Amirkabir University of Technology
(Tehran Polytechnic)
Vol. 46, No.1, Summer 2014, pp. 15- 16

Amirkabir Journal of Science & Research (Civil & Environmental Engineering)
(AJSR - CEE)

Probabilistic Seismic- Hazard Analysis (PSHA) Considering Nonlinear Soil- Site Effects

S. Yaghmaei-Sabegh [1*], R. Motalebzadeh[2]

1- Associate Professor, Department of Civil Engineering, Tabriz University, Tabriz, Iran
2- M.Sc. Student, Department of Civil Engineering, Tabriz University, Tabriz, Iran

(Received 01 Aug 2011; Accepted 04 May 2013)

ABSTRACT

Studies on the behavior of soil layers reflect the fact that the soil is generally enter the range of nonlinear behavior during strong ground motions that have received increased attention in recent years. Conventional seismic hazard analysis often assumes a linear behaviour for soil with considering of a generic-attenuation relation. Generally, for site response analysis, the amplification function is required that is depend on dynamic property of different soil layers, are not known for different parts of the world. This paper is aimed at presenting a straightforward approach for estimating seismic hazard curves taking into account nonlinear soil-site effects. This approach convolves numerically the probabilistic seismic hazard analysis (PSHA) at bedrock with the nonlinear response of soil computed via dynamic analysis. Applications of proposed method has been shown for two different sites located in Tehran and Tabriz, one sandy and one clayey. A Monte Carlo based approach was used for characterization of amplification function values along with those of deterministic curved obtained in the study areas. It is concluded that the proposed model can give satisfactory accuracy for predicting seismic hazard curves when there is a lack of detailed information of dynamic soil properties.

KEYWORDS

Probabilistic Seismic Hazard Analysis, Nonlinear Behavior of Soil, Uniform Hazard Spectra, Amplification Function.

* Corresponding Author, Email: s_ yaghmaei@tabrizu.ac.ir

1- BREIF INTORODUCTION

The first attempt on influence of soil conditions on ground motions during earthquake was formed by Seed and Idriss (1970). Observations from past earthquakes have shown distinctive evidence of nonlinear site response. Hryciw et al. (1991) proposed a non-linear soil model to explain recorded motions of the Loma Prieta earthquake (M=7.1, 1989) at Treasure Island station. Conventional seismic hazard analysis may not be completely calibrated on the basis of nonlinear soil characteristics and could yield inaccurate results. In regard of this topic, several studies such as Abrahamson and Silva (1997), Silva et al. (2000), Tsai (2000), Bazzurro and Cornell (2004a,b), Park and Hashash (2005), have tried to link probabilistic seismic hazard analysis with nonlinear site response.

2- METHODOLOGY

The available attenuation equation for analyzing the bedrocks spectral acceleration, $S_a^{\,r}(f)$, is related to the corresponding value at soil surface ($S_a^{\,s}(f)$) based on the equations 2 and 3 at an oscillatory frequency, f (in hertz) :

$$\ln \overline{S_a^s(f)} \approx c_1 + (c_2 + 1)\ln \overline{S_a^r(f)} \qquad (1)$$

Also a standard estimation of error is given by coupling the Sar(f) with the site specific regression for AF(f) as follow:

$$\varepsilon_{\ln S_a^s(f)} \approx \sqrt{(c_2+1)^2 \sigma^2_{\ln S_a^r(f)} + \sigma^2_{\ln AF(f)}}$$

(2)

Site-specific coefficients could be obtained through dynamic analysis followed by regression scheming. The coefficients (c1, c2) for sandy and clayey sites with unspecified properties have been presented by Bazzurro and Cornell (2004a) taking into account the uncertainties by applying of Monte-Carlo-based modeling approach

3- MAIN CONTRIBUTION

Three different methods are considered in this paper as sufficient approaches for estimating the site-specific hazard spectrum based on the nonlinear site characteristics of study area. Also, the applicability of Monte-Carlo-based modeling for estimating of amplification function in different selected sites of the study area is examined.

4- SIMULATION

The results of seismic hazard analysis for TE2-M0-clay site based on two procedures, MGPE and CM in two return periods, 475 and 2475 years have been presented in Figure1.

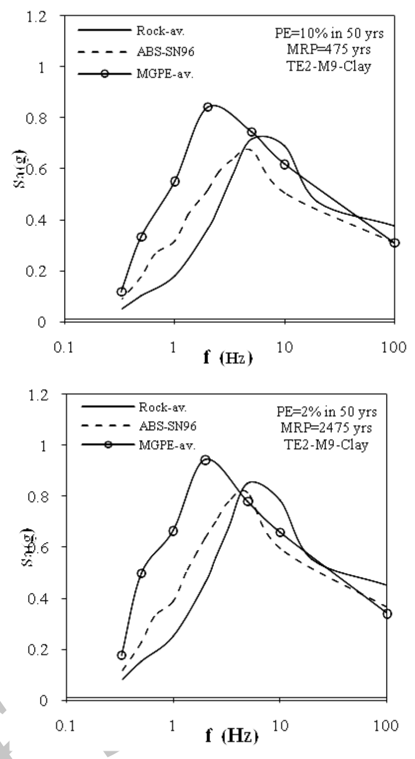

Figure 1 Site-specific spectrum for TE2-M9-clay

5- MAIN REFERENCES

[1] Bazzurro, P. and Cornell C. A. ,“Ground-Motion Amplification in Nonlinear Soil Sites with Uncertain Properties”, Seismosignal Society of America, 94(6), pp. 2090–2109, 2004.

[2] Bazzurro, P. and Cornell C. A. ,“Nonlinear Soil-Site Effects in Probabilistic Seismic-Hazard Analysis”, Seismosignal Society of America, 96(6), pp. 2110–2123, 2004.

[3] Abrahamson, N. A. and Silva W. J. ,“Empirical Response Spectra Attenuation Relations for Shallow Crustal Earthquakes”, Seismological Research Letters, 68, pp. 94–127, 1997.