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CALTRANS DIVISION OF RESEARCH, INNOVATION AND SYSTEM INFORMATION
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Research Notes

Evaluation of Simplified Procedures for Estimating Lateral Spreading

Evaluating procedures using case-history data to reliably estimate and improve the predictive accuracy of liquefaction-induced lateral spreading.

Geotechnical/ Structures

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Project Title: Evaluation of Simplified Procedures for Estimating Lateral Spreading

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WHAT IS THE NEED?

Liquefaction-induced lateral spreading poses a significant risk to bridges, potentially leading to superstructure unseating, column failure, and pile breakage. While current procedures can identify soils susceptible to liquefaction, predicting the magnitude of resulting lateral displacements remains highly uncertain. This uncertainty reduces confidence in the California Department of Transportation's (Caltrans) ability to meet seismic reliability goals and necessitates the use of overly conservative design assumptions, which could result in substantial and costly retrofit programs.

Existing guidelines, including Caltrans' 2011 simplified procedure, are not validated for large displacements due to limited high-quality case-history data. The project's goal is to develop a reliable and validated method for estimating lateral spreading displacements with quantified uncertainty, enabling safer and more cost-effective seismic design decisions.

WHAT ARE WE DOING?

The work is structured into five main tasks. First, the team will develop evidence-based screening criteria to identify high-quality case-history data for validating simplified displacement estimation methods. Next, existing datasets will be vetted and incorporated into the Next Generation Liquefaction (NGL) database. Third, two additional case histories from recent major earthquakes (magnitude > 6.5) will be added to the NGL database. Fourth, various simplified procedures, including current Caltrans guidelines, Newmark sliding block methods, and empirical models, will be evaluated by comparing predicted displacements with field observations, while assessing potential biases from geomorphology and surface

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geology.

Finally, a comprehensive report will summarize findings and provide recommendations. This deliverable will document validated, reliable methods for estimating lateral spreading displacements, equipping Caltrans with the tools to achieve target seismic performance levels efficiently and safely.

WHAT IS OUR GOAL?

The project's primary objective is to develop a reliable procedure for predicting lateral spreading displacements with unbiased estimates and quantified uncertainty, enabling Caltrans to meet target seismic performance levels. It will validate current guidelines using high-quality case histories, improve predictive accuracy through model evaluation, reduce biases from geomorphology and surface geology, and contribute vetted data to the NGL database. Ultimately, the project aims to enhance public safety, prevent structural collapse during earthquakes, and avoid overly conservative designs that could require costly retrofits.

WHAT IS THE BENEFIT?

By refining displacement prediction methods for liquefaction-induced ground deformation, the project enhances Caltrans' ability to prevent structural collapse, achieve regional seismic performance goals, and support rapid emergency response and recovery, thereby improving bridge safety, reducing costs, and increasing the reliability of seismic design procedures.

WHAT IS THE PROGRESS TO DATE?

The team completed uploading 50 sites to the NGL database, building on lateral spread case histories originally compiled by Bartlett and Hosseinali (2022). Through re-digitization and supplementation, displacement vectors expanded from approximately 5,500 to over 8,600. The 2023 Kahramanmaraş earthquake and several existing NGL events, including the 2010 Darfield, 2011 Christchurch, and 2010 Maule earthquakes, are being screened as potential additions. Of particular relevance to Caltrans, bridge sites from the 1964 Niigata and 2023 Kahramanmaraş earthquakes are among the top-priority candidates. Continuing to investigate case history data, the research team will refine the liquefaction evidence criteria by evaluating the quality and completeness of geotechnical, ground motion, topographical, and geological information across compiled sites.

Reference:

Bartlett, S. and Hosseinali, M. (2022). Development of Next Generation Liquefaction (NGL) Database for Liquefaction-induced Lateral Spread (No. MPC 22-477). Mountain-Plains Consortium.