Evaluating Site Response Method Using Borehole Array Data

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Site specific ground motions used in assessment of seismic performance are computed using site response analyses that simulate the nonlinear response of the soil to earthquake ground shaking. The numerical wave propagation in site response analysis requires making simplifying assumptions regarding the nonlinear response of the soil and site characteristics, and these assumptions may introduce bias into results. The bias of the equivalent-linear elastic (EQL) and nonlinear (NL) site response analysis methods are evaluated using data from borehole arrays, which consist of instrumentation at the surface and at depth with a soil deposit. The results indicate that the for low intensity motions ($\mathrm{PGA_{base}} < 0.05$ g), both the EQL and NL methods over predict the amplification at the site frequency. For higher intensity motions ($\mathrm{PGA_{base}} > 0.05$ g), the larger induced strains and associated higher damping values produce better agreement in the spectral acceleration at the site frequency and in some cases the NL method may under predict the spectral acceleration at the site frequency. Over damping of high frequencies associated with the EQL method was not observed, but this may be due to the lack of high intensity input motions considered in this study. The ability for the EQL and NL methods to produce response spectra similar to those observed for intensities of $\mathrm{PGA_{base}} > 0.05$ g is encouraging, whereas the excessive amplification observed for intensities of $\mathrm{PGA_{base}} < 0.05$ g is surprising and requires further study.

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