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Researchers Shake Delta Soil to Better Understand Earthquake Risk

SACRAMENTO -- Researchers will simulate the shaking of an earthquake on a remote part of Sherman Island today to better understand how the unique peat soil of the Sacramento-San Joaquin Delta may respond to a seismic event.

The engineering researchers from the University of California, Los Angeles conducted a similar shaking test last year on dry peat soil. This year, their test will monitor the response of saturated peat soil.

"We hope to learn how the peaty organic Delta soil will contribute to seismic levee performance," said Scott Brandenberg, Vice Chair of the UCLA Civil and Environmental Engineering Department and leader of the research team. "We already know that liquefaction of inorganic sandy soils is an important problem in the Delta, but we don't know as much about the peat."

The research promises to inform an important debate over how much risk earthquakes pose to the Delta's levees -- and thus the state and federal water supply systems that are centered in the Delta.

Using heavy equipment in a cow pasture owned by the California Department of Water Resources, the UCLA engineers built a six-foot-high, 40-foot-wide, 12-foot-long model of a levee. The model levee was reinforced to transmit the shaking into the ground where the motions will be sampled. The researchers attached a mobile field shaker to the model levee crest. Their model levee is unsaturated and built of non-liquefiable materials, unlike the saturated, liquefiable fills in many Delta levees. Their focus is not whether the newly-created embankment fails during shaking. Instead, they seek to understand how the underlying peat soil of Sherman Island responds to the earthquake simulation. Such highly-organic soil serves as the foundation for many of the roughly 1,100 miles of levees across the Delta.

Once a region of tule marsh and tidal wetlands, the Delta of today is a patchwork of islands ringed by levees and separated by waterways. The highly-organic Delta soil, built by thousands of years of decomposing tules, may be as deep as 80 feet, but it oxidizes and disappears easily when dried and tilled. As a result, some Delta islands are bowl-like, dipping as much as 25 feet below sea level.

Though they appear as ordinary farm fields, the Delta islands are critical to protecting infrastructure important to the entire California economy. They serve as barriers that help protect the fresh river water that supplies much of the state from the saltwater that could encroach from San Francisco Bay if the islands were not there. If several Delta levees failed in an earthquake, river water would be sucked into the sunken islands. The flow of freshwater out toward the Bay would diminish, allowing saltwater to be drawn deeper into the Delta and make its way toward the large pumps in the south Delta that supply two major water projects. Federal and state water project operators would be forced to shut down the pumps to prevent saltwater contamination of aqueducts, pumps, and treatment plants. Such a shutdown could interrupt deliveries of water to Southern California, the Central Valley, and the Santa Clara Valley. If the interruption lasted long enough, it could cause billions of dollars of damage to the state's economy.

In the roughly 160 years since people began scraping together levees in the Delta, levee failures have caused island flooding at least 140 times. Though none of the failures have been linked to an earthquake, the record is too brief, geologically, to accurately gauge the seismic hazard to the Delta's levee system.

Several large faults, including the Hayward, Calaveras, and San Andreas faults, lie to the west of the Delta. But smaller local faults that run through the Delta present the most significant seismic hazard to levees, including the western Tracy and southern Midland faults.

According to the 2009 Delta Risk Management Strategy prepared by the Department of Water Resources, a ground motion equivalent to less than 20 percent of the acceleration of gravity would be capable of collapsing, or liquefying, the loose, sandy soils in many Delta levees. An earthquake capable of generating such motion has a 45 percent chance of being exceeded in the western Delta in the next 30 years, according to experts. The hazard decreases farther from the Bay; experts put the probability at 26 percent in the eastern Delta. However, the hazard increases each year that passes without an earthquake.

"The Department of Water Resources welcomes this research that will help us to better understand the vulnerability of the Delta levees and the water supply to earthquakes," said David Mraz, chief of DWR's Delta levees and environmental engineering branch. "In the meantime, the state will continue to work with our local partners to make improvements to the levees in the regions that protect communities, farms, wildlife habitat, and critical infrastructure."

The state has invested approximately $300 million in Delta levee improvements since 2005, when Hurricane Katrina overwhelmed Louisiana's flood defenses.

There are few places in the world with such extensive levees on peat soils as the Delta. Scientists hope to learn from measurements recorded during Wednesday's experiment whether saturated peat soil will settle in response to earthquake shaking. Laboratory tests performed on peat samples indicate that the peat will expel water following shaking, which could result in levee settlement after an earthquake. However, this mechanism has never been observed in the field, and the Sherman Island test will provide that opportunity and help scientists interpret their laboratory results for application to Delta levees.

The Delta is also unusual in that the underlying soil -- peat -- is typically softer than the mixture of sand, silt, clay, peat and other types of materials scraped together to construct levees. By testing the response of peat soils to ground acceleration, researchers will get a better sense of how energy transfers between the peat soils and levee materials. The experiment may help better determine the magnitude of earthquake that could trigger collapse, or liquefaction, of Delta levees.

The research team, including geotechnical engineers Jonathan Stewart of UCLA and Robb Moss of California Polytechnic State University, performed a similar test on Sherman Island in August 2011. At that time, the peat soil beneath the artificial embankment was dry to a depth of six feet and the embankment settled very little upon shaking. Researchers speculate that the fibrous peat soil may be stiffer, stronger, and more resistant to seismic energy when dry than when wet.

For Wednesday's experiment, the researchers built a berm around the experiment site in order to soak the underlying peat to the soil surface. The saturation will mimic the condition of the peat beneath the Delta levees. (Many Delta levees essentially act as dams and are kept wet year-round by the waterways they channel.)

Various instruments arrayed within 300 feet of the test site will measure ground motion and water pressure. Previous tests have shown that the ground motion generated by UCLA's mobile field shaker dissipates before it reaches the levees that protect Sherman Island.

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