

**Geotechnical/
Structures****MAY 2026****Project Title:** UCLA Seismic Hazard and Risk Program**Task Number:** 4525**Start Date:** April 24, 2025**Completion Date:** March 31, 2029**Task Manager:**

Kyungtae Kim
Senior Transportation Engineer
kyungtae.kim@dot.ca.gov

DRISI Division Chief:

Prakash Sah, PE
prakash.sah@dot.ca.gov

UCLA Seismic Hazard and Risk Program

Developing practical tools and guidelines for seismic hazard and risk analysis of typical bridge structures.

WHAT IS THE NEED?

There is a critical need to translate mature seismic research into practical, updated tools that support the Risk-Based Seismic Design (RBSD) framework for the California Department of Transportation (Caltrans). The NGA-West2 ground motion database and record selection utilities used by Caltrans have not been updated in over a decade, despite major advancements in ground motion modeling. Incorporating the recently developed NGA-West3 database and its improved ground motion models is essential to ensure accurate, state-of-the-art seismic assessments. Furthermore, existing tools lack capabilities for selecting and scaling ground motions to match inelastic target response spectra, which limits their usefulness for advanced bridge performance evaluations.

There is also a need to address the overly conservative treatment of epistemic uncertainty within current seismic hazard models. The United States Geological Survey (USGS) National Seismic Hazard Model applies weighted sets of alternative ground motion models, often inflating hazard estimates for the western United States (US). Caltrans supports research to identify the most influential sources of epistemic uncertainty and evaluate whether current practices appropriately represent seismic risk. Reducing unnecessary conservatism could lead to more realistic hazard quantification, significant cost savings, and improved consistency in RBSD applications. Collectively, these needs highlight the importance of research that bridges scientific advances with practical seismic design implementation.

WHAT ARE WE DOING?

The project focuses on updating and improving practical tools and guidelines for seismic hazard and risk analysis of



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typical bridge structures in California. A major effort is dedicated to modernizing computer tools for accessing and selecting ground motion records, incorporating the comprehensive NGA-West3 database. The updated tools will also enable selection and scaling of motions for inelastic target response spectra, a capability currently lacking in existing versions.

A key focus is addressing epistemic uncertainty in seismic hazard quantification. The project identifies influential within-model and between-model uncertainties in the USGS National Seismic Hazard Model and assesses their impact on hazard estimates through numerical analyses. Reducing unnecessary conservatism historically incorporated in the model—which has inflated hazard levels in the Western US—will improve the realism of hazard quantification and potentially reduce bridge design costs.

The project also strengthens RBSD implementation by refining procedures and criteria. Efforts include developing simpler hazard adjustment factors, establishing selection criteria for RBSD analysis methods across multiple bridge models, and quantifying the relationship between bridge collapse probability and construction costs to guide regional performance targets. The project also evaluates the long return period of hazard curves to assess conservatism in traditional Probabilistic Seismic Hazard Analysis results.

WHAT IS OUR GOAL?

The primary goal is to develop practical, user-friendly tools and guidelines for seismic hazard and risk analysis of typical bridge structures in California. The project also supports RBSD implementation and aims to reduce epistemic uncertainty in the National Seismic Hazard Model, which has the potential to reduce seismic hazard estimates and achieve significant cost savings in bridge design.

WHAT IS THE BENEFIT?

The project provides substantial benefits by reducing

seismic risk and hazard and achieving significant financial savings through improved seismic estimation methods. It also delivers practical, user-friendly tools and guidelines that translate mature research into actionable resources for Caltrans engineers and other end-users. Updated computer tools will access the comprehensive NGA-West3 database and incorporate its ground motion models. Additionally, the project will support Caltrans in establishing regional bridge performance criteria by quantifying the relationship between collapse probability and construction costs, aiding in justifying higher seismic performance targets for recovery bridges.

WHAT IS THE PROGRESS TO DATE?

The research team is currently focusing on two key tasks:

- **Investigating epistemic uncertainty in ground motion models:** A working group of experts and end users, including representatives from Caltrans and the USGS, is investigating sources of uncertainty in ground motion estimation.
- **Implementation of RBSD:** The team is evaluating a map comparing the Uniform Hazard Spectrum (UHS) for a 975-year return period with that for a 2475-year return period. Additionally, the team has advanced its bridge modeling and nonlinear seismic analysis, reviewing two benchmark bridges in San Jose and Los Angeles. The models incorporate key structural properties, Caltrans Seismic Design Criteria-compliant abutment elements, and rigid-base foundations. Ground motion selection used a UCLA-developed tool with 40 records. Looking ahead, the team will expand the study to 10 California sites and include additional bridge models.