Solid Earth Physics Seminar, Harvard University

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Faculty Lounge, 4th Floor, Hoffman Lab, 20 Oxford Street

Liquefaction Susceptibility of Engineering Sites: Studying Earthquake-Induced Pore Pressure Evolution

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Abstract:

Groundwater pore pressure built up during an earthquake and the hazard associated with soil liquefaction present a major challenge for our society. Traditional liquefaction susceptibility analysis relies on empirical engineering methods that have been derived from laboratory experiments. A better assessment of liquefaction risk requires an understanding of the coupling between pore pressure and ground motion time histories that can only be derived from field studies of sites in earthquake zones. The Network for Earthquake Engineering Simulation at UC Santa Barbara (NEES@UCSB) operates the Wildlife Liquefaction Array (WLA) and the Garner Valley Downhole Array (GVDA) in southern California. GVDA is located in a high valley next to Lake Hemet, between the San Andreas and San Jacinto fault zones. WLA is located in the Brawley seismic zone at the southern end of the San Andreas Fault, on the banks of the Alamo River, at a site that liquefied in the Superstition Hills event of 1987. Both of these densely-instrumented geotechnical field sites continuously record both ground acceleration and pore pressure, with accelerometers located on the surface and at various depths below the surface, and pore pressure transducers installed at depth within the liquefiable layers. Over the last decade, local and regional seismic activity, including multiple extremely active earthquake swarms, has produced a valuable new data set that provides a unique opportunity to observe site response at an unprecedented level of detail. In that time, approximately 40 events have induced excess pore pressure generation at the two sites. The events are analyzed for ground motion thresholds for nonlinear site response and excess pore pressure generation. Modeling analysis provides an explanation for the correlation between the arrival of the first S-wave pulse and the sudden onset in pore pressure increase. In addition to the earthquakes provided by nature, active testing experiments at the site using the mobile shakers from NEES@UTexas and NEES@UCLA are able to generate excess pore pressure. A new downhole liquefaction array in Seattle also has been recording daily pore pressure changes and accelerations induced by the movement of passenger trains, which are a repeatable source.