelling approaches for seismic vulnerability analysis of churches

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Background.

Italy is one of the richest countries in terms of cultural heritage (CH) structures, with the highest number of UNESCO sites in the world. At the same time, hazard related to various natural disasters, and specifically seismic hazard, is considerable. Among CH buildings, churches represent a widespread building type. In the last decades, the effects of various earthquake and many theoretical studies highlighted the significant vulnerability of churches, mainly due to their intrinsic construction and geometrical characteristics.

All the above suggest the demand for investigating the seismic vulnerability of churches, to improve risk estimates and to promote and evaluate efficient mitigation strategies. For these purposes, analyses at both territorial and single-building scale are requested. Analyses can provide an insight into trends and factors that affect the overall vulnerability, by analyzing empirical data, and allow carrying out detailed vulnerability predictions. Indeed, going from the specific to the general, recurrent vulnerability factors can be deduced, whereas going from the general to the specific, reliability and accuracy of predictions can be improved to better quantify the overall vulnerability and define mitigation interventions.

Aim.

The first aim of the research is to implement various modeling and analysis strategies for churches, to provide an overview of advantages and drawbacks for each of them and evaluate the best option. Also based on this first outcome, the second aim of the research is to develop a framework for the definition of analytical or hybrid fragility curves, based on numerical modeling and in-depth simulation of representative case-studies.

Among the various church classes characterizing the Italian taxonomy, single-nave churches with limited dimensions, typical of the central Italy Apennine area, and more complex three-nave churches, more common in the Po valley area and in its cities, are the two most representative macro-classes. The research will focus on the in-depth study and modelling of these church types. Factors affecting the church vulnerability, and possible solutions to reduce the vulnerability, will be analyzed and studied for each of the two macro-classes.

Expected results.

- Implementation and comparison of various modelling strategies for church buildings.
- Definition of relevant parameters for the overall fragility of churches and sensitiveness analyses.
- Creation of analytical fragility curves and comparison with available empirical fragility models.
- Selection of interventions for improvement of seismic vulnerability and evaluation of effectiveness.
- Practical guidelines for modelling, analysis, and design of intervention on church buildings.

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