THE EFFECT OF SOIL PROPERTIES UNCERTAINTY ON THE GROUND MOTIONS INTENSITY

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Geotechnical characteristics of a site, including soil properties influence the intensity and frequency content of ground motions. Soil depth to bedrock is another parameter that can alter the ground motions' characteristics as they travel from depth to surface. The uncertainties are mostly attributed to the lack of knowledge arouse in the process of identification and measurement of natural phenomena. Soil properties and soil depth to bedrock are not precisely known in many seiesmicity considerations for structural analysis and design. The uncertainty of the input parameters in the analysis and design process leads to lack of trust in the accuracy of the obtained results.

The goal of this paper is to characterize the uncertainty of the soil material properties as a natural material and to propagate the effect of these uncertainties on the variability of ground motions intensity. On the other hand, by the aid of Tornado diagram analysis, a sensitivity assessment is performed to identify the most effective soil characteristic parameter. Furthermore, in this study two probabilistic analysis approaches, including Monte Carlo simulation technique (MC) and First Order Second Moment method (FOSM) are studied and their results are compared. Because of the time and cost consuming feature of full probabilistic analysis methods, such as MC, this study compares two methods to evaluate the accuracy of FOSM in the seismic response studies of soil domain.

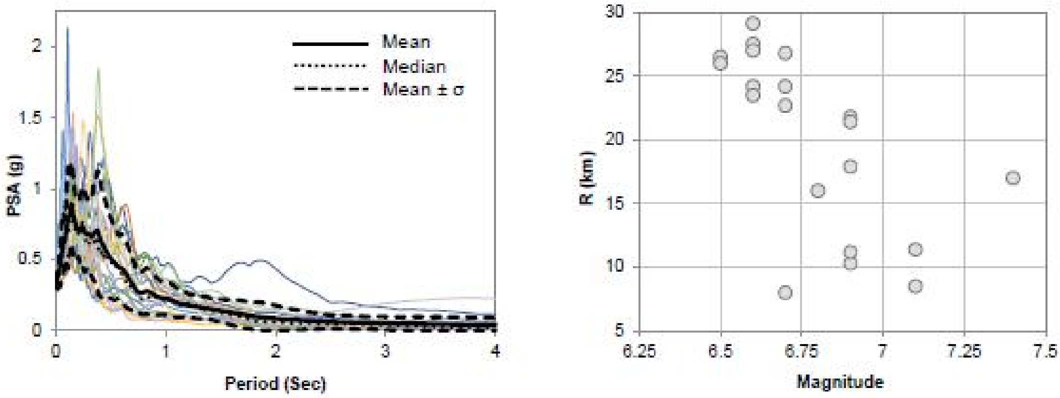
Performing nonlinear time history analysis for soil domain samples subjected to real earthquake records, the results of studies show that the soil depth can severely affect the ground motions intensity at the soil surface and soil shear modulus at small strains is recognized as the most effective parameter of soil. It is also concluded that FOSM approximate method could be reasonably and effectively used instead of MC simulation technique for evaluating the seismic response of soil domain regarding the uncertainty in soil properties.

The soil properties that are considered as uncertain parameters in this study and their symbols are displayed in Table 1. The mean and coefficient of variation (CV) of each parameter are also presented in the table.

Table 1. Mean and Coefficient of Variation of soil properties

Soil properties	Symbol	Mean	CV (%)
Maximum shear modulus (kg/cm^2)	G_0	1700	50
Material unit weight (kg/cm^3)	γ	0.002	10
Relative density (%)	D_r	70	20
Poisson's ratio	v	0.35	20
Viscous damping ratio (%)	μ	2	25

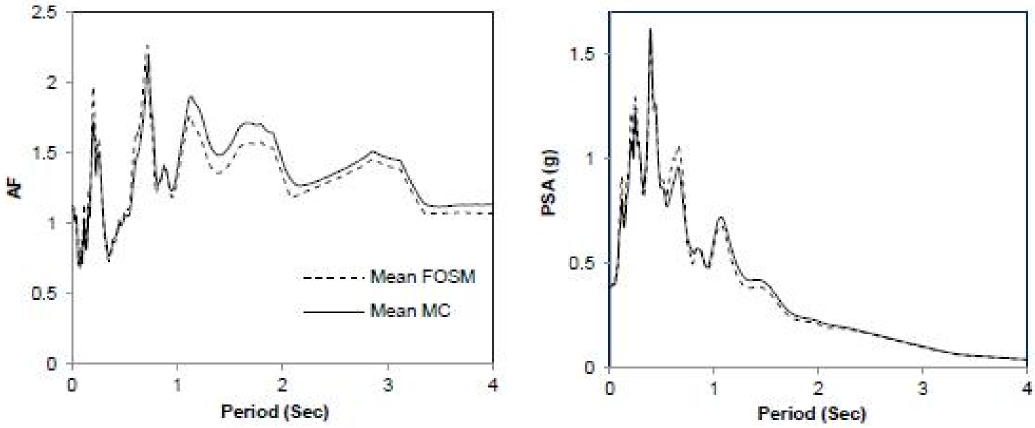
Soil domain samples are analyzed subjected to 20 real earthquake records obtained from 8 different earthquake events around the world. Records are selected based on the magnitude and distance to rupture zone (R) of ground motions according to Shome and Cornel observations. Figure 1 demonstrates the 5% damped spectral acceleration response as well as magnitude and distance to rupture zone scatter gram of selected 20 records used as input seismic excitation.



a) Spectral acceleration response b) Magnitude and distance scatter gram

Figure 1. Characteristics of input earthquake records

The amplification factor of input records and spectral acceleration response at soil surface obtained from FOSM analysis and MC technique are demonstrated in Figure 2. According to the results, two probabilistic methods show good agreement in predicting the responses.



(a) Amplification factor curve (b) Spectral acceleration response

Figure 2. Comparison of the FOSM and MC approaches results

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