SITE EFFECTS USING HVSR AND SSR TECHNIQUES IN RAMSAR CITY

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Over the last century, a lot of cities have expanded dramatically and specialists expect a similar trend for at least the next decades. In many parts of Iran, urban areas are usually built on soft sediments. Because this vast country is a part of Alpine-Himalayan seismic belt, so not only urban, but countryside and villages are also prone to strong ground shaking. The surface of the Earth is always in vibration, even without earthquake. The vibrations at low seismic frequencies called "microtremors", exist everywhere. Site responses computed for a large number of events, allows to define unknown source position and plausible mechanism of the future ground motions. One way that is based on ambient vibrations are the H/V method of Nakamura (1989), has been proven to be a convenient technique to estimate the fundamental frequency of soft deposits. This method is based on the Fourier spectral ratio of the horizontal and vertical components of seismic noise wavefield. The relation between this ratio and the frequency is called the HVSR curve and has a peak within dominating frequencies of the record. The peak amplitude is used for the amplification factor estimate, and its frequency is the principal frequency of surface layer. The ability of the HVSR technique to provide a reliable data related to site response has been repeatedly shown in the past (Duval et al., 2001). We do use this approach for few reasons, first, the instruments and analysis are simple. Second, it can be performed at any time and any place. Third, it does not produce such environmental trouble as active seismic does (Bard, 1998). Each signal recorded in a site has the simultaneous effects of sources, paths, and sites. One has to eliminate the source and the path to determine the effect of soil (Huang & Teng, 1999). For this reason and based on the idea presented by Nakamura (1989), trajectory effects can be eliminated with a particular type of normalization on microtremors. In addition, peaks were achieved by spectral analysis need clarification, as well. In other words, processing the peaks obtained by recording a few minutes of field noise are needed significantly to perform validation steps and clarity for the maximum peaks. It may also have the maxima of industrial origin that must be checked. To do this, standards have been used based on European Comprehensive Research known as SESAME published in the year 2004, to analyzed data separately for each station and compared with the criteria. Finally, the estimated frequency is compared with other methods.

In this study, microtremors data collected from 10 single stations for about few months (Figure 1), and have been analyzed using Standard Spectral Ratio (SSR), comparing spectral noise signals of all components in a single station to the one in rock stations, and Horizontal to Vertical Spectral Ratio (H/V) technique, the Nakamura method for a single station, in Ramsar city (north of Iran). The coordination of area is (N-S: $36°,30' - 27°,00'$, E-W: $50°,30' - 51°,00'$).

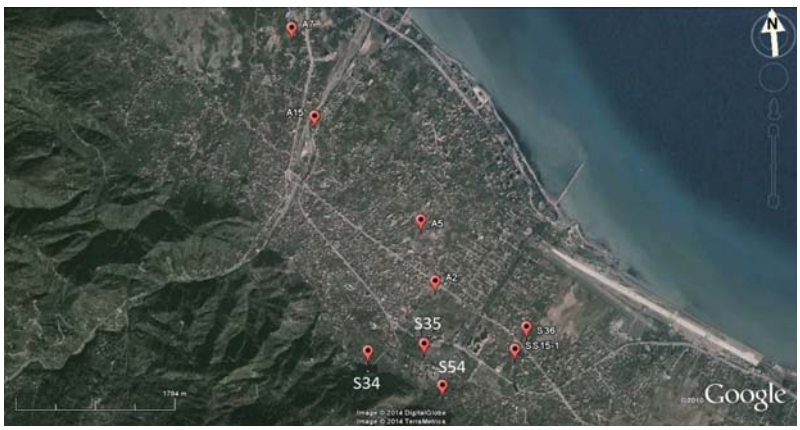

Figure 1. The locations of stations in Ramsar city: S35 is in the urban area, while S34 and S54 are on rock sites.

The frequency and amplification results obtained from both SSR and HVSR techniques are relatively similar in the studied area. By means that, in sites with a close distance to the reference site, H/V technique yields similar to SSR technique. This result demonstrates the advantage of application of the H/V in interpretation of the obtained data (Figure 2).

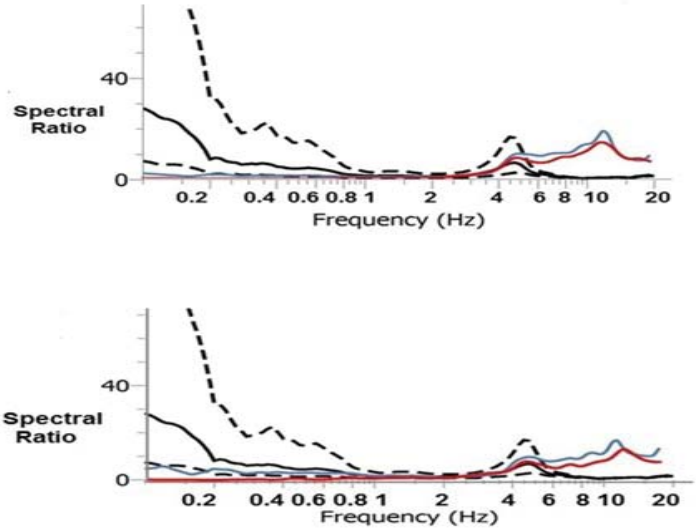

Figure 2. The comparison of Nakamura's method for station S35 (black) with SSR method for S35 (Red: N-S component, Blue: E-W component) by two rock stations: S34 (above) and S54. Standard deviation (dashed lines).

The calculations indicate that the Nakamura method shows a proper estimation of the soil frequency and amplitude of the studied area. The results of station 35, placed on sedimets, using two HVSR and SSR methods, have achieved a good matching between the results of the site response obtained. The results are illustrated in Table 1.

Table 1. The results for single station S35 using two diffrent methods.

Station	The frequency (HZ) using Nakamura's method (HVSR) in single station S35	The frequency (HZ) using SSR method in single station compare to S34 rock station	The frequency (HZ) using SSR method in single station compare to S54 rock station
S35	4.66	4.8	5

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