A technique to estimate phase velocities using a two-sensor array

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S-wave velocity structures are vital to predict ground acceleration, and reduce both casualties and physical destruction, in overall estimates of earth quake damage. In recent years, various arrays have been utilized to measure the phase velocities of surface waves, and studies on simpler linear arrays have also been conducted.
In this research, the basic properties of a simple two-sensor array, which is a component of linear array observations used to estimate phase velocities, was studied using the so-called complex coherence function (CCF, Shiraishi et al.,2006). Since the time domain representation of CCF can also express characteristic behaviors of seismic interferometry (Shiraishi and Asanuma, 2007), the former may also be useful for understanding the latter.
The real part of the CCF consists of two terms: one representing ground properties and another that depends on the source azimuthal direction (incident angle). In the spatial autocorrelation technique, several CCFs with spatial phase differences obtained from an equilateral triangular array are azimuthally averaged to suppress the source- dependent term and extract the ground properties (Shiraishi and Matsuoka, 2005). Therefore, since there are techniques by which the term representing ground properties can be extracted from the CCF, it is also possible to determine the phase velocity. However, the source-dependent term cannot be suppressed when only a single two-point array is used, the ground properties must be extracted using another method.
In this study, numerical experiments were conducted to estimate the correct phase velocity by searching parameters (such as phase velocities, and source azimuthal direction) that minimize the residuals, with the CCF corresponding to observed values. It was found that there are multiple phase velocities that minimize the residual from the CCF corresponding to incident angles, and the correct values are included among them; however, it was considered difficult to specify them because the incident angle could not be determined with simple two-sensor array. Nonetheless, the difference in the velocity of the dispersion curves depends on the incident angle, and this difference tends to increase as the incident angle approaches 90 °(normal incidence). It could be possible to determine an approximate value for phase velocity by utilizing this property.
According to the results, it is difficult to estimate the correct phase velocity only with linear arrays, and it was considered necessary to provide auxiliary observation points with spatial phase differences at several points. This is considered to indicate the validity of a technique using L-shaped arrays together with linear arrays . However, it is not necessary to have an exact L-shape array, the phase velocity with linear arrays can be determined using a technique such as a direct estimation method (Shiraishi and Asanuma, 2009) from a polygon composed of the linear array and the auxiliary observation points.

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