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Applicability of Site Fundamental Frequency as a Descriptive Variable for Site Response in Central and Eastern North America

Behzad Hassani and Gail M. Atkinson

Western University (University of Western Ontario), London, Ontario, Canada

We use the NGA-East ground-motion database to show that site fundamental frequency (f_{peak}), as measured from the horizontal–to-vertical spectral ratios (H/V) obtained from 5%-damped pseudo spectral acceleration (PSA), is a good proxy measure for VS30 (time-averaged shear wave velocity in the upper 30 m) for sites in central and eastern North America (CENA). Measured V_{S30} values at recording stations are well-correlated with f_{peak}, allowing development of a predictive relationship for V_{S30}. The uncertainty of the V_{S30} estimate using the f_{peak}-based model is significantly smaller (0.14 log10 units) than that for the proxy-based methods (e.g. topographic slope and surface geology proxies) used in the NGA-East database (0.25 log10 units). We also examine the applicability of the Next Generation Attenuation-West2 (NGA-West2) site effects model (Seyhan and Stewart, 2014), which is an empirical V_{S30}-based model, to sites in CENA. We determine residual site terms by comparing the observed CENA ground-motion amplitudes, adjusted to B/C site conditions using the western site-effects model, to the corresponding predicted amplitudes of a CENA ground-motion prediction equation for B/C site conditions (Yenier and Atkinson, 2015; YA15). Plotting the residual site terms versus their corresponding site fundamental frequencies (f_{peak}) reveals significant f_{peak}-dependent trends at all frequencies. Average residual site terms for CENA sites, after the western site amplifications have been removed, can be as large as 0.45 in log10 units (a factor of 2.8) for frequencies $f \approx f_{peak}$. We find that at $f < 1$ Hz, site terms in CENA scale with V_{S30}, similar to the way they behave in the NGA-West2 database. However, at higher frequencies the correlation of site amplification with V_{S30} decreases markedly in CENA. By contrast, H/V is a good predictor of the observed f_{peak}-dependent site terms, suggesting that H/V is a more reliable predictor of site amplification for the recording stations of the NGA-East database. The results of this study demonstrate the importance of a well-calibrated regional site effects model for CENA and the importance of f_{peak} as a site indicator.