Regional variation in ground motion scaling - Western United States

External Grant Award Number: 02HQGR0108

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Non-Technical Summary

Southeastern Canada which is a part of eastern North America (ENA) located in a stable continental region but has a relatively low rate of earthquake activity which remains controversial issue to derive ground motion relations from empirical data set. The current seismic hazard analyses of this region rely on Atkinson and Boore's (1995, 1998) result using data sets with a sparse distribution of seismic stations. The first purpose of this work is to refine ground motion predictive relations for the southeastern Canada using dense broadband data and to fill the gaps of previous results. The second purpose is comparing the regional variation in ground motion scaling between ENA and Korea. An estimate of the seismic risk of source characteristics and wave propagation in Korea is also important because its initial result indicated the similarity in its wave propagation with that of ENA.

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Investigations Undertaken

This project focuses on define ground motion parameters for moderate size earthquakes in southeastern Canada and Korea. Followings are the main goal of this work: define absolute excitation spectrum, what is the wave propagational functional?

Results

Vertical and horizontal component velocity seismograms from the Canadian National Seismographic networks are used to study high frequency ground motion scaling for southeastern Canada region. We analyzed a data set consisting of 4519 vertical and horizontal seismograms at distances less than 1000 km. We performed regressions of Fourier velocity spectra and peak filtered ground velocities for southeastern Canada for different combinations of vertical and horizontal components. The modeled regression results are characterized by rapid decrease of amplitude at distance less than 40 km ($r^{-1.3}$) and three segments of geometrical spreading at the distance ranges between 40 to 400 km. The associated attenuation term is expressed by $Q(f) = 650 f^{0.33}$. The geometrical spreading functions for vertical, horizontal, and combined components show similar values at mid- to long-distance ranges, while there are some slight differences at shorter distance ranges. Even if the spectral shaping parameters of κ = 0.005 sec, and stress drop of 200 bars are selected to predict the theoretical excitation spectra, neither the Brune (1970, 1971) model or Atkinson and Boore (1995) do not fit the observed excitation spectra well the events with moment magnitude greater than 4.

The Korea study was undertaken as a cooperative project with the Korean Meteorological Administration and researchers at Seoul National University. This entailed crustal structure studies through the joint inversion of receiver functions and surface-wave dispersion, the determination of inter-station Green's functions from the cross-correlation of ground noise, moment tensor inversion and the analysis of high frequency ground motion. Because we determined that source scaling for $M_W > 4.5$ required a two-corner spectrum similar to Atkinson nd Boore (1995) and because of similarities in surface geology between Korea and southeastern Canada, we chose to include the ground motion scaling study as part of this project.

We analyzed a data set consisting of 3510 horizontal and vertical waveforms for Korea

with hypocentral distances less than 600 km. We performed regressions of Fourier velocity spectra and peak filte red ground velocities for different combinations of vertical and horizontal components. The regression results are parameterized by $Q(f) = 330 f^{0.42}$ and relatively simple geometrical spreading for Korean peninsula. The use of offshore events does not introduce any bias in determining the wave propagation functional. A κ = 0.005 sec, and stress drop of 200 bars are selected for initial spectral parameterization. A simple modification of the two-corner model of Atkinson (199 3) yields a better fit to Korean excitations in the high frequency ranges compared to the constant stress drop model which showed a lack of fit at moderate size magnitude events.

The dissertation work on Korea has just received its reviews from the Bulletin of the Seismological Society of America. The paper on ground motion scaling for southeastern Canada is in final draft stage. Because our work agrees with a recent paper by Atkinson (2004) in that a greater geometrical spreading is required at short distance, we are carefully addressing the interrelation between the source spectrum model and the geometrical spreading in terms of the effect on ground motion estimates at distances greater than 40 km. A direct application of the Atkinson (2004) work could reduce expected ground motions by a factor of 3 or more!

Reports Published

Jeon, Y. S., 2004, High frequency earthquake ground motion scaling in Southeastern Canada and Korea, Dissertation, Saint Louis University
ftp://ftp.eas.slu.edu/pub/incoming/Theses/Sooy_SLU_PhD_04.pdf

Jeon, Y. S., and R. B. Herrmann, 2006, High frequency earthquake ground-motion scaling in Korean peninsula, *Bull. Seism. Soc. Am.*, (In revision).

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