

Love and Rayleigh waves dispersion analysis from microtremor measurements at Bevagna (Italy)

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SUMMARY

In the last decades, researchers focused their attention on using the Rayleigh waves dispersion characteristics to estimate the shear wave velocity profile of a site, since their dispersion characteristics can be extracted also from only one component recordings (namely the vertical ones) of active and passive seismic tests. In particular, inverse analysis of empirical surface-waves dispersion curves from microtremor measurements (passive seismic test) is a very attractive tool since it allows to keep the cost of investigation relatively low and to avoid the use of active sources that might be prohibitive in urban areas. However, until now the full potential of seismic noise array methods was not fully exploited, and, in particular, the possibility of better constraining the subsoil structure by extracting also the Love wave part from microtremors recordings has not been fully investigated.

In this study we report the preliminary results and interpretations of passive measurements carried out at a test site in Bevagna (Italy) near one of the stations (BVG) of the Italian Accelerometric Network (RAN) within the framework of the DPC-INGV S4 Project (2007-2009). At this site, a cross-hole test was carried out in order to classify the station for seismic hazard purposes, offering the opportunity to compare the subsoil velocity profiles derived by seismic noise array data with independent geophysical information.

The array measurements were carried out using 15 LE-3D/5s sensors connected to a Reftek 130 digitizer. The three component recordings have been analysed both for extracting the Love wave and the Rayleigh wave dispersion curves.

The Love waves experimental dispersion curve was obtained after applying the $f-k$ spectral method to decomposed transversal horizontal (that is supposed to be dominated by Love waves) components of microtremor records. The transversal horizontal components were obtained after rotating former horizontal components considering the position of the sources of microtremors, which were identified from the vertical component $f-k$ analysis. The inversion of the Love wave dispersion curves has been performed by a random search (Monte Carlo inversion) on two parameters (thickness and S-wave velocity for each layer (Tokeshi *et al.*, 2008).

Moreover, the Rayleigh wave dispersion curve was estimated both with ESAC (Parolai *et al.*, 2006) and $f-k$ approaches, using only the vertical components of recordings. The ESAC and $f-k$ analysis dispersion curves were compared and showed consistent estimate of the phase velocity of Rayleigh waves, with the well known discrepancies only in the lower frequency part (Parolai *et al.*, 2007). However, the $f-k$ plots analysis also offers the opportunity to verify

if the requirements on the noise source distribution for the application of the ESAC analysis were fulfilled.

A joint inversion of the Rayleigh wave dispersion curve and of the seismic noise horizontal-to-vertical (H/V) spectral ratio was carried out using a Genetic Algorithm, allowing to extend the depth of investigation (Parolai *et al.*, 2005).

The results obtained from the separated Love wave and Rayleigh wave inversions showed that the two procedures provide consistent shear wave velocity profiles, for the shallow part of the model where they can be directly compared. Also, these profiles are in good agreement with the results of the nearby cross-hole test. In addition, there is a good agreement between the observed Rayleigh fundamental mode dispersion curve and the theoretical one calculated for the best models obtained from the Love wave inversion.

This case history shows the capability of surface wave analysis from passive seismic test to adequately retrieve the S-wave subsoil structure, and suggests that more efforts should be devoted in exploiting the potential of coupled analysis of Rayleigh and Love waves from microtremor array measurements for site characterization.

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