



**GEOLOGICAL SURVEY OF CANADA
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**Canadian seismic hazard values for use with the
Federal Emergency Management Agency's
loss estimation program, Hazus**

S. Halchuk

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INTRODUCTION

The Canadian Hazards Information Service (CHIS) was tasked with providing seismic hazard values compatible with the United States Federal Emergency Management Agency's (FEMA) natural hazard loss estimation program, Hazus. Hazus uses Geographic Information Systems (GIS) technology to estimate physical, economic, and social impacts of disasters.

Hazus requires parameters and probabilities that are different from the “standard” values used for the National Building Code of Canada (NBCC). NBCC 2010 parameters are median, firm ground (NBCC soil class C ($v_{ref}=560$ m/s)) spectral ($S_a(0.2)$, $S_a(0.5)$, $S_a(1.0)$, $S_a(2.0)$) and peak ground acceleration (PGA). Hazus requires mean, NBCC class B/C boundary ($v_{ref}=760$ m/s), spectral ($S_a(0.3)$ and $S_a(1.0)$) and peak acceleration and peak velocity.

METHOD

Hazus compatible values were calculated using the same model that generated the NBCC 2010 values. Values were determined for a 10 km spaced grid of points covering all of Canada and its nearby territorial waters. Details of the grid can be found in Halchuk and Adams, (2008). Additional papers of interest to Hazus users which discuss the models and results developed for the 2005 and 2010 editions of the building code are listed in the References section.

Mean values were determined for 8 different return periods: 100, 250, 475, 750, 1000, 1500, 2000, and 2475 years. Spectral acceleration at 0.3 and 1.0 seconds, along with peak ground acceleration values were determined directly. Peak ground velocity values could not be determined directly as the authors whose ground motion equations were used to determine seismic hazard values did not provide a PGV relation. To be consistent with the methodology used in the United States, it was decided to use $S_a(1.0)$ values as a proxy for PGV (N. Hastings/M. Nastev, personal communication, 2010). The formula used to obtain PGV is:

$$PGV(m/s)=[S_a(1.0)s \times 9.81/2\pi]/1.65$$

where S_a is given in g (Newmark and Hall, 1982). The 1.65 factor is based on median spectrum amplification between spectral acceleration and velocity.

Conversion of soil class C values to B/C boundary values was done by applying the following amplification factors (Table 1). These linear factors for $S_a(0.3)$ and $S_a(1.0)$ were supplied by Atkinson (personal communication, 2010). A PGA amplification factor was not supplied. An approximate value was assigned based on amplifications for short periods (0.1 to 0.3 seconds). A PGV amplification factor was also not supplied. The same factor was used as for $S_a(1.0)$, as PGV was directly derived from this parameter.

Table 1: Factors to convert soil class C to soil class B/C boundary values.

Parameter	Factor
Sa(0.3)	1.144
Sa(1.0)	1.238
PGA	1.1
PGV	1.238

Class C values were divided by the amplifications in Table 1 in order to obtain the results for the harder ground conditions at the B/C boundary.

RESULTS

Tabulated Values

Table 2 (electronic supplement file [canada_2010grid_HAZUSvalues.txt](#)) provides seismic hazard values for the four HAZUS parameters (Sa(0.3), Sa(1.0), PGA, and PGV) at eight different probabilities (1/100, 1/250, 1/475, 1/750, 1/1000, 1/1500, 1/2000, and 1/2475 years). The table is an ASCII flat file that contains the latitude and longitude of all of the grid points (approximate spacing is 10 km between each point), and their corresponding spectral and peak values (mean, firm ground NBCC soil class B/C boundary, units of g for acceleration, units of m/s for velocity). The top of each column in the grid file is labelled with the parameter and probability, both in number of years and as an annual probability. The region gridded extends beyond the borders of Canada, mainly to ensure smooth contouring at the border. Grid values in the neighbouring United States should not be used for determining US values. Consult instead the USGS seismic hazard website (<http://earthquake.usgs.gov/hazards/>) for these regions.

CONCLUSIONS

This Open File gives seismic hazard results for Canada that can be used by the Hazus program. These results are derived from the same model that was used to determine NBCC 2010 seismic hazard values. They will be useful in estimating losses due to earthquakes in Canada.

ELECTRONIC SUPPLEMENT FILE

Electronic supplement file [canada_2010grid_HAZUSvalues.txt](#) contains seismic hazard values appropriate for use with the HAZUS program determined for the 10 km grid across Canada. An explanation of the columns is given in the Results section.

REFERENCES

Note that all references (with the exception of Newmark and Hall, 1982) can be obtained from the recent publications on hazard section of the Earthquakes Canada website. At the time of this document's creation they were available at:

<http://earthquakescanada.nrcan.gc.ca/hazard-alea/recpubs-eng.php>

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