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EXTENDED ABSTRACT

Evaluation of the Need for Seismic Microzonation in Bonab County based on Regional Considerations and Probabilistic Earthquake Hazard Analysis from the Vicinity of Urmia Lake toward the Hillsides of Sahand Mountain

Peyman Narjabadifam [a,*], Iraj Chaei-Asl-Tabrizi [b], Mina Bagheri-Mollahajlu [c]

[a] *Department of Civil Engineering, Faculty of Engineering, University of Bonab, 5551761167 Bonab, Iran*
[b] *Building and Housing Department, BHRC, 1463917151, Tehran, Iran*
[c] *Postgraduate School of Environmental Engineering, University of Tehran, 14155-6135, Tehran, Iran*

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1. Introduction

Earthquake can be considered as the most important environmental excitation because of its massive destructivity within a short period of time. Prediction of earthquakes is still a dilemma (Wang, 2015). The questions are also available about the effectiveness of prediction, if possible. It is clear that the society will not be safe with only the prediction of earthquakes. Earthquake protection of structures is required as the main solution. The quality of this protection depends mainly on the quality of the estimation of possible earthquakes. In this regard, earthquake hazard analysis should be followed by seismic microzonation in order to account for the site effects. Evaluation of the need for such a detailed study is carried out for Bonab County, which is the second industrial city in the province of East Azerbaijan after the capital city (Tabriz), being also important because of its cultural heritage. The other motivation for this study comes from the change in the seismicity of the neighboring region referred to the 4th edition of the Iranian code of practice for seismic resistant design of buildings (Standard No. 2800) when compared with the 3rd edition of this standard (PCIRC, 2007).

2. Methodology

The research is carried out in two stages: (1) probabilistic seismic hazard analysis, and (2) seismic microzonation based on site effects.

For the purpose of probabilistic seismic hazard analysis, a uniform catalog is first prepared for the earthquakes occurred in a region located between 44.4°-47.7° E and 35.7°-39° N, when the center of the city of Bonab itself is located at 46.0561° E and 37.3403° N. The fault map of the region is studied and the seismogenic depth is determined. Seismic sources are detected and the maximum magnitudes likely to occur are calculated. Seismic parameters are determined using Zmap (Wyss et al., 2001) and attenuation relations are applied. The hazard analysis is performed using EZ-FRISK (Risk Engineering Inc., 2011) and peak ground accelerations are calculated in the region.

As far as the microzonation is considered, geotechnical data are first collected from the previous projects in the region. The topography of the region is then studied. The effects of topography (Jeong, 2013) and

* Corresponding Author
E-mail addresses: narjabadi@tabrizu.ac.ir (Peyman Narjabadifam),tabrizi.iraj@gmail.com (Iraj Chaei Asl Tabrizi), m.bagheri.hajlu@ut.ac.ir (Mina Bagheri-Mollahajlu).

geotechnical measures (TC4, 1999) are estimated independently. These effects are finally combined together to obtain an evaluation for microzonation.

3. Results and discussion

Based on the probabilistic seismic hazard analysis performed, peak ground accelerations are almost constant in the region. The average acceleration for the return period of 475 years is obtained as 0.21g. This estimation seems to be in accordance with the value suggested by the 4th edition of the standard No. 2800, when the code-based considerations are applied.

As the outcome of the evaluation of the need for seismic microzonation, six microzones are predicted in the region based on the application of the site effects in terms of both topographic and geotechnical measures. The minimum amplification occurs in the area near to the vicinity of Urmia Lake with the amplification ratio (defined as the ratio between peak ground acceleration in the ground surface to that on bedrock) equal to 2. The maximum amplification is obtained for the eastern part of the region in the vicinity of Maragheh with the ratio equal to 4. The amplification ratios for the other four microzones fall between 2 and 4. For example, peak ground acceleration in the surface layers of Savar (the famous touristic village near to the Bonab city) is estimated to be amplified by a value around 2.4 that should be applied on the bedrock acceleration.

4. Conclusions

The need for seismic microzonation in Bonab County was evaluated based on regional considerations in terms of topographic and geotechnical measures as the site effects. These effects were applied after the probabilistic earthquake hazard analysis carried out for the region.

The earthquake hazard analysis indicated that in spite of the changes in the design base accelerations of the vicinities of the Bonab city referred to the 4th edition of the Standard No. 2800 compared with the 3rd edition of that, the intermediate seismicity is reliably acceptable for Bonab.

The site effects applied after the probabilistic seismic hazard analysis emphasized the need for seismic microzonation with 6 microzones predicted based on the amplifications caused by topography and geotechnical measures. The microzonation can be summarized as in below:

Microzone 1: The border area of Bonab and Maragheh with the amplification factor of around 4 estimated as the ratio between peak ground acceleration in the ground surface to that on bedrock.
Microzone 2: The north-western vicinity of Bonab near to the neighboring city Ajabshir with an amplification factor equal to 3.5.
Microzone 3: The vicinities of Urmia Lake with the amplification factor of around 3.
Microzone 4: The eastern-central and north-western parts of the Bonab County with an amplification factor of around 2.5.
Microzone 5: The north-eastern corner of the county with the amplification factor of around 2.4 for the famous touristic villages like Savar located in this area.
Microzone 6: The city of Bonab and its surrounding area from Qareh Qeshlaq in the South near to Malekan up to Shurgol in the north near to Ajabshir with the amplification factor estimated as 2.

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