8th International Conference on Seismology & Earthquake Engineering
11-13 Nov. 2019, Tehran, Iran

FORWARD HVSR UNDER THE DIFFUSE FIELD ASSUMPTION COMPARED TO THE AMBIENT NOISE HVSR AND THE RESULTANT SHEAR VELOCITY PROFILE THROUGH INVERSION AT A SITE IN TEHRAN

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Keywords: HVSR, Diffuse wave field, Seismic ambient noise, Inversion,Tehran

Horizontal-to-vertical spectral ratios (HVSR) of microtremors have been interpreted as representing either the Rayleigh-wave ellipticity or the amplitude ratio of the sum of Rayleigh and Love waves in a horizontally layered structure. However, based on the recently established diffuse field assumption (DFA), which allows obtaining reliable estimates of the H/V spectral ratio as an intrinsic property of a given uniform layered profile in terms of the imaginary components of the Green's function. Such calculation can be very fast by using the classical Cauchy's residue theorem. Moreover, this scheme allows the retrieval of the various wave types contributing to the H/V. Sánchez-Sesma et al. (2011) proposed that microtremors form a DFA containing all types of P and S body waves and Love and Rayleigh surface waves. In this way, the various contributions of body and surface waves within the Green's function can be isolated for further analysis.

This study applies the observed microtremor data collected in a site in Tehran and validates the DF method as an alternative method to explain the observed horizontal to vertical spectral ratio. The comparison of the H/V curve resulted by DFA with the H/V curve obtained from the forward calculation of the shear velocity profile that is extracted from the JICA and Cest (2000) studies shows an acceptable compatibility. In Figure 1, a comparison is made between the DFA and the HVSR curve obtained from the forward calculation of the shear velocity profile that is extracted from the JICA and Cest (2000), studies show an acceptable compatibility. For a diffuse wave field, this equation can be expressed in term of the imaginary part of the Green's function components:

$$H/V(x,\omega)=\sqrt{\frac{\mathrm{Im}\left[G_{11}(x,x;\omega)\right]+\mathrm{Im}\left[G_{22}(x,x;\omega)\right]}{\mathrm{Im}\left[G_{33}(x,x;\omega)\right]}} \quad (1)$$

Equation 1 gives the way to compute theoretically the HVSR which is used in the forward calculation. In this expression, the Green's function components are associated to a specific geometry and to certain material properties. As shown in García-Jerez et al. (2016) the expressions of the imaginary part of the Green's function, for the special case when source and receiver coincide at the top of the layered media, can be written in a very compact form. It is clear that the contributions from surface and body waves can be isolated:

$$\mathrm{Im}\left[G_{33}(x,x;\omega)\right]=\underbrace{-\frac{1}{2}\left(\overbrace{\sum_m A_{Rm}}^{Rayleigh}\right)}_{Surface waves}+\underbrace{\frac{1}{2\pi}\int_0^{\omega/\beta_N}\mathrm{Re}\left[f^{V}_{PSV}(k)\right]_{4^{th}}dk}_{Body waves} \quad (2)$$

The HV-Inv inversion software provided by García-Jerez et al. (2016) has been written in Matlab® and includes implementations of three main inversion algorithms: i) Monte Carlo sampling ii) the Simulated Annealing method (SA) and iii) the Interior Point method (IP), together with a suitable graphic user interface. In addition, two simpler methods such as the Random Search (RS) and the Downhill-Simplex are also available.

In this work, we used the Monte Carlo inversion method in the Park-e Ghaem site, as a result of the inversion two layers of contrast are found at depths of 60 and 170 meters, that is consistent with the result of the JICA report, which delineated 70 meters of depth based on the classification of the soil.

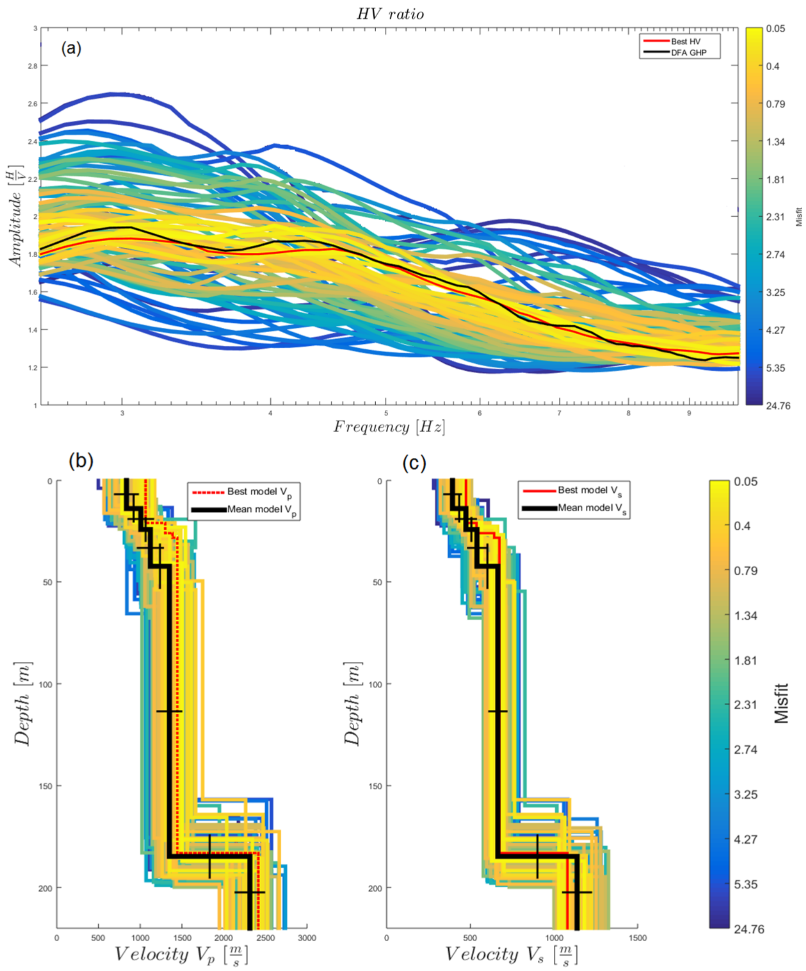

Figure 1. Inversion of the HVSR at the site of Park-e Ghaem in the South of Tehran. The black line in the panel (a) represents the experimental HVSR. The coloured curves in (a) show the forward calculations for the corresponding sampled models shown in the panels b and c, which were evaluated during application of the Monte Carlo Sampling method. The red lines show the best fitting models (b and c) again (a) depicts their corresponding theoretical HVSRs (a).

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