# Walkaway surface wave survey: a new method for obtaining wide frequency band phase velocities utilizing walking noises along a linear seismic array

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We propose a new passive seismic survey method for obtaining phase velocity curves of Rayleigh waves in a wide frequency band utilizing walking noises along a short-spacing linear seismic array. The method is featured as a technical extension of “hybrid surface wave survey method” we proposed in 2014, and is originated from the passive surface wave survey method named “Linear Array Microtremor Survey” (LAMS), also proposed by the last author in 2011. In the LAMS, spatial autocorrelation (SPAC) analysis is employed for the calculation of a dispersion curve for an arbitrary pair of seismic records estimating random or isotropic microtremor source. Furthermore, the linear array or setting a number of geophones along a line enables us to obtain more accurate phase velocity curves by applying common midpoint spatial autocorrelation (CMP-SPAC) analysis proposed by the third author in 2015. The hybrid surface wave survey is characterized as the combination of active and passive surface wave survey simultaneously conducted along the same seismic line. A number of geophones, set along a line at 0.5 to 2 m intervals, are used to record active surface hitting waveforms and passive microtremor. Two dispersion curves, one is for a higher frequency part calculated from common midpoint cross-correlation (CMP-CC) analysis to active survey records, and the other is for the lower frequency part calculated from passive data applying CMP-SPAC analytical method, are combined to form a single dispersion curve for a specific CMP in a survey line. The method enables us to reconstruct a dense 2D S-wave velocity profile along a line up to 50 m in depth or more using conventional 4.5 Hz geophones. One of the advantages of hybrid surface wave survey is its robustness to the traffic noises or positive utilization of them vice versa. It means it is more suitable for the method to set the line along trunk, heavy traffic highways. We have conducted hybrid surface wave surveys along operational highways which had traffic flows of 300 to 1,500 vehicles per hour. During the field tests, we found a more effective noise source. That is, random walking but along the survey line. We could efficiently obtain wide frequency band dispersion curves emulative to both active and passive survey, only from passive seismic data including noises generated by waking along the survey line. The method is expected to expand the surface wave survey for delineating high-resolution 2D S-wave velocity structure in large urban areas.

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