Time Domain, Intrusive Framework for Probabilistic Seismic Risk Analysis of Nonlinear Soil-Structure Systems

Hexiang Wang[1], Han Yang[1], Fangbo Wang[1], Jeff Bayless[1], Norman A. Abrahamson[1,2], Boris Jeremić[1]

[1] University of California, Davis, CA, USA
[2] University of California, Berkeley, CA, USA

Presented is a time domain intrusive framework for probabilistic seismic risk analysis of nonlinear, inelastic soil-structure systems. Methodology for simulating non-stationary seismic motions, for given source(s), path(s) and site is proposed. Both uncertain motions and uncertain soil-structure system parameters are characterized as random process and random field, respectively, and represented using Hermite polynomial chaos. Stochastic Elastic-Plastic Finite Element Method (SEPFEM) (Sett et al., 2011) is then used to calculate full probabilistic results for all displacements, stresses and strains. Calculated results are used to develop time-evolving probabilistic soil-structure response and full-spectrum seismic risk(Wang et al., 2020). Presented methodology resolves issues with proper choice of one or many intensity measure (IM) that is used in conventional PSRA framework.

All uncertain characteristics of seismic motions (e.g., spectrum acceleration Sa, peak ground acceleration PGA, etc.) are directly taken into account by random process excitations. Stochastic dynamic equations are solved in an intrusive way, circumventing Monte Carlo simulations, thus gaining accuracy and efficiency. Modeling epistemic uncertainties in conventional ESSI simulations, e.g., simplifications of spatially varying input seismic motions and nonlinear inelastic soil and structure modeling, are also quantified and highlighted. Examples will be used to illustrate developed framework. Developed framework is implemented in the Real-ESSI Simulator system, http://real-essi.us/.

REFERENCES

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