ESC2016-132, 2016
35th General Assembly of the European Seismological Commission

Retrieval of Rayleigh Wave Ellipticity from Ambient Vibrations Recordings

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Analysis of ambient vibrations is a useful tool in microzonation and geotechnical investigations. Ambient vibrations are composed to a large part of surface waves, both Love and Rayleigh waves. One reason to analyse surface waves is that they carry information about the subsurface. The dispersion curve of Rayleigh waves and Love waves can be retrieved using array processing techniques. The Rayleigh wave ellipticity, including the sense of rotation of the particle motion, can also be retrieved using array techniques. These quantities are used in an inversion procedure aimed at obtaining a structural model of the subsurface.

The focus of this work is on the retrieval of Rayleigh wave ellipticity. We show applications of the maximum likelihood method presented in Maranò et al. (2012) to a number of sites in Switzerland. The sites examined are chosen to reflect a wide range of soil conditions that are of interest in microzonation studies.

Using a synthetic wavefield with known structural model, we compare our results with theoretical ellipticity curves and we show the accuracy of the considered algorithm. The sense of rotation of the particle motion (prograde vs. retrograde) is also estimated. In addition, we show that by modelling the presence of both Love and Rayleigh waves it is possible to mitigate the disruptive influence of Love waves on the estimation of Rayleigh wave ellipticity.

Using recording from several real sites, we show that it is possible to retrieve the ellipticity curve over a broad range of frequencies. Fundamental modes and higher modes are retrieved. Singularities of the ellipticity, corresponding to change of the sense of rotation from prograde to retrograde (or vice versa), are detected with great accuracy.

Knowledge of Rayleigh wave ellipticity, including the sense of rotation, is useful in several ways. The ellipticity angle allows us to pinpoint accurately the frequency of singularities (i.e. peaks and zeros of the H/V representation of the ellipticity). Information about the prograde and retrograde particle motion can be valuable in mode separation and identification. At last, we believe that the use of the ellipticity angle is an important additional observable to be used to constrain the inversion for a structural model.