

2018 Research Symposium

Quantifying the Vulnerability of Vermont Bridges to Seismic Loading

& STIC Annual Meeting

RESEARCH PROJECT TITLE

Project 737 Quantifying the Vulnerability of Vermont Bridges to Seismic Loading

STUDY TIMELINE

May 2013-August 2017

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Fact sheets can be found for additional projects featured at the 2018 Symposium at

<http://vtrans.vermont.gov/planning/research/2018symposium>

Additional information about the **VTrans Research Program** can be found at

<http://vtrans.vermont.gov/planning/research>

Additional information about the **VTrans STIC Program** can be found at <http://vtrans.vermont.gov/boards-councils/stic>

Introduction

Quantifying the seismic vulnerability of Vermont's bridges is vital for managing those key transportation assets. Quantification is hampered by the quantity of bridges, the degree of deterioration present, the knowledge and effort required for the quantification analysis itself, and the continually changing condition of the inventory. Adding to this is the limited guidance existing on evaluating vulnerability both for low to moderate seismic hazard regions and for older, deteriorated bridges.

Methodology

The study began with a survey of state transportation agencies regarding their seismic vulnerability rating methods, particularly for states in low to moderate seismicity regions, followed by evaluating guidance on seismic vulnerability quantification from research institutions and FHWA. Few states in low to moderate seismic regions perform system-wide seismic vulnerability evaluations. Single span bridges are generally considered to be less seismically vulnerable, therefore not included. The research involved non-linear finite element modeling of existing Vermont bridges representative of about 80 percent of the multiple span bridge inventory subjected to earthquakes specified in the current AASHTO LRFD design requirements, for both pristine and fully spalled concrete substructures. UVM developed the Vermont Rapid Seismic Screening Algorithm (VeRSSA) to be applied to data available in the Vermont NBI.

Conclusions

The study indicates that Vermont's multiple span bridges are susceptible to varying degrees of earthquake damage depending on their geographic location, foundation conditions, and bridge features particularly those related to span continuity and support types, and alignment (skew). The bridges were assigned three levels of vulnerability.

The VeRSSA algorithm is specifically designed to yield a moderately conservative seismic vulnerability rating subject to subsequent refinement after obtaining more specific data on the soil and foundations, substructure concrete details, and span support dimensions at each of the bridges through plan review and site visits. The study indicates that individual bridge vulnerability ratings could improve where further bridge-specific information indicates more favorable conditions than can be justifiably inferred from what is available in the current NBI database and VTrans' supplemental data.

Potential Impacts and VTrans Benefits

This research provides VTrans with a quantitative estimate of the seismic vulnerability of the bridge inventory applicable to both individual and system-wide bridge rehabilitation and replacement decision-making in consideration of improving Vermont's transportation system disaster resilience. The resulting seismic vulnerability ratings also provide a tool for prioritizing response following an earthquake.