Simulation of high variable random processes through the spectral-representation-based approach

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Abstract

To date the unique universal method of structural analysis when strong nonlinearities as well as input and/or model uncertainties are involved is the Monte Carlo simulation method. Assuming that a reliable structural model is defined, the crucial point for applying the Monte Carlo simulation technique is the generation of appropriate samples of the random process representing the external input such as the earthquake, the wind or the sea waves. Spectral-representation-based simulation techniques are among the most widely-used today for this purpose. Accordingly, the input is modeled as a Gaussian random process, fully defined by the well known power spectral density function/matrix. Therefore, after defining a suitable model for the power spectral density of the input samples loading time histories can be simulated through the superposition of harmonics with random phases (see e.g. Shinozuka, 1971, Shinozuka 1987, Shinozuka and Deodatis, 1988). Recently, it has been showed by Cacciola and Zentner (2011), that this approach might suffer the drawback that the simulated samples are too similar each other and are not able to represent the natural variability of random processes such as the earthquakes. In this paper the traditional simulation technique based on the superposition of harmonics with random phases is revisited. A modification aimed to control the variability of the simulated samples of the random process is proposed. Comparison between the traditional simulation technique and the new one proposed in this paper will be also discussed.

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