SELECTING BUILDING VULNERABILITY FUNCTIONS FOR EARTHQUAKE LOSS ESTIMATION STUDIES

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Vulnerability functions, which are one of the major component of earthquake loss estimation (ELE) studies, represent the structural capacity and behavior of a certain building typology and define the probability of suffering a certain level of damage along a given ground motion intensity parameter.

In many cases, ELE studies are conducted by selecting existing vulnerability functions that had been originally derived for similar building typologies in other parts of the world rather than to develop customized functions that address the peculiar structural and non-structural characteristics of the respective building stock. The reasons for this are either to reduce the calculation efforts, especially when studies are conducted for large portions of the building stock, lack of available resources, or lack of information which does not allow for detailed survey and data acquisition (D'Ayala and Meslem, 2013a).

However, the selection of vulnerability functions that represent the peculiarities of the building stock can be the most challenging task in order to ensure a reliable earthquake loss assessment. For instance, HAZUS vulnerability functions (FEMA, 2003) that were derived for buildings in the U.S. only, have been used in conducting ELE studies in many parts of the world: Romania (Vacareanu et al., 2004), India (Gulati, 2006), Algeria (Boukri et al., 2013), Venezuela (Bendito, 2014) among others. Typically, differences in construction techniques and detailing between different countries are significant, even when buildings are nominally designed according to similar code clauses (Meslem et al., 2014).

Moreover, it has often been noticed that a number of academics as well as engineers have used existing vulnerability functions that were constructed based on simplified assumptions in terms of structural characteristics modeling, the choice of mathematical modeling, the non-consideration of record-to-record variability, or in defining the damage thresholds… etc.). Such simplifications may highly decrease the reliability and accuracy of the obtained results introducing important uncertainties in the ELE process (D'Ayala and Meslem, 2013b).

The main scope of this present work is to define a quality rating framework, able to provide guidance in choosing suitable and robust analytically derived vulnerability functions available in literature when performing ELE at regional level. In this respect, the first part of the work reviews the extensive literature available on the derivation of vulnerability functions in the past decades, considering the salient steps of the process of construction of a vulnerability function; the choice of the basic relationship between damage and intensity measure, the characterization of the damage, the choice of the analytical approach to determine the structural response and the implications for data quality, the identification and quantification of uncertainties throughout the process. For each of these steps indications are given on the merits of the various choices.

On the basis of this review, the second part of the work presents a rational quality rating system based on four attributes: representativeness, data quality, rationality, and quality of documentation (Figure 1). For each attribute a number of criteria are identified as being critical to the selection of vulnerability functions for a given building typology and for each criteria the influential parameters defining the quality are listed. A quality rating is defined by considering three qualitative classes, i.e. High, Medium and Low. For each attribute the overall rating is determined as the rating most commonly assigned to the criteria within the attribute.

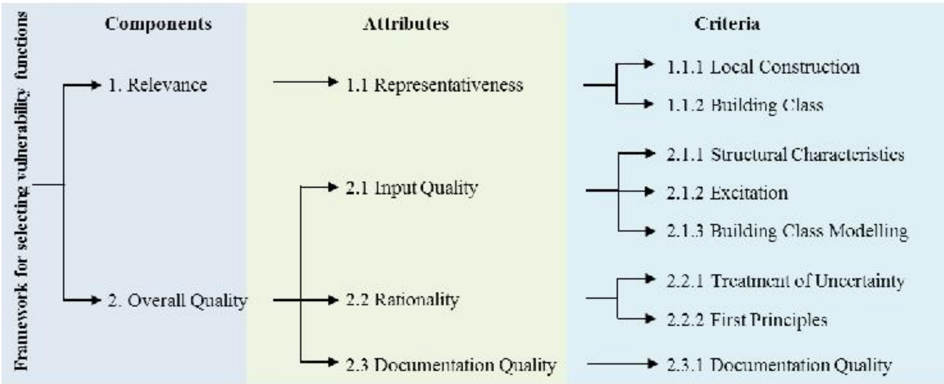

Figure 1. Components, attributes and criteria for quality rating of analytically-derived fragility curves

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