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Development of Site-Specific Design Spectra for the Central Parts of Ardabil City, Iran

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ABSTRACT

Development of site-specific spectrum for alluvium and design of tall and special structures is needed. Due to position of the city of Ardabil on the alluvium and spreading of construction in the central part of the city, developing of site-specific design spectrum is inevitable and worthwhile. In this paper, the geotechnical boreholes data is applied to site response analysis and developing of site-specific spectrum. The boreholes are tends to 40 meters deep. Based of boreholes distribution the site was segmented in to 15 zones with an area of 1 Km^2. According to probabilistic seismic hazard analysis (PSHA), hazard curve is produced for the city. Peak ground acceleration (PGA) with 10% probability of exceedance (approximately 475-yaer-return-period earthquake) is obtained about 0.32g that is about 6% more than one proposed by Iranian Code of Practice for Seismic Resistant Design of Buildings (Standard-2800).

Site-specified design spectra are obtained using three methods of ground response analysis, statistical analysis of different earthquakes and uniform hazard spectra. By applying the data from geotechnical measurements, soil types in the different zones of the city center are designated. The soil types in the most parts of studied area are classified as type III of the standard 2800 classification. Comparison of the developed spectra with the proposed spectra of standard 2800, showed that in the range of constant acceleration, the values of site-specific design spectra is 25% higher than those proposed by the standard 2800.

KEYWORDS

Site-Specific Spectra, PSHA, Site Response Analysis, Uniform Hazard Spectra, Statistical Analysis.

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1- INTRODUCTION

Iran is an earthquake prone-region, located on the Alp-Himalayan seismic, has lost many human lives, and encountered a lot of economic losses due to earthquakes. The seismotectonic conditions of the Ardabil region are under the influence of Iranian tectonic plate in the Middle East. Fig. 1 shows the map of active faults around Ardabil City. Due to position of the city of Ardabil on the alluvium and developing of construction in the central part of the city, producing of site-specific design spectra is worthwhile. Borehole-geotechnical data and strong-motion measurements constitute basis to account local geological condition in design spectrum. Therefore, in this paper, by applying PSHA and using the geotechnical data of some boreholes site-specific response spectrum were developed for different zones of central part of Ardabil city. Also, for engineering application, soil types were identified based on geotechnical data and categories of Standard 2800.

2- METHODOLOGY, DISCUSSION, RESULTS

The two general approaches for developing site-specific response spectra are the deterministic and probabilistic approaches. In deterministic seismic hazard analysis (DSHA), site ground motions are deterministically estimated for a specific, selected earthquake, that is, an earthquake of a certain size on a specific seismic source occurring at a certain distance from the site. In probabilistic seismic hazard analysis (PSHA) site ground motions are estimated for selected values of the probability of ground motion exceedance in a design time period or for selected values of annual frequency or return period for ground motion exceedance [1].

Seismic hazard analysis was done in Ardabil city by applying PSHA and recently developed attenuation relationships and hazard curve was developed as shown in Fig. 1. Hazard curve relates the level of ground shaking to the annual frequency of exceedance of that level. The ground motion parameter in Fig. 1 is peak ground acceleration (PGA). Based on the developed hazard curve, PGA with 10% probability of exceedance within 50 years is about 0.32g, which is 6% higher than that proposed by Building Design Codes for Earthquakes - Standard 2800.

It has been well-recognized that earthquake ground motions are affected by earthquake source conditions, source-to-site transmission path properties, and site conditions.

Site–specific desing spectra were developed for central part of Ardabil city. To this end, borehole-geotechnical data at the central part of the city was collected and studied [1]. The seismic borehole log contains information about the depth, observed SPT N value, density of soil, fine content, soil class, water table level. Regarding the data, the target area was segmented to 15 zones that each zone has area of 1 km^2 [2] as shown in Fig. 3.

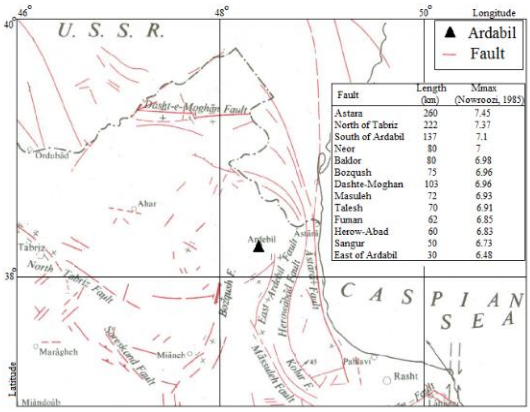

Figure 1. Active Faults in and around Ardabil city

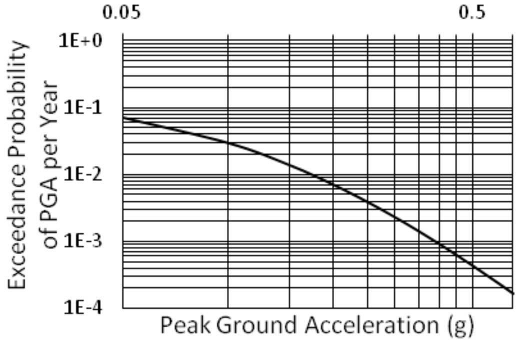

Figure 2. Seismic hazard curve showing relationship between peak ground acceleration and probability (annual frequency) of exceedance

Figure 3. The segmented zones of the interested area

Three approaches were applied to develop response spectrum for each segment of the city. Design spectrum was developed based on non-linear ground response analysis, site-specific response spectrum

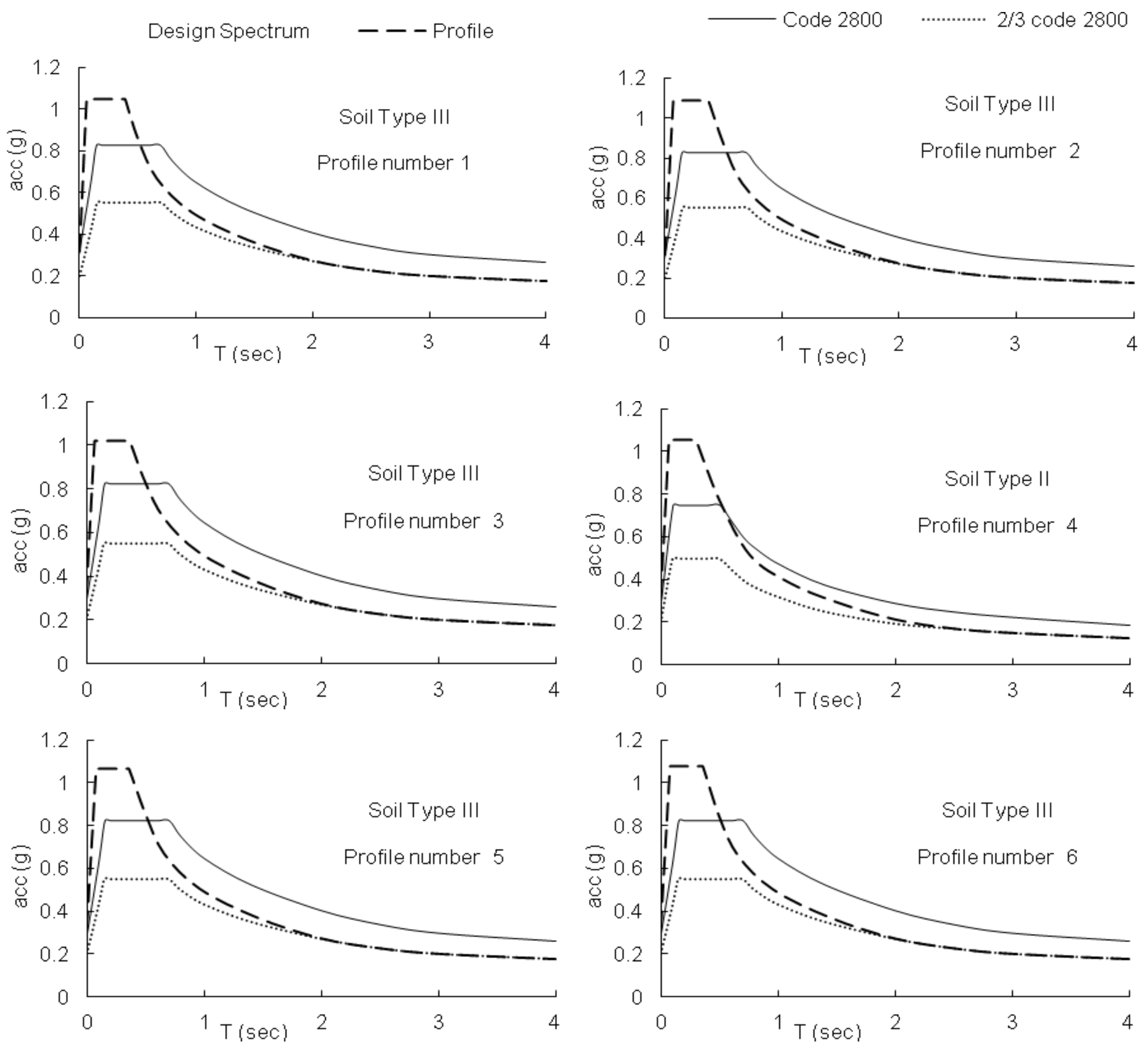

Figure 4. Site-specific, Standard 2800 and 2/3 of code proposed design spectra for the zones of 1 to 6.

through statistical evaluation and finally uniform hazard spectrum. The third spectrum is developed by first performing the above PSHA calculations for spectral accelerations at a range of periods. Then, a target rate of exceedance is chosen, and for each period the spectral acceleration amplitude corresponding to that rate is identified [3-4].

Fig. 4 shows the site-specific design spectra developed from previous aproaches, for each zone of interested area. In this figure, design spectra and 2/3 of Standard 2800 design spectra were illustrated for comparison.

3- CONCLUSIONS

Due to the use of new relationships and comprehensive data in this study, the peak ground acceleration (PGA) of 0.32g was determined based on risk analysis which is 6% higher than that proposed by Building Design Codes for Earthquakes - Standard 2800.

For the engineering applications, the soil type of the region, according to Standard 2800, was determined. Soil type in the regions of No. 4, 12, 13 and 15 is classified in type II and the rest falls into soil type III.

Comparison of the obtained design spectrum with the proposed spectrum of standard 2800, showed that in the range of constant acceleration, the values of site-specific design spectra is 25% higher than those proposed by the standard 2800.

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