Physical Modeling of the Effects of Natural Hazards on Soil-Structure Interaction

by

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ABSTRACT

Natural hazards, such as earthquakes, flooding, hurricanes, tornados, etc. very often have devastating effects on civil structures, with the consequences of loss of human lives and negative economic impacts. The RPI 150 g-ton Geotechnical Centrifuge was used to carry out physical simulations of two types of natural disasters with the objective of studying their effects on geotechnical critical structures:

- **Earthquake Induced Lateral Spreading and its Interaction with Bridge Foundations.** Liquefaction and lateral spreading have been a major cause of damage during strong earthquakes. The most vulnerable structures are bridge foundations which failure always produces serious consequences. The effect of the liquefiable sand permeability on the load acting over the foundations is studied using centrifuge modeling and the results are compared with a full scale test. The results show a negligible influence of the sand permeability on the lateral spreading and on the pressure that the liquefied soil applies on the foundations. The results also revealed an inconsistency with the scaling laws used in centrifuge technology when modeling the phenomenon of shear band formation around the bridge foundation.

- **The performance of New Orleans flood protection system during hurricane Katrina.** Hurricane Katrina and the failure of the levees in New Orleans are considered the worst natural disaster on US history, producing extensive loss of lives and economic impacts. Many of the levees breached due to overtopping, in that case the failure mechanism is primarily associated with erosion. There were important exemptions where levees failed without being overtopped. The breaches that occurred on the levees located at 17th Street and London Avenue Canal were not attributed to overtopping. The failure mechanism of these levees was studied using RPI centrifuge. The results showed that as the water pressure acting over the sheetpile increased due to the storm surge a gap opened between the canal side of the levee and the sheetpile. In the case of London North and South this gap led to a reduction on the effective stress on the sandy foundation of the levee and in the case of 17^{th} street the gap triggered the shear failure of the clayey foundation of the levee.