SUMMARY REPORT

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Seismic Hazard Mapping for Bridge and Highway Design in South Carolina

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The study involves probabilistic seismic hazard mapping for South Carolina. A hazard model is developed which defines the sources for potential earthquakes and earthquake recurrence relations. Seismic hazard, expressed as maps of motion intensity corresponding to 4 probabilities of exceedance, are derived from calculations at 1247 site locations within and adjacent to South Carolina. The motions are defined in terms of pseudo-spectral acceleration (PSA) oscillator response for frequencies 0.5, 1.0, 2.0, 3.3, 5.0, 6.7 and 13 Hz, for 5% critical damping and peak horizontal ground acceleration (PGA). The 4 probability levels are 2%, 5%, 7% and 10% probability of exceedance for 50 year exposure periods. The seismic hazard for 1.0 Hz PSA and PGA are deaggregated for 19 cites and towns across South Carolina, to represent the contribution to seismic hazard from various magnitude earthquakes at various distances.

The approach used in this study is similar to that used by the U. S. Geological Survey (USGS) to develop the National Seismic Hazard Maps (Frankel et al., 1996, 2002). However, there are some important differences between the studies. Similar to the USGS approach, model uncertainty is incorporated using a logic tree. Important model elements involved in the logic tree analysis are alternative source configurations for earthquakes in the magnitude range ($5.0<M<7.0$), alternative source models for larger, characteristic type earthquakes ($7.0<M<7.5$) in the coastal areas of South Carolina, maximum magnitudes for the characteristic earthquakes in those areas, and 5 alternative ground motion prediction models adopted by the U. S. Geological Survey for the 2002 update of the National Seismic Hazard Maps.

A significant difference between the National Seismic Hazard Maps and the results presented here arises from our attempt to develop hazard maps reflecting actual geological conditions in South Carolina. Also, our aim is to provide results that may be directly used in conjunction with the current bridge design procedures implemented by SCDOT. Unfortunately, a generic site response model such as that adopted for the 1996 National Seismic Hazard Maps (and also used in the 2002 update) does not adequately represent the range of conditions in South Carolina. This is particularly the case for those coastal areas of the state where earthquake resistant design is most important from past experience. Providing a probabilistic mapping of seismic hazard in terms of motions that can be incorporated easily into current of design procedures requires treatment of wave propagation within the Coastal Plain sedimentary section.

For sites in the Coastal Plain, we map ground motions for a hypothetical outcrop of "firm coastal plain sediment" (NEHRP B-C boundary, Vs=760 m/s). It is anticipated that material with this shear wave velocity will behave in an approximately linear manner to expected levels of strong motion at most sites in the state. These motions can serve as input for nonlinear dynamic analysis using shallow site specific geotechnical information, implemented with a program like SHAKE. Such an analysis would be straight-forward, requiring only an estimate of the depth at which the mapped outcrop motion would be applied in the soil/sediment column. In most cases this would be at depths of less than 50 m.

The motions mapped for sites outside the Coast Plain are to be interpreted as surface motions on "weathered southeastern U.S. Piedmont rock". This is very distinct from "weathered rock" in California. The mapped motions for sites outside the Coastal Plain represent surface motions on a velocity profile consisting of 250 m of material with shear wave velocity Vs=2,500 m/s, overlying a hard rock basement half-space with velocity 3,500 m/s. The quality factor for the weathered rock layer is 600. These velocities are higher than typically encountered at similar depths in California. Again, these motions may serve as input motions for dynamic analysis using a program such as SHAKE, if site investigations indicate significant soil or alluvial overburden.

This study also provides hazard calculations for hypothetical hard rock (basement) outcrop conditions (Vs=3.5 km/sec). The two suites of results together represent a definitive assessment of the nature of potential ground motion for design purposes, and provide a comprehensive basis for defining input ground motions for non-linear analysis using site-specific geotechnical information.

The results of this study are presented as hardcopy maps, Excel spreadsheets, and as interactive computer routines that provide the capability to interpolate the discrete results of the hazard calculations to any site location within South Carolina. The interactive programs provide the user with the means to generate times histories of horizontal ground acceleration for 4 probabilities of exceedance. The deaggregation analysis provides information for decisions regarding magnitude and distance combinations for these scenario time series.