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Frameworks for the consideration of ground motion and seismic response uncertainties in seismic performance assessment

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ABSTRACT

Quantification of the seismic performance of engineered structures is complicated by the significant uncertainties in the future strong ground motions such structures will be subject to and engineering models of the consequent seismic response. As a result, rigorous seismic performance quantification must embody a probabilistic approach in which a key aspect is uncertainty characterisation. This paper discusses two recently proposed frameworks which provide a rigorous and holistic characterisation of uncertainties in ground motion selection and seismic response analysis.

The first framework utilizes a generalised conditional intensity measure (GCIM) approach as the basis for the holistic selection of ground motions for any form of seismic response analysis. The essence of the method is the construction of the conditional multivariate distribution of any set of ground motion intensity measures using PSHA results. The approach therefore allows any number of ground motion intensity measures identified as important in a particular seismic response problem to be considered. Ground motions are then selected, modified, and/or simulated based on the statistical comparison, for each intensity measure, of the empirical distribution of the ground motion suite with the 'target' GCIM distribution. The second framework makes use of observations from seismometer arrays for the validation of computational seismic response models. The framework explicitly accounts for the epistemic uncertainty related to the unknown characteristics of the 'site' (i.e. the problem under consideration) and constitutive model parameters. Multiple prediction-observation pairs are used to improve the statistical significance of inferences regarding the accuracy and precision of the computational seismic response methodology and constitutive model. Among other things, the benefit of such a formal validation framework includes an improved understanding of the uncertainties in computational model assumptions, constitutive models and their parameters.

In the context of the two presented frameworks, discussion is given to the presently perceived significance of 'ground motion' and 'seismic response model' uncertainty in the quantification of seismic performance. Particular attention is given to potential sources of bias in the perceived significance of these uncertainties.