DRISI

CALTRANS DIVISION OF RESEARCH, INNOVATION AND SYSTEM INFORMATION

TRANSFORMING IDEAS INTO SOLUTIONS

Research Notes

Evaluation of Seismic Design for Temporary Structures

Bridge research to develop guidelines for seismic loading on the design of temporary bridges.

Geotechnical /Structures

May 2025

Project Title:
Evaluation of Seismic Design for Temporary Structures

Task Number: 3945

Start Date: June 1, 2022

Completion Date: May 31, 2024

Task Manager:

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WHAT IS THE NEED?

The California Department of Transportation (Caltrans) commonly constructs temporary bridges that have an expected lifespan of less than five years. Currently, seismic loading for temporary structures is based on a uniform hazard spectrum consistent with a 10% probability of exceedance in 10 years (100 years return period). This criterion was established to correspond to an approximate 0.2 PGA load level, the minimum design level before Caltrans adopted probabilistic-based specification of seismic demand. While the approximate 0.2g PGA target seems reasonable, it is rather arbitrary. In recent years, the ability to quantitatively assess bridge performance risk has advanced. Reassessment of our current seismic loading policy for temporary bridges is needed to advance Caltrans reliability and cost efficiency goals. There is a clear need to evaluate the relative risks and costs associated with alternative design hazard levels and provide recommendations for relevant seismic hazard levels for temporary bridge design.

WHAT ARE WE DOING?

Through the PEER-Bridge Program, Caltrans is contracting with University of Reno (PI) and University of California, Davis (Co-PI) to evaluate temporary bridge performance levels and the corresponding cost differentials for selected representative prototype bridges under the study. The project aimed to provide recommendation on hazard level for future design. Representative prototype bridges were selected for study on four locations (Sacramento, San Francisco Bay Area, San Luis Obispo, and Los Angeles). The project will develop nonlinear numerical modeling procedures and systematic probabilistic-based analysis to assess bridge seismic performance. Also, to investigate the selection of alternative hazard levels for design.

Caltrans

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WHAT IS OUR GOAL?

The primary goal of this project is to evaluate the performance of temporary bridge design under different seismic hazard levels using nonlinear time-history (NLTH) simulations of prototype bridge models. Develop quantitative bridge performance vs. cost matrix for risk assessment and provide recommendations on future temporary bridge design.

WHAT IS THE BENEFIT?

Bridges play a critical role in our transportation system in enhancing California mobility and economy. While the expected lifespan of temporary bridge is no more than five (5) years, with California's high seismic demands in many areas, the significance of temporary bridge performance cannot be overlooked. Although Caltrans' current design guidelines proposed simplified method on the design of temporary bridge, a more in-depth assessment is warranted to quantitatively measure the potential damages and associated risk on existing design methodology. Evaluating cost and benefits associated with different hazard levels and corresponding performance will ultimately ensure reliability in the performance-based design of temporary bridge. The recommendations developed from this project will allow Caltrans to achieve consistency in design-basis performance assessment and also provide economically feasible options to our stakeholders on temporary bridge design.

WHAT IS THE PROGRESS TO DATE?

This project is completed on May 31, 2024.

Project identified baseline models for all four locations (Sacrament, San Francisco Bay Area, San Luis Obispo, and Los Angeles). Structural properties of ACROW truss superstructure have been obtained from Manufacture. Developed and designed bridge columns for each bridge prototype based on different site hazard levels. Conducted pushover analysis to establish column capacity and ductility. Investigate various hazard levels (50, 100, 200, 500, and 1,000 yr. return period) to be appropriately used in study. Assess design columns to see if they meet design criteria.

3D nonlinear bridge models are developed in OpenSees. Non-linear time history analysis is performed at different hazard levels to capture bridges responses. Column fragility functions are also being developed based on various damaged states. Results are compared for 2 different design methodologies of hazard-based design vs. minimum requirement design. Hazard-based design could ensure constant satisfactory bridge performance across California. Minimum requirement design could lead to inconsistent performance levels.

IMAGES

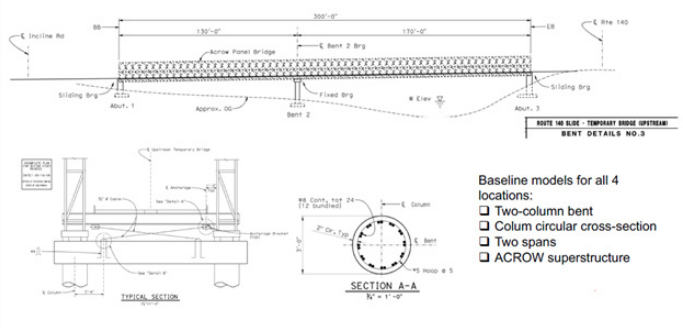

Image 1: Baseline model with ACROW superstructure.

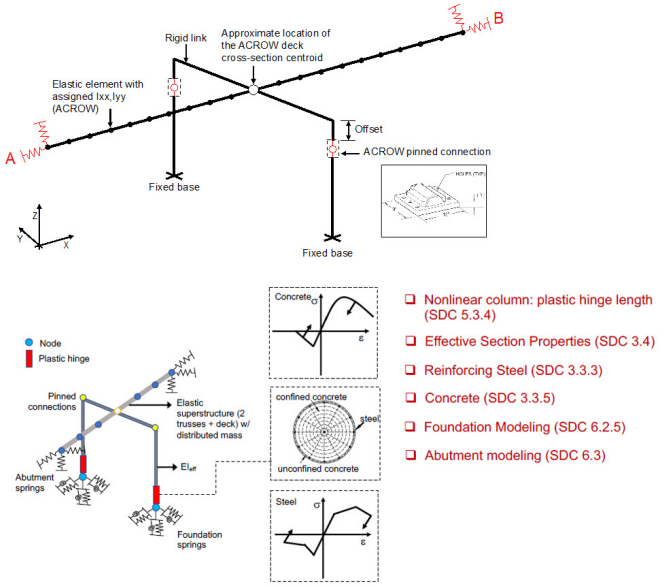

Image 2: Modeling approach in OpenSees (Courtesy of UNR/UCD research team).