UCLA researchers shake model levee, for peat's sake

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The earth rippled and squirmed on this Delta island Monday. It did not yawn open, but did reignite a debate about the seismic safety of levees in the Sacramento-San Joaquin Delta.

In the first experiment of its kind, scientists from UCLA erected a shaking machine atop a model levee about the size of a two-car garage. Their goal: find out if the peat soil on Sherman Island would rupture, causing the "levee" to fail.

Peat, a spongy material composed of decaying plants rather than mineral soil, is known as a poor thing to build on. Yet it lies under most of the Sacramento-San Joaquin Delta, including its 1,100 miles of levees.

A debate has raged for years about whether those levees and their peat foundations will liquefy in a quake, potentially causing a monumental flood.

"We don't know how this peat is going to behave in an earthquake," said Scott Brandenberg, the study's lead investigator and an associate professor of civil and environmental engineering. "If it settles on the order of a few feet, this could cause a breach."

Quake experts previously have said there is at least a 60 percent chance of a quake striking the Delta in the next 30 years that would be large enough to liquefy levees. Other scientists say the results could be catastrophic, flooding multiple islands and compromising a Delta freshwater supply that serves the entire state of California.

That doomsday scenario lies behind the controversial plan for a $13 billion tunnel to divert a portion of the Sacramento River out of the Delta, thereby securing the water supply.

Monday's experiment was the first true field test of peat's ability to withstand a temblor.

With $375,000 in funding from the National Science Foundation, the team built a cross-section of a model levee 40 feet wide, 12 feet thick and 6 feet high.

Perched atop, and anchored inside the levee on stout wooden legs, was a machine called an "eccentric mass shaker." Originally built to test nuclear power plants, it consists of two large counterweights that are spun parallel to the ground by an electric motor. The greater the weight, and the faster it spins, the more shaking force directed into the ground.

The model levee itself was built with a mixture of peat, clay and sand - similar to how a contemporary levee is repaired. But the levee was not the test subject.

Instead, the researchers wanted to find out how the peat underneath would respond. Under a 3- to 4-foot-thick surface crust of dried peat lurked 30 feet or more of liquid peat that looks much like a thick chocolate milkshake.

Would the surface crack and spew a geyser of fudge? Would a void open beneath the test levee and swallow the shaking machine?

In initial tests, the machine generated ground motions equivalent to a local quake in the "high 6" range on the Richter scale, Brandenberg said.

With a generator thrumming and the machine whining, waves could be seen - and felt - radiating through the ground as though from ocean swells. Ducks, in a marsh nearby, squawked in alarm and took flight.

The machine exerted about 30,000 pounds of shaking force, enough to erode its mounting holes in the levee. But there was no evident damage to the island's peat soil.

Bob Nigbor, a UCLA research professor and earthquake engineer, came away impressed.

"Just the fact that it can move that much and not tear is pretty amazing," Nigbor said of the peat soil. "Our research very well could show that peat is stronger than we thought."

He and Brandenberg, however, noted that a similar test on a real levee - composed of weaker soils and partly saturated with water - could produce a different outcome.

In the afternoon, workers repaired the machine's eroded mounting holes and added more mass to the counterweights. This time the machine exerted 40,000 pounds of shaking force. The island's elastic surface whipped and waved a little more. That was all.

"It seems to bounce around just like that when we're running big trucks on the levees," said Gilbert Cosio, a civil engineer at MBK Engineers in Sacramento who was on hand to observe the test.

A skeptic of the Delta quake disaster scenario, Cosio said he thinks the region's levees are more resilient than the doomsayers claim. Levees may settle a bit in a quake, he said, but they've yet to prove fragile.

"If these guys can't fail that peat, we're all going to have some questions to answer," Cosio said. For example: How much will a levee settle in a certain size quake?

With about 40 accelerometers installed under, around and inside the model levee, the UCLA researchers gathered a wealth of data that will take months to analyze.

They learned Monday the model levee settled about 1 centimeter during the test shaking. The spongy peat is likely to continue settling, so sensors will be left in place for a few weeks to measure that.

Could peat soil act as a natural shock absorber in a quake, rather than a buckboard?

"That's the million-dollar question," said another observer, Mike Diller, an engineer at the California Department of Water Resources. "In this case, it looked like it made things better. But this is just one test."

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