Ground Motion Parameterization for Structural and Geotechnical Analysis

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Abstract

Characterizing and quantifying the level and variability in near-source strong-motions is one of the major challenges in seismology and earthquake engineering. Moreover, defining alternative, more powerful seismic intensity measures (IM) than the classical peak ground acceleration (PGA) or spectral acceleration (SA) has been a topic of recent research activities, A related problem pertains the selection of earthquake ground motions, considering the accurate estimation of the structural response at a specified ground motion intensity, as measured by spectral acceleration at the first-mode period of the structure Sa (T1). As non-linear dynamic analysis has become a more frequently used procedure, one can now examine in more detail which properties of a recorded ground motion are more strongly related to the response of the structure, offering new pathways to formulate alternative IM's for seismic performance. In this study, we seek to define waveform-based IM's that can be applied in structural analysis using residual displacements and for geotechnical work on ground amplification and liquefaction potential.

As an initial step, we use the Next Generation Attenuation (NGA) strong-motion database, consisting of 3551 records from 127 earthquakes from tectonically active regions. The NGA database serves as a "training data set" with uniformly processed and well documented (including abundant meta-data) strong-motion time histories, for which we develop computer algorithms to measure IM's like pulse period, dominant frequency, and number of (load) cycles. First explorations consider a subset of NGA recordings for which finite-source rupture model exist, allowing us to correlate IM-values to a number of earthquake source parameters. We calibrate our results with the work by Somerville (2003) who proposed preliminary equations relating the period of the fault–normal component (measured manually) of the forward rupture directivity velocity pulse to the earthquake magnitude. Additionally, we investigate application specific IM-definitions, for structural analysis using residual displacements and for liquefaction susceptibility in geotechnical soil analysis.

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