DRISI

Caltrans Division of Research, Innovation and System Information

Research Results

Improving Seismic Guidelines for Earth-Retaining Walls

Testing the seismic performance of retaining structures in various soil types

Seismic

MARCH 2014

Project Title:
Seismic Earth Pressures on Retaining Structures in Cohesive Soils

Task Number: 2170

Start Date: June 30, 2010

Completion Date: June 1, 2013

Task Manager:
Peter Lee
Research Contract Manager
peter.s.lee@dot.ca.gov

WHAT IS THE NEED?

Earth-retaining structures along California highways are essential to the operational maintenance of underground facilities and the transportation infrastructure. While observed seismic failures of modern retaining structures have been rare, these structures were built using methods that date back to the 1920s. Geotechnical engineers are interested in evaluating the performance of current design approaches to learn more about the dynamic behavior of retaining structures built over different soil types. Testing the range of soils underlying the state's existing retaining structures—from dry granular sands to compacted, cohesive clays—will provide a more refined and accurate picture of the situation in the field.

WHAT WAS OUR GOAL?

The goal was to develop new seismic guidelines for earth-retaining structures in cohesive and noncohesive soil types.

WHAT DID WE DO?

Caltrans, in partnership with the University of California, Berkeley Department of Civil and Environmental Engineering, conducted scaled centrifuge model experiments. Two related projects measured the seismic response of retaining walls on models containing cohesive clays and dry, granular cohesionless backfills, using structures with varing degrees of stiffness. Centrifuge experiments included a scaled 6-meter basement wall and a scaled 6-meter freestanding cantilever wall with level and sloping backfill. The model bases were subjected to ground motions of multiple intensities.

Numerical models calibrated with the soil properties determined from laboratory tests produced consistent agreement with the centrifuge experiments, capturing the most important aspects of the seismic responses, including ground motion propagation and dynamic soil structure interactions.

WHAT WAS THE OUTCOME?

A dual approach combining centrifuge experiments and numerical modeling generated new recommendations for designing more seismically robust retaining structures. The data provided insight into the dynamic interaction between retaining structures and varying soil backfills.
The recommended next step is to instrument and test full-scale structures using a variety of backfill soils and collect performance data to characterize the response of earth-retaining structures to seismic pressures. This information will help validate some of the developed design equations.

WHAT IS THE BENEFIT?

Studies that focus on understanding the seismic behaviors of the varied soil conditions underlying California's retaining structures lead to rational design guidelines for future earth-retaining structures. Despite being built in earthquake-prone areas using methodologies nearly a century old, the state's retaining structures have performed well, and researchers report few if any structural failures following recent earthquakes. Geotechnical engineers want to understand this apparent paradox and explain why retaining structures have been able to withstand even severe earthquakes, despite being built in a wide range of soil types.

LEARN MORE

To view the complete report:
www.dot.ca.gov/hq/esc/earthquake_engineering/Research_Reports/vendor/uc_berkeley/Final_Report_ 65A0367_Cohesive.pdf

IMAGES

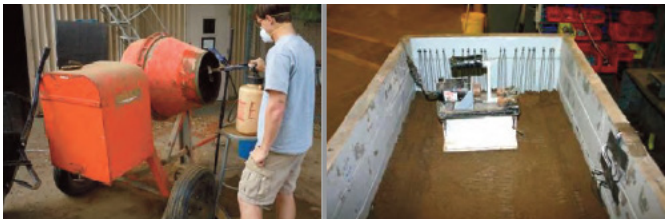

Figure 1: Construction of level ground model: soil mixing and cantilever wall on north end

Figure 2: Construction of sloping backfill model

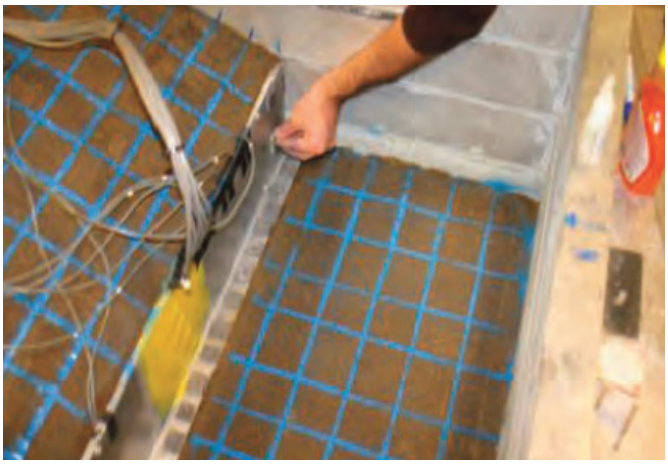

Figure 3: Construction of sloping backfill model