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Simulation of Ground Motion Using the Stochastic Method

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Abstract — A simple and powerful method for simulating ground motions is to combine parametric or functional descriptions of the ground motion's amplitude spectrum with a random phase spectrum modified such that the motion is distributed over a duration related to the earthquake magnitude and to the distance from the source. This method of simulating ground motions often goes by the name "the stochastic method." It is particularly useful for simulating the higher-frequency ground motions of most interest to engineers (generally, $f > 0.1$ Hz), and it is widely used to predict ground motions for regions of the world in which recordings of motion from potentially damaging earthquakes are not available. This simple method has been successful in matching a variety of ground-motion measures for earthquakes with seismic moments spanning more than 12 orders of magnitude and in diverse tectonic environments. One of the essential characteristics of the method is that it distills what is known about the various factors affecting ground motions (source, path, and site) into simple functional forms. This provides a means by which the results of the rigorous studies reported in other papers in this volume can be incorporated into practical predictions of ground motion.

Key words: Stochastic, simulation, ground motion, random vibration, earthquake, strong motion, site amplification.

Introduction

Keiiti Aki was one of the first seismologists to derive an expression for the spectrum of seismic waves radiated from complex faulting. In a 1967 paper (Aki, 1967) he used assumptions about the form of the autocorrelation function of slip as a function of space and time to derive an ω-square model of the spectrum (and he coined the term "ω-square model" in that paper). He then used the assumption of similarity to derive a source-scaling law, showing that the spectral amplitude at the corner frequency goes as the inverse-cube power of the corner frequency. He explicitly recognized that this is a constant-stress-drop model. His work has been used knowingly and unknowingly by several generations of seismologists to predict ground motions for earthquakes, particularly at high frequencies where the space- and time-distribution of fault slip is complicated enough to warrant a stochastic description of the source. Usually these predictions are for a specified seismic

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