

Geotechnical/ Structures

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Project Title: Bridge Rapid Assessment Center for Extreme Events (BRACE2) – Phase II

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Bridge Rapid Assessment Center for Extreme Events (BRACE2) – Phase II

Real-time estimates of bridge damage during major earthquakes.

WHAT IS THE NEED?

The California Department of Transportation (Caltrans) operates 7 toll bridges in the San Francisco Bay Area and over 13,000 state bridges. A number of these bridges includes seismic sensors that are mounted at key locations on the bridge. During an earthquake these sensors measure horizontal and vertical acceleration and transmit this data to the California Geologic Survey (CGS) for processing. CGS creates data reports for major events and Caltrans later uses this data to validate the structural model used to design or seismically retrofit the bridge.

There are several areas for improvement with our current practice. First, the transfer and processing of seismic data is too slow to utilize in the immediate assessment of a bridge following an earthquake. Second, sensor and telemetry technology are rapidly advancing. While the sensors used on Caltrans bridges are very rugged and reliable, they are very expensive to install and maintain. Finally, validation of a bridge's structural model using CGS recorded sensor data requires a substantial effort usually involving contracting with engineering consultants.

WHAT ARE WE DOING?

Under a previously Caltrans funded project (hereinafter referred to as "Phase 1"), a data and simulation center for real time rapid assessment of Caltrans designed and operated bridges under seismic events has been established. By using sensor data, the objective of BRACE2 is to develop a useful tool for Caltrans Earthquake Engineering, Maintenance,



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and other stakeholders to monitor and assess bridge damages. This tool can be used to inform decisions concerning emergency response during seismic event and can also be used to improve Caltrans bridge design practice. The development and completion of BRACE2 Phase 1 was done by Professor Khalid Mosalam and his team at the University of California, Berkeley.

Completed deliverables under Phase 1:

- BRACE2 center is established and housed at UCB.
- Seismic sensor data communication infrastructure between bridge site and the center is completed for Hayward 580/238 Separation bridge
- OpenSees bridge models of 1) Hayward 580/238 Separation 2) San Bernardino E10-N25 Connector, 3) Painter Street OC, 4) Meloland Road OC, and 5) South Landing Road OC, have been developed
- For Hayward 580/238 Separation, real-time monitoring, and bridge assessment to identify bridge responses and damage estimations is completed
- Damage identification and model calibration methodologies has been developed for all 5 bridges

Building upon the completed deliverables under Phase 1, the objective of this project (Phase 2) is to expand the usefulness of BRACE2. Real-time monitoring and bridge assessment will be developed for 4 more bridges. A second deliverable of Phase 2 is to develop CSiBridge model for Hayward 580/238 since CSiBridge is the main authorized modeling platform used by Caltrans bridge design. With BRACE2 center fully operational for real-time assessment and monitoring, another main objective of Phase 2 is to improve the functionality of the tool in both accuracy and timeliness.

WHAT IS OUR GOAL?

The goal of this project is to develop the technologies and a comprehensive assessment tool for bridge component damage prediction with aided decision-making framework to assist our stakeholders for emergency response and future strategy planning.

WHAT IS THE BENEFIT?

Bridges represent a major public investment and the closure of one or more of these bridges has a substantial detrimental impact on regional travel times. However, system and component assessment of bridges are complicated and inheritably difficult. As we establish a viable bridge monitoring center, BRACE2 will use state-of-the-art communication, computation, and sensor technology to provide real-time assessment of the structural condition of the monitored bridges immediately following an earthquake. These assessments can help avoid unnecessary closures when damage is light and identify the location and severity when damage is heavy. Sensor data will also be used to validate and update structural models and possibly result in improvements in bridge design.

WHAT IS THE PROGRESS TO DATE?

Development and testing of the CSiBridge upload mechanism using the Painter Street bridge model and an example bridge connector model. Five example bridge models built with Bridge Wizards in CSiBridge are also being developed to test superstructure features and various section-definition methods. Development of a testing and validation framework to support the analysis capabilities of the BRACE2 platform. Enhancements to model viewing, reporting, and user-interface navigation are also being developed.

IMAGES

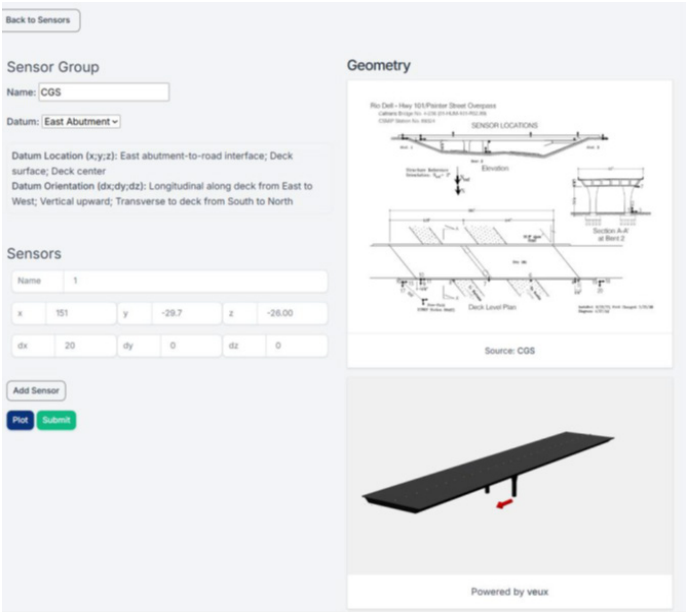


Image 1: BRACE2 platform with rendering of Painter Street Bridge (courtesy of UCB).