Assessing uncertainty in the computation of seismic failure rates due to record-selection process

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Abstract

Current seismic codes suggest selecting earthquake records close to uniform hazard spectrum (UHS) estimates in the frame of non-linear time history analysis of structural systems subject to earthquakes. However, different results can be achieved using the same number of records but with different strong motion data, and also the number of records itself can impact results of the seismic fragility estimation process. The present work aims therefore to highlight how the process of record selection can significantly influence the results, being a source of relevant uncertainty. Hence, a methodology for stochastically define a hazard-consistent record selection is defined with the aim to assess its influence on the uncertainty in quantifying a seismic failure rate λ_f.

Keywords: failure rate, fragility curves, seismic reliability, record selection, seismic risk.

1. Introduction

When dealing with the assessment of seismic risk of structures, often computer simulations are carried out for virtually analysing the dynamic behaviour of structural systems and assessing their reliability. Computer models are required for modelling real structures and testing them against a set of input signals that have to be selected in order to suitably represent the seismic hazard for the site in which the structure is located [1]. Different analysis methods can be performed for evaluating the behaviour of a structure, like spectral analysis [2], non-linear static analysis [3] or non-linear time history analysis [4,5]. Simulations are performed with the aim to generate artificial (instead of experimental) samples of structural response that are clearly conditional to the input signals selected by the analyst [6]. On this basis, the sampled set of structural response, usually expressed via the quantification of an engineering demand parameter (*EDP*), is correlated with a synthetic parameter called intensity measure (*IM*) representative of the input signal, and subsequently statistical inference is performed to derive a continuous relationship between them, and consequently calibrating a fragility curve. Fragility curves are functions that give the probability of exceeding a certain performance level (*PL*) for a specific structure, conditional to the *IM* acting at that site. Iervolino [7] presents a review of the common seismic fragility modelling strategies actually adopted. Fragility functions are subsequently combined via the Total Probability Theorem with the hazard curve of the site of interest to obtain the failure rate λ_f, that is the main parameter for characterizing the homogeneous Poisson process of earthquakes causing the failure of the structure over time. Such approach is very diffused, since the seismic risk framework is structured to allow a disconnection

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