October 14, 2011

The Canterbury Earthquake Sequence and Implications for Seismic Design Levels

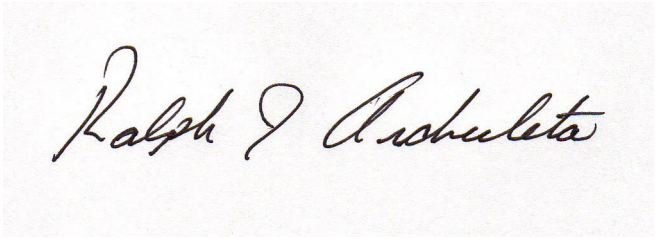
Following my report of September 25, 2011 on the Canterbury earthquake sequence and implications for seismic design levels, the GNS sent a response dated October 5, 2011. On October 7, 2011 (New Zealand time) we had a conference call to discuss the GNS response and my report.

One issue that remains outstanding is the effect of directivity in the ground motion prediction equations. While including directivity in the ground motion prediction equations would accentuate the ground motion in the forward direction, it is difficult, if not impossible, to know the direction an earthquake will rupture. Moreover, even if one knew the fault, e.g., the Alpine Fault, one would have to know the location of the hypocenter with respect to a given site to apply the modification. Consequently it is not a correction that can be applied uniformly throughout New Zealand without a lot of uncertainty. It is doubtful that it could be applied in any uniform sense in Christchurch. The data from the February 22 earthquake do not unambiguously show directivity.

Although it is not conclusive at this stage, the ground motion from the February 22 earthquake may have been amplified relative to the median due to a larger stress drop. It is not clear that the mainshock had a larger than normal stress drop; however, the maximum slip and the short length would suggest a larger than normal static stress drop. It seems that in the rebuilding of Christchurch it would be judicious to use stress drop scaling in the ground motion prediction equations. With respect to the other regions in New Zealand, it is not clear what stress drop scaling would be necessary. If stress drop scaling were applied, the scaling might not be the same scaling from one region to the next. Justifying the numerical value of the scaling factor is not easily done without analyzing the seismicity and determining stress drops for the different regions.

There seems to be a solid rationale for having a design criterion that changes with time following the mainshock of September 4, 2010. The approach taken would have a significant effect, certainly over the next 5 to 10 years.

The current decision to increase the Z factor for Christchurch to 0.3 is a prudent step in trying to mitigate future losses. With respect to the rest of New Zealand I am not yet convinced that magnitude scaling should be applied to spectral amplitudes for periods 0.5 s and less. The spectral level at 0.5 s is the anchor for the spectrum. It seems to me that changing the spectral value at 0.5 s would change the entire spectrum. This will require more thought on my part and more discussion with those more knowledgeable about how the uniform hazard spectrum is affected by the disaggregation of the hazard.



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