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CALTRANS DIVISION OF RESEARCH, INNOVATION AND SYSTEM INFORMATION

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Research Notes

Next Generation Liquefaction (NGL) Models for Predicting Triggering and Manifestation of Liquefaction

This research aims to enhance liquefaction triggering models by utilizing the recently created Next Generation Liquefaction (NGL) database.

Geotechnical /Structures

MAY 2025

Project Title:

Next Generation Liquefaction (NGL) Models for Predicting Triggering and Manifestation of Liquefaction

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WHAT IS THE NEED?

Soil liquefaction has caused significant bridge damage during past earthquakes. Liquefaction weakens soil layers beneath bridge foundations, leading to settlement and potentially causing horizontal ground movement that exerts lateral loads on the foundation, increasing the risk of the bridge superstructure becoming unseated. Accurately assessing the potential for liquefaction or severe strength loss in soil is crucial in geotechnical seismic hazard assessments for bridge design.

Current liquefaction triggering models still face uncertainty regarding the influence of Fines Content (FC) in sandy soils on penetration resistance and soil response to cyclic loading. Additionally, traditional intensity measures like peak ground acceleration and magnitude may not be the best predictors of liquefaction, as suggested by recent laboratory studies. Alternative intensity measures, such as Peak Ground Velocity (PGV), Arias Intensity (I_A) and Cumulative Absolute Velocity (CAV), could be more effective. However, the depth-independence of these measures is not yet fully understood, necessitating further investigation.

WHAT ARE WE DOING?

This project seeks to update liquefaction triggering models by addressing two key areas of uncertainty:

1. **Effect of fines in sandy soils on cyclic resistance ratio and penetration resistance.** The research team is investigating the influence of FC on the cyclic resistance ratio (CRR) and cone tip resistance. They are analyzing cyclic laboratory test data to explore the trend in which cyclic strength transitions from sand-dominated behavior (FC

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< 5%) to fines-dominated behavior at higher FC. For intermediate FC, a logistic function is developed for interpolation. To assess CRR based on both drained and undrained tip resistance, correction factors are developed using the soil behavior type index (Ic).

2. **Triggering models using alternative intensity measures.** By analyzing liquefaction history data from the NGL database in relation to cone tip resistance, the research team computes alternative intensity measures such as PGV, IA, and CAV to distinguish cases with and without liquefaction.

WHAT IS OUR GOAL?

This project aims to develop a correction for FC that separates its effects on penetration resistance and cyclic strength. Additionally, it seeks to evaluate the effectiveness of ground motion intensity measures beyond peak acceleration and magnitude for predicting liquefaction triggering and manifestation.

WHAT IS THE BENEFIT?

This research will clarify the role of fines in sandy soils on liquefaction triggering, leading to more accurate and reliable liquefaction assessments. By improving the understanding of how earthquake intensity measures vary with depth, the project will enhance seismic hazard evaluations and bridge resilience to liquefaction-related risks.

WHAT IS THE PROGRESS TO DATE?

The research has been completed on the following main tasks:

1. Investigating the effects of fines on CRR and cone tip resistance
2. Analyzing the NGL database to develop alternative intensity measures for distinguishing liquefaction case histories from non-liquefaction cases.

Based on the completed research, the team is currently drafting a final report.