Research Project Summary

Improvement of Capacity Models in the Caltrans Risk-Based Seismic Design (CT-RBSD) Procedure

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Abstract
The Caltrans Risk-Based Seismic Design (CT-RBSD) procedure enables performance-based seismic design of reinforced concrete (RC) bridge columns by incorporating probabilistic demand and capacity models. Current CT-RBSD capacity models are primarily based on experimental data for circular columns developed prior to 2010 and do not adequately represent modern bridge column configurations, including rectangular and interlocking rebar cages. This project aims to improve CT-RBSD capacity models by integrating new and existing experimental data, defining quantitative damage states, and developing validated models applicable to a broader range of RC bridge columns. A comprehensive dataset of column tests will be compiled, including force-displacement response and observed damage under cyclic and dynamic loading. This dataset will be filtered using Caltrans bridge inventory data to ensure relevance to current design practice. An extensive experimental program will be conducted to address identified data gaps, primarily using shake-table testing of large-scale column models to capture dynamic response, residual drift, and strain demands. Quantitative damage states will be defined using measurable response parameters and observed damage characteristics, improving consistency with the Damage Index (DI) framework used in CT-RBSD. Updated capacity models will be developed through statistical analyses of experimental data and validated against independent datasets. The models will then be integrated into the CT-RBSD procedure, with example applications demonstrating their use in bridge design and assessment. The outcomes of this project will enhance the accuracy and applicability of CT-RBSD capacity models, supporting improved seismic performance evaluation of RC bridge columns.

Deliverables
We will deliver a PEER report and several conference and journal papers describing the compiled experimental dataset, experimental testing of RC bridge columns, quantitative damage state definitions, updated CT-RBSD capacity models, and their validation and integration into the CT-RBSD procedure.

Research Impact
This project will enhance the reliability and applicability of the CT-RBSD procedure by improving the underlying capacity models for RC bridge columns. Current models are primarily based on limited

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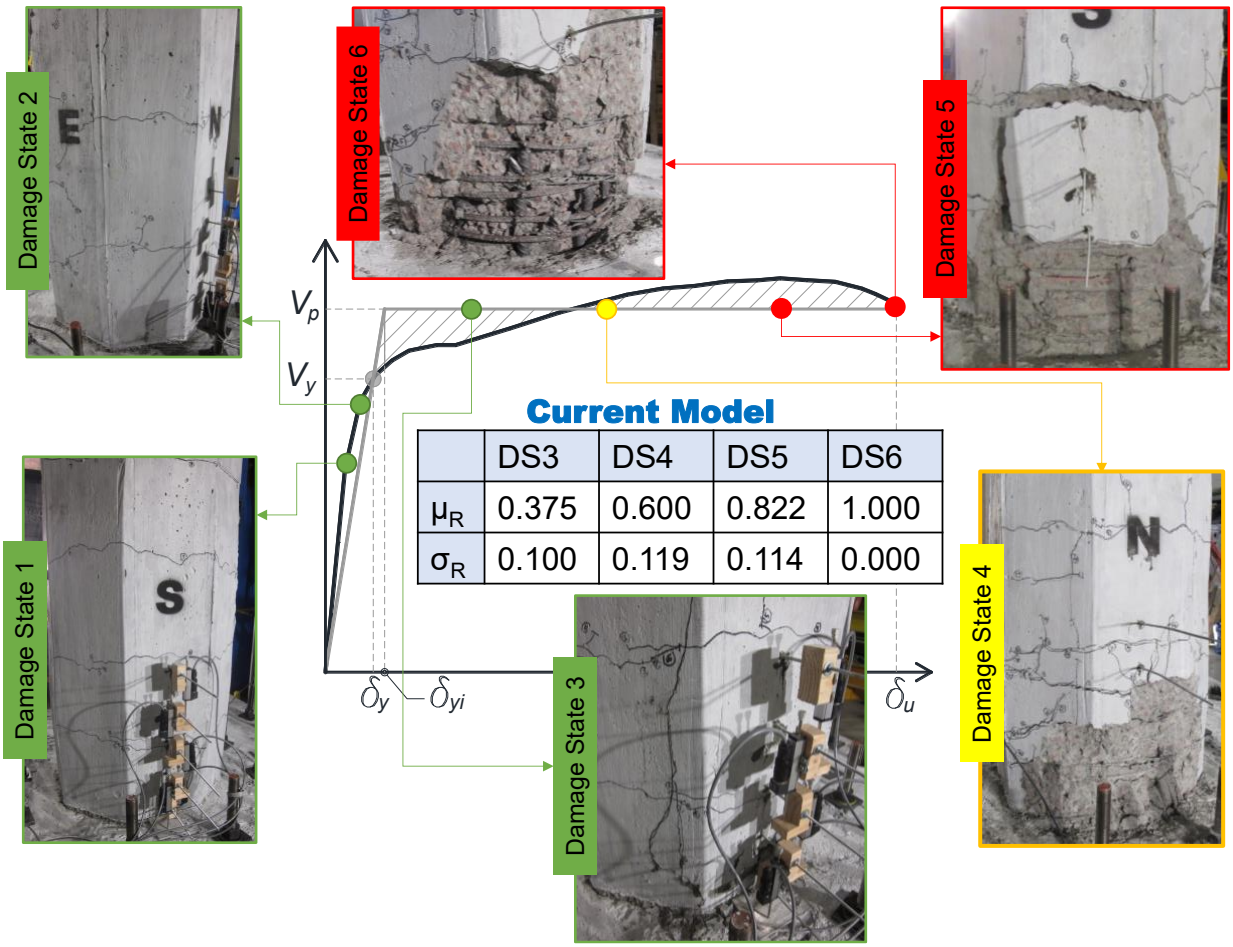
experimental datasets for circular columns and do not fully capture the behavior of modern bridge column configurations, including rectangular and interlocking reinforcement systems. By integrating recent experimental data, conducting large-scale shake-table testing, and defining quantitative damage states, this research will provide a more robust and consistent representation of column behavior across multiple damage levels. The development of updated capacity models based on expanded datasets will reduce uncertainty in performance predictions and improve the accuracy of probabilistic seismic design. The integration of the updated models into the CT-RBSD framework ensures that the research outcomes can be directly implemented in Caltrans practice. This will support more consistent performance targets, improved risk-informed design decisions, and enhanced resilience of California's bridge network. The results will also benefit other state departments of transportation and the broader engineering community engaged in performance-based seismic design.

Project Image



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