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THE EFFICIENCY OF USING THREE COMPONENT ARRAY-BASED ELLIPTICITY METHODS FOR SITE CHARACTERIZATION

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Many researchers believed that the spectral ratio between horizontal and vertical components has been introduced by Nakamura for the first time in 1989. But, started from 1971 and based on the assumption that the noise wavefield is predominantly consists of surface waves, many authors expressed that the H/V ratio is related to the ellipticity of Rayleigh waves (Konno and Ohmachi, 1998).

The fact is, in contrast with Love waves, Rayleigh waves are polarized in both horizontal and vertical directions, so the peak observed in the H/V may be related to the polarization of Rayleigh waves.

In this regards, Bard (1999) noticed that the existence of Love waves will not affect the interpretations of H/V ratio because it does not affect the vertical component and also due to the airy phase of Love waves, the peaks is get more strength near the resonance frequency. He also mentioned that the sensitivity of this ratio to body waves is not important if the wavefield is not significantly including the body waves.

Since the sources are unknown, it is necessary to consider some assumptions concerning the spectral content of SH waves, because the SH part of the wavefield contributes to the horizontal component and if it could be removed, the H/V ratios would better determine the ellipticity (Fah et al., 2001).

For this purpose two main methods has been introduced: The first one is reducing the SH wave influence by identifying P-SV wavelets from the signal in this regard, the most energetic parts of vertical component is identified in time for each frequency and therefore P–SV wavelets are located. This method is called HVTFA (Fah et al., 2001). The second method using the vertical component as a master trigger and stacking a large number of horizontal and vertical signals based on random decrement technique to extract Rayleigh waves respect to Love and body waves. This method is called RayDec (Hobiger, 2009).

From 2001 as part of NERIES project (2004-2008) using ellipticity information for site characterization has been popularized. The first attempt to get additional information like shear wave velocity from this parameter comes back to Fah et al. (2001) paper. Two years later he succeeded to invert the stable part of ellipticity to retrieve shear wave velocity (Fah et al., 2003).

As respects to the non-uniqueness of the inverted results from single station methods there is some difficulty for using this kinds of method, for example it is difficult to find the exact correction for the distribution of SH and Love wave's energy in the horizontal components. Also, difficulty in identifying and separating the contribution of higher modes is another disadvantage of this set of techniques, and generally it is not possible to identify the propagation direction and the sense of rotation with single station methods (Hobiger et al., 2013).

From 2011 several Array based methods was introduced by different authors. MUSIQUE method based on classical MUSIC and the quaternion-MUSIC algorithms is just working very well with earthquake data (Hobiger, 2016). In the meantime Marano (2017) introduced the new method based on Maximum likelihood estimation of wave parameters. In this method, the previous parameters are reestimated based on the newer ML estimates. Rayleigh wave is parameterized by the parameter vectors including the ellipticity angle ξ. The absolute value of ellipticity is represented by tangent of the ellipticity angle ξ.

Recently, Wathelet et al. (2018) used the new three-component beam forming method to introduce new strategy for identifying the Rayleigh wave ellipticity. Based on original capon idea if a Rayleigh wave mode is identified on the f-k planes, the amplitude ratio between the horizontal and the vertical f-k power-spectra will represent the ellipticity. This method is called RTBF.

In this paper, we try to distinguish the results between single station methods and array methods. We tested the results in shallow site in Arak city with large impedance contrast between surface and bedrock and another unknown site in the east of the Tehran. The results show that despite the good and usable results from single station methods, the arrays methods can introduce more precise results for right flank and additional results like sense of rotation. (Figure 1).

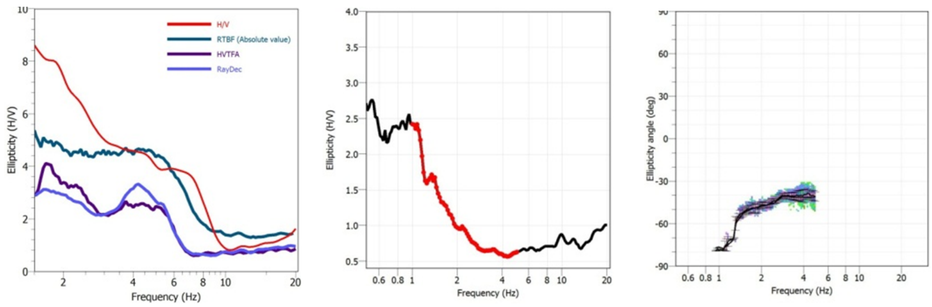

Figure 1. a) Comparing the absolute ellipticity value between classic H/V, ellipticity single station methods (HVTFA and RayDec) and array method (RTBF) in Arak. b) Ellipticity single station methods (SKH station, East of Tehran). c) Sense of rotation estimation for SKH using RTBF method.

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