Research Project Highlight

Testing and Hybrid Simulation of Environmentally Damaged Bridge Columns

Project #NCTROC

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Abstract
Hybrid Simulation (HS) is utilized to investigate the seismic response of a corrosion-damaged reinforced concrete bridge. Data regarding the seismic performance of corroded reinforced concrete (RC) bridge columns is very limited, leading to inaccurate simulations of environmentally damaged bridge columns, due to the complicated behavior of corrosion-damaged RC elements. Additionally, full-scale testing is complicated and expensive and is thus virtually nonexistent. Hybrid Simulation (HS) provides a cost-effective, accurate method for testing corrosion-damaged bridge columns subjected to seismic demands. The purpose of this investigation is to evaluate the effect of corrosion damage in the plastic hinge of bridge columns on the seismic performance of bridge structures. The study considers a single-column, single-bent bridge with two spans, with the plastic hinge region of the column to be simulated as the experimental substructure, and the remainder of the column and bridge will be simulated as the analytical substructure. Prior to HS testing, an impressed current will accelerate the propagation of corrosion damage in the experimental substructure and induce vertical cracks matching those observed on existing bridge columns in the field. A set of three specimens will be tested: one non-corroded specimen as a control, and two with varying levels of corrosion damage. The HS test will be conducted using ground motions in two directions, one horizontal and one vertical. A three-actuator setup is used to control three degrees of freedom (DOF), two translational and one rotational, as shown in Project Image Figure 1. Results of this test will then be used to assess the effects of corrosion-induced longitudinal cracking in the plastic hinge region on the seismic performance of bridge columns.

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Deliverables

Results of this study will provide useful information on the capacity and behavior of bridge columns at various stages of corrosion damage under seismic demands. This data will be compiled into a PEER report along with conference and journal papers.

Research Impact

In 2016, the Federal Highway Administration reported that 5.6% of all reinforced concrete bridges in the United States are structurally deficient. The deteriorated state of these bridges poses a serious risk, not only in day-to-day use, but especially in the case of a large seismic event. Following such an event, mobility of emergency and rescue crews is imperative for post-disaster response. Reinforced concrete bridges in seismically active regions are designed and tested thoroughly, with high confidence that such bridges will be operational immediately following a large earthquake. This assumes, however, that bridges are in pristine, undamaged condition prior to the seismic event. The residual drift and load-carrying capacity of corroded bridges following a seismic event is unknown. This lack of data poses a large research gap, one that comes with potential threat to the safety of people living in seismically active areas. The research conducted in this project will help fill that gap in knowledge and obtain a better understanding of the seismic performance of deteriorated bridges such as those in the field.

Project Image

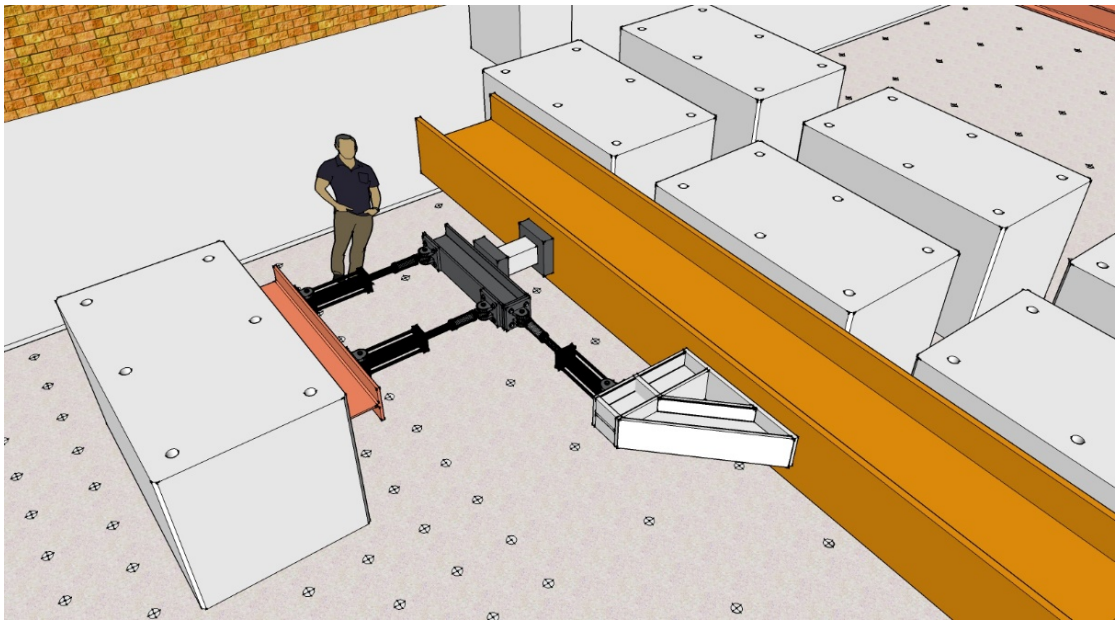

Figure 1: Experimental Setup

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