



Research Project Summary

Framework of Identifying Shear Cracking in Bridge Columns using Lidar

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Start-End Dates:

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Abstract

With the support of the Washington State Department of Transportation (WSDOT) (\$200,000), the University of Washington (UW) research team will develop a model of column cyclic shear resistance that takes into account not only the maximum level of column deformation, but also, the amount of cycling. This model will enable bridge engineers to evaluate the collapse potential of older reinforced concrete bridges that are likely to be subjected to long-duration earthquakes, such as those located in Northern California, Oregon and Washington State.

The proposed PEER-supported research would take advantage of the WSDOT testing program to:

1. Develop a framework for obtaining lidar data of concrete bridge components, developing 3D models, and isolating and measuring cracks that can be extended to other types of bridge systems and components,
2. Identify and evaluate the most promising existing methods of identifying and measuring cracks in concrete structures from lidar-derived 3D point cloud models of bridge components; and
3. Correlate cracking pattern with likelihood of shear versus flexural failure for reinforced concrete bridge columns.

As the use of lidar becomes more common and computing capabilities continue to grow, the developed framework and recommendations will enable the deployment of lidar-enabled technologies to support the rapid, post-earthquake assessment of bridges.



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Deliverables

Project deliverables include: conventional measurements of column response for the six tests, which would be added to the PEER Structural Performance Database, a comprehensive dataset of lidar data for the six columns and ten levels of column deformation, and a framework for obtaining, processing and interpreting lidar data (6 columns, each scanned at 10 levels of deformation) to support rapid, post-earthquake inspections of bridges. The deliverables will be presented in a PEER report and other conference papers, presentations and journal articles.

Research Impact

The use of promising, new technologies within transportation asset management is critical for improving accuracy, efficiency, and safety of the transportation system. Lidar coupled with methods to identify cracks and determine their potential to cause critical failure represents such a modern technology. The framework developed in the proposed research could be important to bridge asset managers across the country. Identifying potential brittle failure of bridge components is critical for prioritizing bridge retrofit and replacement and is a central purpose of asset management.

The proposed research will develop a framework that will aid asset managers by making lidar technology approachable and weeding through the dense literature on crack detection algorithms to make lidar data useful to asset managers. The proposed output for this project is a framework for using lidar to identify the potential for brittle failure in bridge components. The framework will include: (i) recommendations for lidar scanning procedures including necessary point cloud accuracy and resolution, (ii) recommended algorithms for identifying cracks in reinforced concrete bridge components using lidar derived point clouds, (iii) recommendations for identifying potentially brittle failure modes from cracking patterns and amplitudes in reinforced concrete bridge components, and (iv) example applications to bridge columns tested in the UW Structural Research Laboratory.

Project Image

The figure below shows lidar used to identify and quantify spalling in a reinforced concrete frame building tested on the E-Defense shake in Japan from a paper the PI is a co-author. Similar methods will be used in this project.

The citation for this is: Calvi, P.M., Che, E., Sweet, T., Lowes, L.N., and Berman, J.W. (2024) "Data Collection Using Terrestrial Laser Scanners from the Shake-Table Test of a Full-Scale Reinforced Concrete Building." *Journal of Structural Engineering*. 150(2).

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