DRISI

Caltrans Division of Research, Innovation and System Information

Research Notes

Calibration of Probabilistic Damage Control Approach (PDCA) for Seismic Design of Bridges — Phase II

Develop reliable and verified methods for probabilistic design of new and substandard bridge columns to control damage depending on the level of seismicity and various structural and soil parameters.

Seismic

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Project Title:
Calibration of Probabilistic Damage Control Approach (PDCA) for Seismic Design of Bridges – Phase II

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WHAT IS THE NEED?

PDCA is an engineering procedure to predict the damage and the performance of new bridges when subjected to earthquakes larger than the design earthquake. It also helps to make sound funding resource decisions based on the expected seismicity and target performance level that suits a particular bridge.

This is a continuation of a study performed at University of Nevada, Reno to develop a realistic and proven probabilistic based design method that will be incorporated in PDCA. This approach could have huge cost savings for new bridges and help decide maintenance repair responses without being too conservative. Additionally, for existing bridges PDCA can better prioritize bridge components needing a specific level of retrofit.

WHAT ARE WE DOING?

To accomplish the objective of the study, the proposed research will consist of seven tasks including a literature search of recent relevant probabilistic seismic design research and methods, seismic performance fragility curves for substandard bridge columns, and methods on bridge system reliability analysis. Extensive analytical modeling of the seismic response of new and deficient bridge columns, piers, and systems supported on different soil types subjected to large number of earthquake records will be conducted. The earthquake records will cover a wide range of intensities and return periods. They will include earthquake records obtained and modified on a range of soil types and fall both in far-field and near-field categories.

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Statistical variation of the seismic damage in bridge columns will be captured as a function of structural and ground motion parameters. The data will be evaluated, interpreted, and incorporated in design methods to enable Caltrans engineers to assess probability of exceedance of certain damage state under different earthquakes and help decide how to allocate resources for new bridge design as well develop seismic retrofit plans for substandard existing bridges. Design examples will be provided to aid engineers in implementing the proposed design methods in actual bridges.

WHAT IS OUR GOAL?

The Phase I study provided valuable information and tools that were focused on new bridge columns subjected to transverse motions. Many important issues and pivotal considerations could not be included the Phase I study. The primary objective of the proposed study for Phase II is to expand the Phase I study both in terms of depth and scope and to address the gaps that could not be included in Phase I.

Because the ultimate goal of the study is to develop useful and practical tools that can be readily used by Caltrans designers, interaction with Caltrans staff is expected to prioritize the gaps in knowledge and tools that will be addressed in Phase II.

Specifically, the Phase II study will focus on development of (a) a robust demand model utilizing the United States Geological Survey (USGS) hazard curves, (b) new fragility curves for existing substandard bridge columns in California that are yet to be retrofitted, and (c) a preliminary framework for addressing overall bridge system reliability, with the primary emphasis being on (a) and (b).

WHAT IS THE BENEFIT?

What has been envisioned is that by transforming current fixed route operation into dynamic focused transit services in suburban regions across California, transit service will become faster and better transportation option for significantly more travelers. Furthermore, the transit operation costs will be reduced, and transit systems will assume a greater role in the total solution to transportation congestion, safety, and improved air quality.

The use of PDCA will lead to optimized design and efficient use of the limited available funding for both new design and retrofit of existing bridges. The efficient use of funding will enable Caltrans to do more with fewer resources thus leading to substantial benefit to the tax payers.

WHAT IS THE PROGRESS TO DATE?

Preparing to begin work in January 2015 as described in the scope.