

Seismic Vulnerability Assessment of Old Buildings

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Portugal, alike southern Europe, has not adequately dealt with the vulnerabilities associated to risks such as the seismic risk, that occur suddenly but in a sharply manner, at an unpredictable time, location and severity. Lisbon, as an early settlement of populations, has witnessed along the centuries to a significant number of large events that have been narrated and are known to us nowadays. However, given that the time distance between events surpasses that of several generations, earthquake catastrophes tend to be forgotten... just until another one strikes. Conversely, given its centuries of History, the capital has a patrimonial value in old constructions, still standing in our days, of great importance and continuous need for preservation. Some of these constructions were built with anti-seismic concerns (for instance the Pombalino buildings) while other old constructions have been designed to withstand gravity loads alone, presenting a vulnerable group at seismic risk (a recognised example would be the Gaioleiros buildings).

The response of this type of structures to strong earthquakes is still an open research subject. The analysis of the existing old masonry buildings in the light of the present seismic codes would lead to the conclusion that they are highly vulnerable to severe earthquakes; nevertheless, they behaved relatively well during past earthquakes, albeit with large variability of performances. Such discrepancies demonstrate the weakness of the available methods in accurately predicting the real behaviour of these types of buildings under destructive earthquakes. By the use of modern design techniques it is possible to apply many retrofitting schemes for the desired level of strengthening, in most cases with questionable accuracy. Moreover the level of interventions is significantly limited due to functionality and architectural reasons. Furthermore, many of these buildings belong to the historical heritage or their initial structural system should be maintained or emphasized, thus limiting the level of applicable interventions.

Nowadays, the vulnerability that the seismic hazard poses to old masonry structures and possible retrofitting solutions are a main concern. Additional developments concerning the derivation of fragility curves are still required for particular, less common, building typologies, namely old masonry constructions. A main goal for future research work will be to derive fragility curves for the masonry constructions encountered in Lisbon, which will be a significant contribution to the state of the art. For that it is required to characterize, from a structural point of view, these constructions, including, among others, their typologies, materials, dynamic characteristics, stage of conservation. Having all the elements essential to characterize the constructions, one needs to assess their seismic behaviour and decisions have to be made regarding the type of theoretical and numerical and experimental tools that are available and best suited for each case. Finally, one has to know how to use these tools to assess the performance of these structures under different severity levels of the seismic action, in other words, to assess the seismic vulnerability. For this the mechanical approach should be chosen given the specificness of the constructions analysed conjugated with their importance. For that simplified non-linear static methods and, in particular cases, non-linear dynamic analysis should be performed so as to validate the previous. The numerical tools to be used could be state-of-the-art macro-element software. This has proved to be a very good cost-effective tool, in terms of reliability and time consumption, to analyse this type of structures, and especially when compared to refined non-linear finite element analyses. The research work developed until now has been limited to the use of finite element analyses and some of work previously performed will be presented.