Challenges and Consequences of Input Motion Selection for Subduction Zone Environments: Seattle, Washington

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Seismological Society of America (SSA) 2019 Annual Meeting
April 23-26, 2019 • Seattle, Washington
Session: Earthquake Ground Motions and Structural Response
in Subduction Zones: A Focus on Cascadia

ABSTRACT:

The selection of hazard-consistent ground motions is a critical step for many geotechnical and structural engineering analyses. Earthquake ground motions serve as the link between evaluations of seismic hazards and assessments of civil infrastructure performance. This study investigates the challenges associated with selecting and scaling motions representative of the site-specific seismic hazards in subduction zone environments, using Seattle, Washington, as an example. Like many locations in subduction zones, Seattle has seismic hazard contributions from both crustal events and subduction events (including interface and intraslab earthquakes). This diverse tectonic setting makes the selection of representative input motions a challenging task, as the mean magnitude and distance from the seismic hazard deaggregation are not physically consistent with any individual type of seismic source. Moreover, the paucity of available ground motion recordings in the U.S. corresponding to subduction events imposes yet another challenge for ground motion selection. In this study, we have used ground motions from subduction events included in the Japan KiK-net database. A site-specific seismic hazard analysis is conducted for Seattle, and target spectra are defined for different hazard levels and different periods of interest. Input motion sets representative of each seismic source identified are then selected from different databases. Geotechnical site response analyses are conducted to investigate the implications of selected motions, and significant soil nonlinearity is observed in Seattle for design level ground motions. The study site in Seattle consists of approximately 50 m of loose soil (artificial fill over young alluvial deposits), overlying a dense layer of glacial deposits. The results suggest that the selection approach for hazard-consistent ground motions may require explicit consideration of multiple design earthquake scenarios in subduction zone environments.