Seismic Risk Analysis

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Seismic risk analysis combines site-specific seismic hazard with fragility models to provide loss metrics. At the state of the art, site-specific probabilistic seismic hazard analysis (PSHA) is used to calculate exceedance rates, over a range of values of some measure of ground motion intensity, while fragility models provide the conditional probability of structural failure given said intensity. The latter are generally based on dynamic analysis of a numerical model of the structure that adequately represents nonlinear response to strong ground motion.

The purpose of this course is to acquaint the audience with the intricacies of consolidated methodologies for performing probabilistic seismic hazard analysis, as well as fragility estimation using the results of various dynamic analysis strategies (e.g., incremental dynamic, multiple-stripe and cloud analysis). The final portion of the course will deal with putting these two components together to arrive at seismic reliability metrics for structures. During the course, interactive illustrative examples, with direct involvement of the students, will take place, covering all three aspects of hazard, fragility and risk calculations.

Topics that will be discussed during the course are:

- Engineering seismology basics: analysis of seismic catalogues, desclustering, assessment of completeness, earthquake occurrence rates, Gutenberg-Richter laws, ground motion prediction equations, seismic faults and seismogenic zones, site-to-source distance distributions.
- Fundamentals of PSHA: Homogeneous Poisson process, uniform hazard spectra, disaggregation of seismic hazard, peak over the threshold, logic three.
- Advanced intensity measures and tools for record selection: statistical correlation of spectral intensity measures, correlation structures, conditional spectra, occurrence disaggregation.
- Nonhomogeneous Poisson process, Aftershock probabilistic seismic hazard analysis (APSHA), sequence-based probabilistic seismic hazard analysis (SPSHA).
- Strategies for non-linear dynamic analysis, record-to-record variability of response and model uncertainty.
- Procedures for seismic input selection appropriate for each analysis strategy.
- Desired properties and selection of appropriate measures of ground shaking intensity, as interfacing variables in the risk integral.
- Methodologies for fitting parametric probability models to the analysis results and inferential procedures for evaluating the standard error of risk estimates obtained.
- Seismic risk analysis: loss estimation and seismic reliability metrics.