DRISI

CALTRANS DIVISION OF RESEARCH, INNOVATION AND SYSTEM INFORMATION

Research Results

Bridge Rapid Assessment Center for Extreme Events (BRACE2)

Real-time estimates of bridge damage during major earthquakes

Geotechnical/ Structures

JULY 2024

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

Task Number: 3703

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WHAT WAS THE NEED?

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 WAS OUR GOAL?

The primary goal of BRACE2 is to demonstrate the viability of the Rapid Assessment Center concept through trial implementation on the Hayward 580/238 Separation bridge. A future goal, the developed technologies and monitor center viability from this project can be used for implementation to Caltrans bridge inventory and Bay Area toll bridges.

Caltrans

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WHAT DID WE DO?

Through Caltrans' PEER-Bridge Program, Caltrans collaborated with UC Berkeley Dr. Khalid Mosalam and his team to develop the Bridge Rapid Assessment Center for Extreme Events (BRACE2), a trial implementation center that monitors the Hayward 580/238 Separation bridge 24/7. Under this project, communication and processing infrastructure has been established that enables monitoring in real-time. State-of-the-art structural models has been developed for the trial bridge and it is being used to develop simpler fragility algorithms to provide damage estimates in real-time. These estimates are being provided to Caltrans via a limited access web site to support decision-making regarding bridge closure and inspection. Efficient updating of bridge models using recorded sensor data has also been developed. Further, the goal of the study is also to capture varies influence parameters critical to bridge responses from recorded data.

WHAT WAS THE OUTCOME?

BRACE2 web application for real-time monitoring of Hayward 580/238 Separation bridge was established.

- BRACE2 we-based platform interacts with several databases to establish real-time monitoring and provides bridge response predictions.
- BRACE2 uses OpenSees as the computational platform for response analysis including capabilities for Soil-Structure Interaction. The platform will be expanded using CSiBridge in the next phase of the project.
- Computed damage states could be related to bridge assessments criteria guided by Caltrans.
- BRACE2 platform is designed to maximize scalability to larger number of instrumented bridges in Caltrans' inventory.

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 the first step to 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 trial bridge 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. If the trial implementation proves successful, these same techniques and technologies can be applied to other bridges in Caltrans inventory.

LEARN MORE

Final Report online access forthcoming.

IMAGES

Image 1: Bridge Rapid Assessment Center for Extreme Events

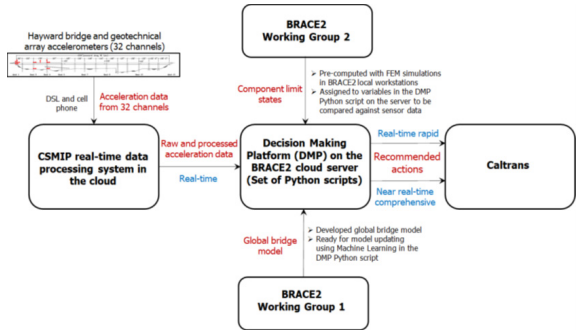

Image 2: BRACE2 Operation Workflow. Curtesy of UC Berkeley project team.

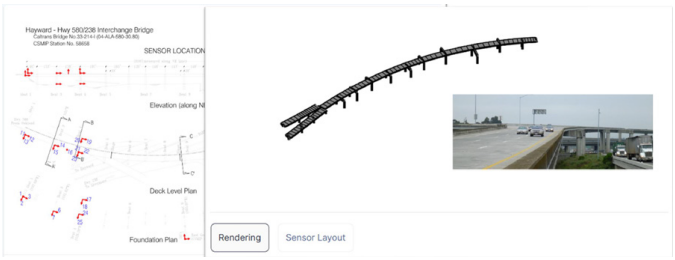

Image 3: Completed Hayward 580/238 Digital Twins and sensor layout. Curtesy of UC Berkeley project team.

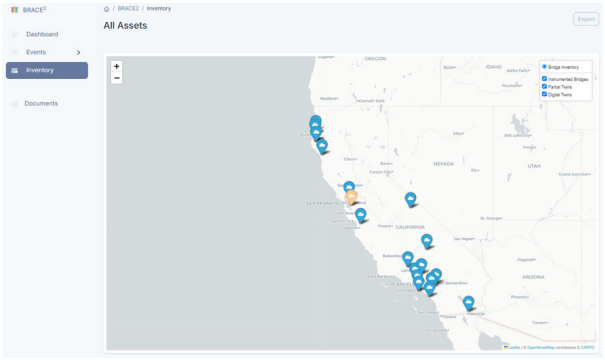

Image 4: BRACE2 web-based platform interface. Curtesy of UC Berkeley project team.

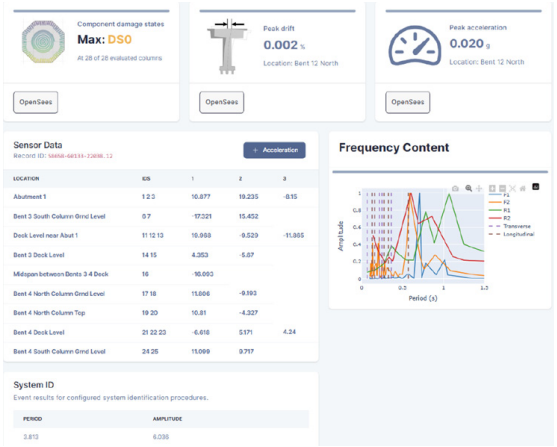

Image 5: Platform interface for result evaluation. Curtesy of UC Berkeley project team.