DRISI

CALTRANS DIVISION OF RESEARCH, INNOVATION AND SYSTEM INFORMATION

TRANSFORMING IDEAS INTO SOLUTIONS

Research Notes

Calibration of Caltrans Risk Based Seismic Design for Modern Bridges

This research will provide Caltrans with improved bridge design procedures that support consistent bridge performance, increase transportation network reliability, and reduce the risk of service disruptions following seismic events.

Geotechnical/ Structures

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Project Title: Calibration of Caltrans Risk Based Seismic Design for Modern Bridges

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WHAT IS THE NEED?

The current California Department of Transportation (Caltrans) Seismic Design Criteria (SDC 2.0) uses the mean value of the 975-year Acceleration Response Spectrum (ARS) as the design basis earthquake. This approach is intended to minimize the probability of bridge collapse across a range of possible earthquake events. The recently developed Caltrans Risk-Based Seismic Design (CT-RBSD) methodology has quantified this performance objective for modern bridges.

Although bridges designed using SDC 2.0 generally satisfy the minimum-collapse objective, the actual seismic risk may vary among individual bridges. In addition, following a major earthquake, it may be difficult to explain bridge failures solely on the basis that ground shaking exceeded the Safety Evaluation Earthquake (SEE) design level. CT-RBSD provides a framework for quantifying bridge-specific seismic risk across all earthquake hazard levels.

This project will use CT-RBSD to evaluate the seismic risk of at least 100 recently designed Caltrans bridges, as recommended by the Caltrans Seismic Advisory Board (SAB) during its July 2023 meeting. The resulting database will establish a benchmark risk level for bridges that satisfy current SDC performance objectives and will support the development of acceptable target risk levels for future bridge designs.

WHAT ARE WE DOING?

This research will apply the newly developed CT-RBSD procedures to 100 modern California bridges to establish a database of seismic risk values for bridges designed according to Caltrans' current seismic design practices.

Caltrans

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WHAT IS OUR GOAL?

The objective of CT-RBSD into bridge design, allowing for tailored seismic performance and risk management for future highway bridges. This approach is intended to improve the reliability and resilience of the transportation network while minimizing overall costs.

In the initial stages of this initiative, the previous project under Contract No. 65A0774 established a thorough methodology for integrating CT-RBSD, along with implementation tools. The current effort seeks to further enhance CT-RBSD implementation by leveraging complete bridge models and establishing seismic risk values for bridges designed according to Caltrans' current SDC.

A better understanding of the current seismic risk within the bridge inventory will help prioritize seismic retrofit projects and support post-earthquake response and recovery planning. A comparative analysis will be conducted to quantify the seismic performance of modern California bridges.

WHAT IS THE BENEFIT?

Bridges are a major component of California's transportation network. A long-term goal of Caltrans is the adoption of performance-based seismic bridge design concepts. The primary benefit of this approach is the creation of a uniform level of seismic performance throughout California. This uniformity will enhance transportation network reliability and reduce costs through more efficient seismic design. In support of this effort, this project will develop a database of the seismic risk inherent in current Caltrans practices, which will help provide infrastructure that is both cost-effective and safe for the traveling public.

WHAT IS THE PROGRESS TO DATE?

A bridge model of representative inventory bridges is being developed. The goal of the bridge model analysis is to compare the total risk of bridges under 3D analysis to determine bridge performance based on Caltrans' past bridge design practice.

The first thirty inventory bridges are being assessed using nonlinear time-history analysis (NTHA). Ground motions based on the USGS 2018 Hazard Model are being generated as input motions. The 3D bridge model analyses are being performed using the Caltrans SDC. Total risk for various damage states (DS3, DS4, and DS5) is being generated for each as-built bridge.

A sensitivity study is being performed on the impact of foundation flexibility on bridge response and risk values. Foundation types under study include Type 1 shaft, Type 2 shaft, and pile group foundations. Bridges are being selected from the Caltrans inventory, and p-y data are being generated based on site-specific bridge conditions.