Testing vintage US bridges for vulnerability -- and finding ways to protect them

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This is the Ft. Steuben Bridge, built in 1929, in Steubenville, Ohio. Credit: State of Ohio

It took only 13 seconds for the bridge to collapse into the Mississippi River in a thunderous rain of concrete and steel. When the Minneapolis I-35W bridge – an eight-lane, steel truss arch bridge – cracked and plummeted in 2007, one of the first thoughts was: *SABOTAGE*?

While sabotage was *NOT* the cause of the I-35 bridge collapse, sabotage *CAN* be used to weaken steel plates, girders, cables, or other key structural elements of a major bridge. And while sabotage may not be easy to carry out, DHS takes all such threats seriously.

More than 600,000 bridges in the U.S are 20 feet long or longer, some over a century old, many of them national iconic monuments. The Department of Homeland Security's Science and Technology Directorate (S&T) has joined forces with the Federal Highway Administration and the U.S. Army Corps of Engineers Engineer Research and Development Center to conduct series of experiments that assess potential vulnerability of critical structural components of aging steel bridges.

This seminal research is discovering how materials, connection details, and designs in aging bridges react to IEDs, other explosives, kinetic impact, intense fires and other accidents. In addition to vulnerability analysis, DHS S&T is funding several complementary efforts that investigate advances in effective and affordable ways to strengthen bridges. Data obtained through such research will help update computational models, and may be integrated into engineering software for construction of more durable bridges.

Bridge specimens for research have been obtained from state Departments of Transportation and bridge authorities. Primary bridge components (tower sections, cables, suspenders, trusses) are recovered from bridges undergoing demolition or major renovation, including several significant bridges, such as the Crown Point Bridge (NY State - Lake Champlain), and the Ft. Steuben Bridge in Ohio. These are then transported to specific facilities for testing. One such series of tests was recently performed at test ranges in Ft. Polk, LA to determine explosive effects.

"Bridges slated for demolition are hard to come by," says S&T Transportation Security Laboratory's Tom Coleman. "However, last year the research team found out that the Ft. Steuben Bridge—a vintage 1929 suspension bridge in Steubenville, Ohio—was to undergo demolition in 2012."

With the Ft. Steuben Bridge closed to traffic, there was a unique opportunity to conduct onsite tests. "We developed a way to perform controlled impact testing on the bridge using a specially designed "cold gas thruster" device," said Coleman. "Lateral impact loads were directed at specific locations on the main cable and forces transmitted to the rest of the structure were monitored in real time. This testing, along with similar experiments performed a few years ago on the Waldo Hancock Bridge in Maine, will help us learn bridge behavior and develop mitigation measures to better prevent damage."

In a laboratory, it's nearly impossible to replicate the myriad dynamic and static forces that interact within a bridge structure. Opportunities to conduct field tests at the Ft. Steuben have made it possible to gain better knowledge of in situ bridge behavior. In addition to the onsite testing, cables and steel tower sections were recovered from the Ft. Steuben Bridge following its recent demolition. These specimens will be assessed to determine material characteristics and vulnerabilities during blasts, and to further develop mitigation measures.

"Our current work is quite unusual because we are testing actual vintage bridge components from long-span bridges, as opposed to newly manufactured samples," says John Fortune, S&T's Bridge Vulnerability Project Manager. "The results will help us predict susceptibility to different threats and develop effective, feasible technologies to protect the Nation's bridges. We are developing innovative approaches that will protect iconic bridges from hazards, and also aid in building smarter, more secure bridges for the future."

Most U.S. bridges are owned by regional authorities, state departments of transportation, private authorities, county authorities, or local municipalities. These bridges are designed using codes and standards approved by the American Association of State Highway Transportation Officials (AASHTO), whose membership includes State DOTs and other bridge owners.

The work taking place will be shared with AASHTO and specific bridge owners and operators to ensure that project results will be available to engineers responsible for building new bridges and renovating existing ones.

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