

# Seismic vulnerability assessment method for vernacular architecture considering uncertainty

Javier Ortega\*, Savvas Saloustros<sup>†</sup>, Graça Vasconcelos<sup>††</sup> and Hugo Rodrigues<sup>†††</sup>

\* ISISE, Department of Civil Engineering, University of Minho  
Campus de Azurém, 4800-058 Guimarães, Portugal  
e-mail: javier.ortega@civil.uminho.pt

<sup>†</sup> Department of Civil and Environmental Engineering  
Technical University of Catalonia (UPC)  
Campus Norte UPC, 08034 Barcelona, Spain  
Email: savvas.saloustros@upc.edu

<sup>††</sup> ISISE, Department of Civil Engineering, University of Minho  
Campus de Azurém, 4800-058 Guimarães, Portugal  
e-mail: graca@civil.uminho.pt

<sup>†††</sup> RISCO, School of Technology and Management  
Department of Civil Engineering, Polytechnic Institute of Leiria  
Campus 2, 2411-901 Leiria, Portugal  
Email: hugo.f.rodrigues@ipleiria.pt

## ABSTRACT

Built vernacular heritage embraces those buildings that are not designed by specialists, but are part of a process that involves many people over many generations and relies on empirical knowledge. Its value as a key-element for cultural identity is unquestionable. However, precisely due to its empirical and traditional nature, it is often seen as an obsolete and unsafe way of construction, which leads to its progressive abandonment. This lack of proper construction details and poor maintenance increases the seismic vulnerability of the vernacular heritage. There is an evident need for simplified easy-to-use seismic vulnerability assessment methods for vernacular architecture, given the generalized lack of resources that can be assigned to its study and preservation. Most of the times, visual inspection will be the only tool available to carry out the assessment.

Nevertheless, simplified methods demand a deep understanding of the seismic behavior of vernacular architecture. This is a complex task given the great heterogeneity in the geometrical, structural, construction and material characteristics of vernacular buildings. Previous works on the topic have proposed to use finite element modeling and pushover analysis to evaluate the influence of a set of key parameters on the seismic response of vernacular buildings. As a result, a simplified numerical tool was developed particularly intended to assess the seismic vulnerability of vernacular buildings [1]. However, the final developed tool did not consider the high amount of uncertainty in the definition of geometrical, structural and material parameters of vernacular architecture. The present work aims at developing a probabilistic method for the analytical derivation of seismic fragility functions of vernacular buildings considering uncertainty in material and construction variables, while still being based on visual inspection. The procedure followed to investigate the effect of uncertainty in the proposed method is based on stochastic analysis previously applied for the assessment of masonry structures [2]. This approach is meant to extend the applicability and reliability of the seismic vulnerability assessment method previously developed by considering uncertainty in the parameters.

## REFERENCES

- [1] J. Ortega, *Reduction of the seismic vulnerability of vernacular architecture with traditional strengthening solutions*, PhD Thesis, University of Minho, 2018.
- [2] S. Saloustros, L. Pelà, F. R. Contrafatto, P. Roca and I. Petromichelakis, “Analytical derivation of seismic fragility curves for historical masonry structures based on stochastic analysis of uncertain material parameters”, *International Journal of Architectural Heritage* (2019).