DRISI

CALTRANS DIVISION OF RESEARCH, INNOVATION AND SYSTEM INFORMATION

TRANSFORMING IDEAS INTO SOLUTIONS

Research Notes

Geotechnical/ Structures

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Project Title:

Uncertainty Quantification for Meeting Bridge Design Objectives

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

Uncertainty Quantification for Meeting Bridge Design Objectives

Evaluating bridge seismic response variability due to ground motion scaling methodologies.

WHAT IS THE NEED?

There is a need to enhance the accuracy, reliability, and cost-effectiveness of the current seismic design practice, particularly in optimizing ground motion scaling methods.

WHAT ARE WE DOING?

This project will begin with the development of ground motion suites tailored to the seismic profiles of two Caltrans-managed bridges: a toll road bridge and a highway overpass. Using the third version of uniform California earthquake rupture forecast seismic model (UCERF3), site-specific spectra for a 975-year seismic event will be created for each bridge. These spectra will then guide the creation of up to ten suites of seven ground motions for each bridge, using both amplitude scaling and spectral matching techniques. These suites will be compared against the Conditional Scenario Spectrum (CSS) methodology to provide a risk-based framework for evaluating engineering demand parameter (EDP) risks.

Next, two 3D nonlinear bridge models will undergo detailed computational analyses to simulate the bridge responses under the generated ground motions. Key EDPs, such as peak pier drift and isolation displacement, will be recorded, allowing for comparisons between the average EDPs produced by each suite and the established damage states defined by Caltrans. This data will provide insights into the effectiveness of the different scaling methodologies.

In the later stages, the project will assess the uncertainties involved in seismic design, evaluating how uncertainties transfer from seismic hazard analysis through structural modeling. By comparing current practices with a more integrated approach that maintains the full distribution of uncertainty, predominant sources of variance will be identified.

WHAT IS OUR GOAL?

The research aims to determine whether the method of ground motion scaling directly affects the structural performance prediction, and if so, it will determine the most appropriate method for use in design of California bridges. The project will result in two bridge case studies comparing the results of amplitude and spectral matching scaling methodologies.

WHAT IS THE BENEFIT?

This research will provide supports to Caltrans current SDC practices for bridges, particularly in optimizing ground motion scaling methods. By comparing amplitude scaling and spectral matching techniques, this study will clarify their impacts on seismic response predictions, helping Caltrans make bridges safer and more resilient against earthquakes.

The outcome of this study will enhance the accuracy, reliability, and cost-effectiveness of the current seismic design practice; thus, contributing to a safer and more resilient transportation infrastructure.

WHAT IS THE PROGRESS TO DATE?

The research team has developed three-dimensional finite-element models for two Caltrans-managed bridges with varied natural periods, using the OpenSees platform and following Caltrans bridge modeling practices. To ensure accuracy, these models were validated against another modeling software. Using the validated bridge models, the team finalized the development of bridge response hazard curves for two selected sites: Orange County and San Jose. These hazard curves will be used as the baseline for the subsequent study. The next step involves determining alternative ground motion suites for the two bridges using amplitude scaling and spectrally matched methods.