DRISI
CALTRANS DIVISION OF RESEARCH, INNOVATION AND SYSTEM INFORMATION
TRANSFORMING IDEAS INTO SOLUTIONS

Research Notes

Seismic Design Evaluation of Shallow Bridge Foundations at Potentially Liquefiable Soil Sites

This research will provide new guidelines and analytical procedures to evaluate bridge foundations at sites with liquefiable soil.

Geotechnical /Structures

May 2026

Project Title: Seismic Design Evaluation of Shallow Bridge Foundations at Potentially Liquefiable Soil Sites

Task Number: 4270

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Task Manager:

David Liao
Senior Transportation Engineer
David.liao@dot.ca.gov

DRISI Division Chief:

Prakash Sah, PE
prakash.sah@dot.ca.gov

WHAT IS THE NEED?

The California Department of Transportation (Caltrans) and Federal Highway Administration (FHWA) Guidelines currently prohibit the use of shallow foundations sites with liquefiable soils even though shallow foundations can provide acceptable performance in certain cases. A change in guidelines that provides straightforward guidance as to when shallow foundations can meet the performance criteria at sites with liquefiable soil layers is needed to avoid unnecessary costs during bridge retrofit or new construction. This new guidance will include guidelines and analytical procedures to evaluate bridge foundations at sites with liquefiable soil, identifying when performance specifications can be met with shallow foundations and when deep foundations are necessary.

WHAT ARE WE DOING?

Perform three geotechnical centrifuge experiments to investigate fundamental mechanisms, to provide key insights, and to supply results that can be used to calibrate dynamic analyses of shallow bridge foundations on liquefiable soil sites. Perform calibrated nonlinear effective stress Soil-Structure-Interaction (SSI) dynamic analyses of shallow bridge foundations on liquefiable soil sites with different characteristics to identify key parameters, to examine additional cases through sensitivity analyses, and to develop analytical and design guidance.

Caltrans

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WHAT IS OUR GOAL?

The goal of the research is to provide a sound theoretical and empirical method for identifying the conditions that permit bridges with shallow foundations to be used at sites with liquefiable soils while still achieving the required seismic performance. Guidance for performing analysis to evaluate the capacity and serviceability of shallow bridge foundations will be developed.

WHAT IS THE BENEFIT?

Caltrans and FHWA Guidelines do not permit the use of shallow foundations at any site with liquefiable soils even though shallow foundations can provide acceptable performance in certain cases. Consequently, Caltrans engineers are forced to use deep foundations such as piles, which are often much more expensive and which can, in some cases, exacerbate hazards such as ejecta-induced settlement. A change in guidelines that provides straightforward guidance as to when shallow foundations can meet the performance criteria at sites with liquefiable soil layers is needed to avoid unnecessary costs during bridge retrofit or new construction.

WHAT IS THE PROGRESS TO DATE?

Completed 2nd geotechnical centrifuge experiment in December 2025. Currently performing calibrated nonlinear effective stress SSI dynamic analyses of shallow bridge foundations on liquefiable soil sites. Preparing for third geotechnical centrifuge experiment.

IMAGES

Image 1: The 9-m radius centrifuge (Center for Geotechnical Modeling, UC-Davis).

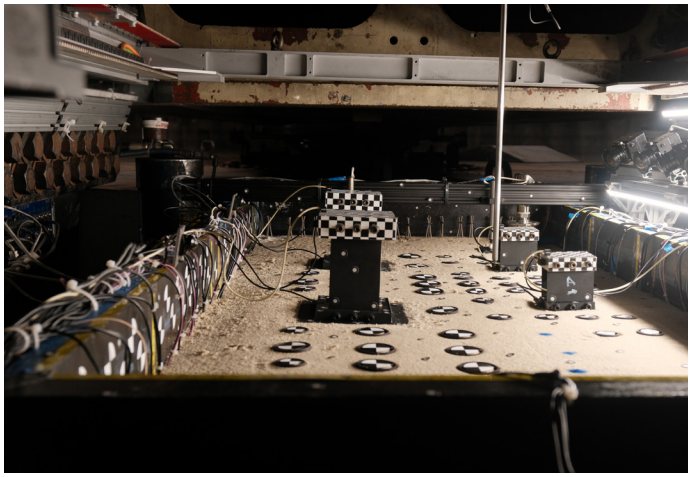

Image 2: The centrifuge test model.