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HVSR inversion using synthetic curves from one source and enhanced by Rayleigh dispersion curve from MASW

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In the last years, the joint inversion of the Horizontal-to-Vertical Spectral Ratio (HVSR) and the Rayleigh wave dispersion curves has been spread as a technique for estimating more consistent Vs ground profile (shear wave velocity Vs – thickness of surface layers) of a site. Both the HVSR and the Rayleigh dispersion curves are obtained from microtremor measurements carried out at the ground surface of the site in study.
The joint inversion technique was proposed by Arai and Tokimatsu (2005) by combining the Rayleigh wave dispersion inversion and the HVSR inversion (a pioneer technique proposed by Arai and Tokimatsu in 2004). In the latter method, they proposed the calculation of the synthetic HVSR curve based on a surface wave model (Rayleigh and Love) propagated in a multi-layered elastic media, using infinite sources distributed at the ground surface. In this mathematical model, the source-free circular area radius, r, is equal to one wavelength of surface waves at each angular frequency, ω, as a way to attenuate the effect of body waves and to make dominant the effect of surface waves. However, the calculation of the theoretical dispersion curve is required to obtain the wavelength of the surface waves inherent to corresponding angular frequencies.
In the present paper, a new method for calculating the synthetic HVSR curve using only one source applied at the ground surface is proposed. The authors have found that quite stable synthetic HVSR curve around the predominant peak is obtained when this source is applied at a distance equal to the bedrock depth of the site. The synthetic HVSR and the experimental HVSR amplitudes are fitted using the relation of forces, RF, of the source. The HVSR inversion is enhanced with the experimental Rayleigh dispersion curve (used here as a kind of "filter"). The technique is tested at sites of the Kik-net Japanese seismological network where borehole records are available. Passive microtremors records were measured at these sites to obtain both the experimental HVSR and the experimental Rayleigh dispersion curves. The proposed technique is validated by comparing the estimated Vs ground models with the boreholes of the sites.
It is expected that the proposed technique can be used both for designing civil engineering infrastructures and for disaster prevention purposes.