

TRANSFORMING IDEAS INTO SOLUTIONS

Research Notes

Geotechnical /Structures

May 2025

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

Task Number: 4270

Start Date: March 1, 2024

Completion Date: February 28, 2027

Task Manager: David Liao

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



DRISI provides solutions and knowledge that improves California's transportation system.

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 liauefiable soil

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.

WHAT IS OUR GOAL?

The goal of the research is to provide a sound theoretical and empirical method for identifying the conditions that permit

ADA Notice: Users with accessibility issues may contact the California Department of Transportation, Division of Research, Innovation and System Information. For TTY assistance, call the California Relay Service at 711, email: pm2.communications@dot.ca.gov or write Caltrans, DRISI - MS-83, P.O. Box 942873 Sacramento, CA 94273-0001



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

Research Notes

Notes

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?

The first geotechnical centrifuge experiment was completed in February 2025. Currently performing calibrated nonlinear effective stress SSI dynamic analyses of shallow bridge foundations on liquefiable soil sites.

The contents of this document reflect the views of the authors, who are responsible for the facts and accuracy of the data presented herein. The contents do not necessarily reflect the official views or policies of the California Department of Transportation, the State of California, or the Federal Highway Administration. This document does not constitute a standard, specification, or regulation. No part of this publication should be construed as an endorsement for a commercial product, manufacturer, contractor, or consultant. Any trade names or photos of commercial products appearing in this document are for clarity only.