Public Abstract
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Title: A Study on the Benefits of Including Near-field Effects in Active-source Surface Wave Data Collection and Interpretation

Geotechnical analyses for earthquake engineering and other applications are often predicated on the accurate determination of shear wave velocity (VS) profiles. Surface wave methods (SWM) are a non-invasive approach to developing VS profiles that involve measurement of Rayleigh wave propagation between a wave-generating source and a receiver array placed on the ground surface. There are several variations of SWM, but all utilize the same three-step process for developing a VS profile, namely: (1) data collection – measuring ground surface vibrations emanating from a source; (2) data processing – developing an experimental dispersion curve relating wave velocity to wavelength or frequency; and (3) inversion – finding the VS profile that produces a theoretical dispersion curve matching the experimental dispersion curve. In current practice, the theoretical model used to fit the experimental data is a far-field model that only simulates motions from planar Rayleigh waves. Therefore, the receiver array used to collect the data in step 1 must be located far from the source (or “far-field”), where body waves have largely dissipated (due to greater damping) and Rayleigh wavefronts are nearly planar. Closer to the source – in the so-called “near-field” – the ground motion includes coupled interactions of body waves and non-planar Rayleigh waves and is inconsistent with a far-field theoretical model.

The primary objective of this study was to investigate the effectiveness and potential benefits of including near-field contributions in both the surface wave data collection and modeling. First, it was hypothesized that source offset distance criteria currently used to mitigate near-field effects could be greatly reduced without affecting the quality of surface wave results. Second, it was hypothesized that additional information about the soil profile could be determined if the near-field portion of the dispersion curve was included in both the data collection and theoretical modeling. Three different studies were performed for this research, namely: (1) a preliminary sensitivity study, to study the sensitivity of the near-field portion of the dispersion curve to changes in various profile parameters, (2) surface wave analysis using simulated experimental data, to assess both profile recovery effectiveness and the possibility of inferring additional profile parameters (specifically, Poisson's ratio), and (3) surface wave analysis with real data, to validate the profile findings from the study using simulated data. Experimental data were collected and/or simulated using both the Spectral-Analysis-of-Surface-Waves (SASW) method and multi-channel surface wave methods, but the primary focus of this study was on the SASW method.

The results from the study showed that surface wave analyses that included near-field contributions in both data collection and theoretical modeling were as effective or more effective at recovering the VS profile as conventional far-field approaches, with the benefit of shorter arrays and smaller sources. This study also showed that surface wave measurements that included near-field data were sensitive to changes in Poisson's ratio of the profile, as compared with the known insensitivity of conventional far-field surface wave methods. The results from the limited experimental study were less conclusive, but generally confirmed the findings from the study performed using simulated data.