EXTRACTING RAYLEIGH WAVES ELLIPTICITY CURVES IN TEHRAN BASIN: EFFECTS OF MICROTREMORS ENERGY AND CONSEQUENCES FOR VELOCITY STRUCTURE IMAGING

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Tehran (Iran) city is facing large ground motion amplification over a wide frequency range (amplification up to 8 from 0.3 to 8 Hz) (Haghshenas, 2005; Haghshenas et al., 2003). Such important site effects are most probably due to a combination of very thick and stiff sediments overlaying very rigid bedrock and 2D/3D wave propagation effects (Haghshenas, 2005). In order to derive shear-wave velocity from the surface down to the deep seismic (or geologic) bedrock, 11 microtrmor arrays consisting of 9 to 12 element have been recently performed throughout the Tehran basin using Guralp CMG6TD acquisition systems. Due to logistical constraints, array apertures were ranging from 50 to 1500 m which allow the dispersion curve to be retrieved from about 1-2 Hz to about 10 Hz. Such a frequency range obviously does not allow to invert velocity structure of the deepest layers. However, recent studies (Hobiger et al., 2013) have shown that extracting Rayleigh wave ellipticity helps in retrieving information on the dispersion characteristics of Rayleigh waves in the low frequency range, especially down to the ellipticity peak frequency. Joint inversion of dispersion and ellipticity curves then allows to derive shear-wave velocity over the entire alluvium column. In Tehran, Haghshenas (2005) - by using CMG40T velocimeters connected to Reftek72A acquisition units - has clearly experienced difficulties in extracting reliable resonance frequencies through the use of H/V technique applied on microtremors. While H/V peak frequencies are clearly observed on earthquake recordings, H/V curves computed on microtremors exhibit peak at low frequency only during periods of large storms in the Caspian sea (see also Haghshenas et al., 2008).

The present study focuses on the extraction of ellipticity of Rayleigh waves at 10 sites instrumented by Haghshenas (2005) for which 1 month of continuous microtremors data, strong motion recordings and 1 to 3 hours array microtremor measurements are available. Ellipticity curves were extracted by using the RAYDEC (Hobiger et al., 2009) and the Time Frequency Analysis - TFA (NERIES-JRA4, 2010) applied on microtremors in 3 different energy contents; the calm and stormy days, as well as recording time containing earthquake events. First, we confirm that the H/V curves computed on microtremors recorded by CMG6TD instruments does not exhibit peak in most sites, consistently with Haghshenas (2005) findings. It confirms the lack of excitation of the basin at low frequency and rejects any instrumental issues in the study of Haghshenas (2005). Ellipticities computed by using RAYDEC and TFA techniques provided similar average ellipticities. For all sites, ellipticiy curves show very similar trend at frequencies above 1 Hz for all the 3 mentioned condition. For the frequencies lower than 1 Hz ellipticities measured on microtremors during stormy days and including earthquake events are in good agreement, while for the other one the ellipticity cannot be extracted due to the low ambient noise energy level.

These results outline that dispersion data retrieved from microtremor measurements are reliable down to 1 Hz only and that extraction of dispersion estimates at lower frequencies should be preferentially performed on earthquake recordings in lack of evidence of large storms in the Caspian sea.

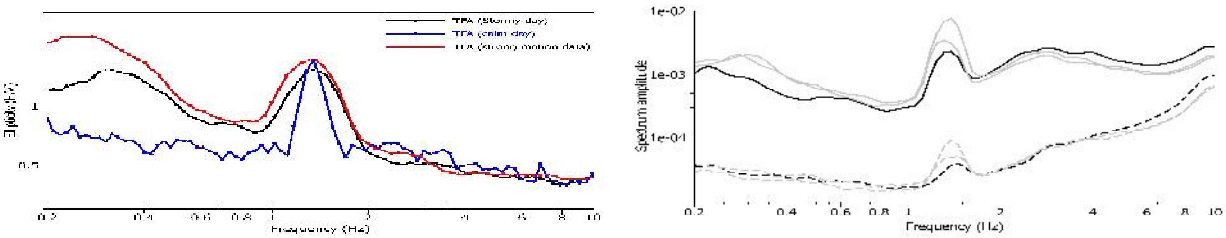

Figure 1: (Left) Average ellipticity curves extracted at FAR station (Haghshenas, 2005) by using Time Frequency Analysis method applied on calm and stormy days in Caspian sea and strong motion events. (Right) Fourier amplitude spectra recorded (ms^{-1}) in FAR station during calm (dash black line stands for vertical component while dashed gray lines stand for horizontal components) and stormy (black line stands for vertical component while gray lines stand for horizontal components) days. The resonance frequency of this site is 0.3 Hz. The ellipticity peak observed at 1.3 Hz is related to industrial activity (Haghshenas, 2005)

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