The seismic vulnerability assessment of old building stocks as an effective seismic risk mitigation tool at the urban scale

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The seismic risk management of old city centres is an important topic of today's societies. It is impossible to ignore the devastating effects of powerful recent earthquakes, which have affected millions of people and stressed the necessity of improving knowledge and resilience of our cities, particularly old city centres. The absence of a real risk policy limits the capacity for response and recovery after a disaster and therefore the understanding of risk factors is crucial for guaranteeing effective post-event responses.

Among the many aspects that urban management and planning depend on, our research focuses on the vulnerability assessment of masonry buildings and mitigation of seismic risk in old city centres. Seismic vulnerability can be defined as an internal risk factor of a structure exposed to an earthquake and corresponds to its intrinsic predisposition to be damaged by earthquakes of defined intensity. The evaluation of structural safety conditions is often forgotten or undervalued in Portugal considered a seismic prone country, perhaps due to the absence of significant seismic activity during the recent decades, fact that has led to a lack of national risk management consciousness and preparedness.

To face this issue, a simplified seismic vulnerabi-lity assessment method has been developed and applied by this research team in several case stu-dies over the last years. The method is based on post-seismic damage observation and consists in the calculation of a vulnerability index that results from the weighted sum of 14 parameters, each of which representing a building feature that influence the seismic response of the building.

For large-scale risk assessment and management, these vulnerability results are then integrated into a geographic information system (GIS), wherein various modules can be developed for different tasks, including damage and loss estimation (such as collapsed buildings, human casualty and severely injured, unusable buildings, repair costs) for different earthquake intensities, allowing the construction of multiple damage and loss scenarios (see Fig. 1). This data, associated with GIS, can be updated periodically, revealing the utility of this type of tools and assessment methods for the management of the old building stock, allowing for both data storage and spatial analysis.

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FIGURE 1

Example of a damage scenario for a certain macroseismic intensity and probability curves for different loss outputs.
(a) Damage scenario spatial result using GIS.
(b) Probability of losses for different values of vulnerability.