PRELIMINARY SEISMIC MICROZONATION OF BOJNORD USING MICROTREMORS

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Seismic hazard assessment of big cities is imperative to mitigate the potential damage and loss of life due to earthquakes. Local ground conditions substantially affect the characteristics of incoming seismic waves during earthquakes. Soft soil deposits amplify certain frequencies of ground motion and extend the duration of the motion, thereby increasing earthquake damage. Seismic waves are trapped in the soft soil layer and multi-reflection phenomenon occurs. As a result, the ground vibrates severely with a specific dominant period. This period is called the predominant period of the ground, and the vibration of structures on the surface is highly influenced by it.

The variation in the ground motion, according to the geological site conditions, makes it necessary for big cities to do more detailed seismic hazard assessments. Seismic microzonation is defined as the process of subdividing an area into zones with respect to geological characteristics of the sites, so that seismic hazards at different locations within the city can correctly be identified (Haghshenas et al., 2008).

Microtremor observations can be used to determine the dynamic properties of a site and, hence, can be used for microzonation (Bard, 1998). In order to clarify the surface ground motion characteristics at Bojnord City, a microtremor measurement grid has been designed. Different 1-hour microtremor measuring during day and night has been carried out. The map of measurements is shown in Figure 1.

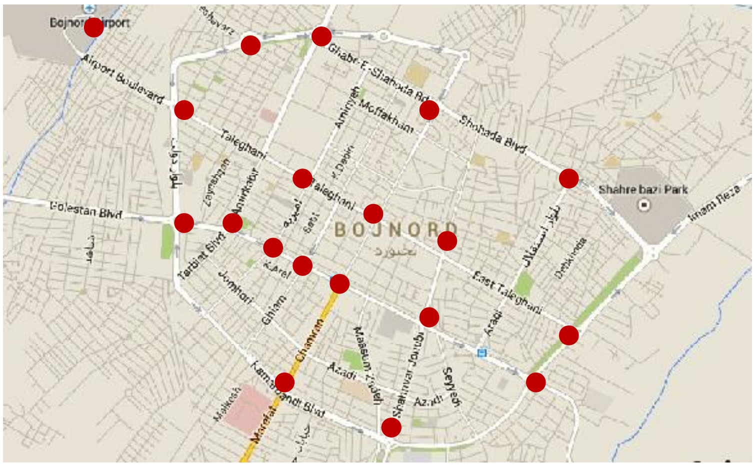

Figure 1. Map of Measurement Point

This field experiment was carried out in the urban area of Bojnord city and its surroundings. During the recording period, different stations were equipped with 3011short period sensors (flat velocity response between 1 and 50 Hz) coupled with

PDER data loggers (url: www.geoparsian.com).

The horizontal to vertical spectral ratio technique, also called Nakamura's method (Nakamura, 1989) or HVNR was used as a principal data processing procedure in order to extract the experimental transfer function of the site. The method relies on interpretation of Rayleigh waves in a single layer over half space. A further assumption is that vertical component of motion is not amplified by soft soil layer (Lermo and Chavez-Garcia, 1994).

HVNR spectral ratios were calculated using the Geopsy software provided by the European SESAME consortium applying the following procedure. The continuously recorded data were split into 30 minutes microtremor records for the experiment. The mean and any linear trend were removed from the records. The records were band-passed filtered between 0.2-25 Hz. The stationary noise windows of 20 to 30 seconds were selected by the anti-triggering algorithm incorporated in the software with a 5% window overlapping. Then the squared average has been used to combine different horizontal spectra components. The Konno-Ohmachi smoothing function has been used to avoid spurious peaks or sharp troughs in the spectra (Konno and Ohmachi, 1998). To minimize the border effects due to the windowing of the Fourier spectra, 5% cosine taper has been used.

To investigate the differences between differently polarized horizontal components, directional spectral ratios were obtained by applying different rotation angles (Khandan Bakavoli et al., 2011). Besides the amplification, ratio resulted from spectral analysis have been compared with existing geotechnical and geophysical information.

As a conclusion, fundamental frequencies of the sites using HVNR have been extracted. Following this extraction, the city zonation considering the low-rise, mid-rise and high rise building has been carried out and finally distribution maps of site periods and peak ground acceleration throughout the city were developed

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