



5-6916-01: Implementation of TxDOT Seismic Vulnerability Measures and Post-Event Actions

Background

Increases in the rate of seismicity in Texas and in neighboring states since 2008 motivated research to investigate the seismic vulnerability and potential risk to Texas bridge infrastructure. Recent TxDOT research (0-6916) characterized seismic hazards and bridge fragility, or likelihood of damage based on ground shaking intensity, in Texas; these factors were combined to develop a post-earthquake inspection plan. In this implementation project (5-6916-01), these research outcomes were incorporated into a conversion software—termed the TexasBridgeDataConverter—to facilitate use of ShakeCast, the software developed by the U.S. Geological Survey (USGS) to automate the process of identifying and prioritizing post-earthquake inspection needs. ShakeCast is made available to TxDOT through participation in the Federal Highway Administration's ShakeCast Transportation Pooled Fund project.

What the Researchers Did

The research team, comprising civil engineers with specializations in geotechnical and structural engineering, (1) developed a new software for updating the TxDOT bridge inventory and associated fragility functions in ShakeCast; (2) incorporated updated Vs30 maps into USGS ShakeMaps, which are used to estimate ground shaking levels in the ShakeCast software; and (3) created an operating manual and conducted a virtual workshop for TxDOT personnel on how to use ShakeCast and the researcher-developed software for inventory updating. To update the bridge fragility functions in ShakeCast, the researchers provided recommendations for the use of HAZUS fragility functions for bridge classes not covered in the previous TxDOT research, the

optimal ground shaking intensity measures to predict bridge damage, and a method to adjust fragility functions to account for bridge skew based on results of prior research.

What They Found

This project yielded the following findings:

- Due to the large number of bridges in Texas, updating the bridge inventory in ShakeCast requires the assistance of software to automate the extraction of relevant information from the National Bridge Inventory (NBI) and assignment of appropriate bridge fragility parameters.
- Previous TxDOT research focused on developing fragility functions for seven common bridge classes with low to no skew. For bridge classes outside of those considered in the previous TxDOT research, existing

Research Performed by:

Center for Transportation Research

Research Supervisor:

Patricia Clayton, CTR

Researchers:

Farid Khosravikia
Meibai Li
Iason Grigoratos
Ellen Rathje
Brady Cox
Eric Williamson

Project Completed:

08-31-2020

fragility functions employed in the Federal Emergency Management Agency (FEMA)-produced HAZUS software were employed. Fragility functions of skewed bridges were adjusted to account for skew based on results of previous research in the literature.

- The ShakeCast system automatically retrieves ground shaking information from the USGS ShakeMap system, which rapidly characterizes the extent and distribution of strong ground shaking following significant earthquakes. The updated regional Vs30 map for Texas was incorporated into the Global Vs30 Mosaic map used by USGS as input to estimate the ground motion shaking intensities in the ShakeMap system.
- The research team has developed a new ground-motion model (GMM), termed ZR19, to improve the characterization of ground shaking for Texas. This GMM is not yet incorporated into the ShakeMap system due to the USGS policy of utilizing the same GMMs for ShakeMap and for the National Seismic Hazard Maps. Using a regional GMM (such as ZR19) within ShakeMap would include a change in current USGS practice, thus requiring a more deliberative approach to decide on an appropriate course of action.

What This Means

To maintain up-to-date bridge inventories in the ShakeCast software, TxDOT employees can use the researcher-produced software (the TexasBridgeDataConverter.exe) to convert relevant NBI data into the input files needed for ShakeCast. The software was developed to allow TxDOT flexibility in what bridges to include, what fragility functions and intensity measures to use to predict the likelihood of bridge damage, and a means to account for the increased vulnerability due to skew. The operating manual provided along with this software provides recommendations for each of these considerations. The work done to implement the updated Vs30 maps for Texas into the USGS ShakeMap system will be automatically incorporated into ground shaking estimates used for any future earthquake events or scenarios analyzed in ShakeCast, as ShakeCast retrieves ground shaking information from the USGS ShakeMap system immediately following an event.

For More Information

Project Manager:

Joanne Steele, RTI (512) 416-4657

Research Supervisor:

Patricia Clayton, CTR (512) 471-4063

Technical reports when published are available at
<http://library.ctr.utexas.edu>.

Research and Technology Implementation Division
Texas Department of Transportation
125 E. 11th Street
Austin, TX 78701-2483

www.txdot.gov

Keyword: Research