

Geotechnical/
Structures

MARCH 2022

Project Title:
Statistical Variation of Seismic
Damage Index (DI) of California
Bridges

Task Number: 3677

Start Date: February 1, 2021

Completion Date: February 28, 2023

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Statistical Variation of Seismic Damage Index (DI) of California Bridges

Bridge research to improve Caltrans performance-based bridge design procedure to enhance transportation network reliability and reduce overall costs

WHAT IS THE NEED?

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, Caltrans bridge engineers have developed a prototype performance-based design procedure called Probabilistic Damage Control Assessment (PDCA). Currently, the PDCA procedure requires laborious Nonlinear Time History Analysis (NTHA) and earthquake input record selection is not well defined. In order to deploy this method, it needs to be made easier and more repeatable in application.

WHAT ARE WE DOING?

Through the PEER-Bridge Program, Caltrans is contracting with UC Irvine to investigate ways to simplify PDCA. Focus areas will include developing estimates of dispersion in structural response that can be used statewide instead of calculated individually for each bridge. These dispersion estimates may include adjustments for regional hazard or bridge geometry.

Another focus area will be the development of earthquake record selection procedures for NTHA. Two objectives of these procedures are simplicity and reducing variation in results when



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performed by different engineers. To speed bridge design, procedures for initial column sizing will be developed that will reduce the number of design iterations required. Finally, incorporation of directivity effects that impact near-fault locations will be investigated.

WHAT IS OUR GOAL?

The primary goal of the project is to refine PDCA design procedures so that they are accurate, repeatable, and efficient for implementation on the design floor.

WHAT IS THE BENEFIT?

Bridges play a critical role in our transportation system in enhancing California mobility and economy. For most bridges (approximately 80%) seismic loading is their dominant load case. Transitioning to a performance-based design framework will result in equal risk of bridge damage and closure statewide. The benefit of this uniform performance will increase network reliability and cost efficiency. The quantification of performance has the added benefit of providing Caltrans and stakeholders critical information for decision making and future planning of California's transportation network.

WHAT IS THE PROGRESS TO DATE?

This project is being initiated as a task order through the PEER-Bridge Program. It is targeted to being in February 01, 2020 and continue for 24 months.

Procedures for preparing input information for nonlinear time-history analysis have been developed. Single column models are developed based on the varies column parameters. The parameters under consideration are column diameter, column height, axial force, longitudinal reinforcement ratio, transverse hoop size, and hoop spacing. Push over analysis has been conducted to determine column yield displacements, capacity displacements, and demand displacements. Hazard curves and selected ground motions for five (5) give testbed locations are generated for Eureka, Sacramento, Oakland, Los Angeles, and San Diego. Time-history analysis results has been extracted on selected columns. Column Damage Index (DI) values and coefficient of variations (COV) has been calculated per Caltrans PDCA procedure. Future work includes devising a contour mapping for the state of California for location specific time-history analysis for DI and COV calculations.