Testing bridges for safety after major hurricanes like Irma

September 18 2017, by Millie Acebal

Credit: Florida International University

After Hurricane Irma hit, there was a major concern about South Florida's bridges, mainly the ones in the Florida Keys. Would the structures be safe to cross for drivers anxious to get back home? Would relief efforts be impaired due to damage caused by massive winds? Fortunately, all 42 bridges that connect the mainland to the Keys were inspected and declared safe by Monroe County officials.

If another major hurricane like Irma hits South Florida, an FIU researcher and one of the world's leading bridge engineers shares an easy and cost-effective way to test a bridge for safety.

"We can assess the damages on a global and local level. Global approaches can quickly identify the bridges sustaining damages while local methods can provide more detailed information. We can establish the 'signature' of a bridge before a hurricane occurs to familiarize ourselves with its characteristics," said Atorod Azizinamini, director of FIU's Accelerated Bridge Construction-University Transportation Center (ABC-UTC), and chair of the College of Engineering & Computing's Department of Civil & Environmental Engineering. "By knowing a bridge's signature, it is a lot easier to assess damage after the hurricane because we will be able to identify deficits in the structure." A bridge's signature refers to its stiffness. That stiffness, says Azizinamini, can change due to damage.

One tool that can be used to detect a bridge's signature is the impulse-response test (IR), originally used to test foundations, but it's been adapted to assess bridge decks and columns and other infrastructure types. With the IR technique, stress waves are generated using a small hammer with a load cell attached at its end, to establish the mobility and stiffness of the bridge elements and identify the areas with deficiency. If none were present in the testing prior to the hurricane, any new deficits that turn up would likely be a result of the storm's impact and could quickly be assessed. The data collected displays in pictorial form as a graph. "You can immediately see any damage on the image."

Credit: Florida International University

Here's how the data is collected. The transducer measures the velocity at a given point on the bridge, and the hammer measures force. When an engineer strikes the hammer, it causes the structure to vibrate and, in doing so, generates waves that cause the structure in the vicinity of the transducer to displace. The information from the transducer and load cell attached to the hammer are then used to establish the stiffness of the structure at the grid points. The bridge's structure is divided into a grid, and measurements of the vibrations are taken at each grid point allowing to establish the stiffness of the structure in a given area. "Changes in stiffness is what we look for," says Azizinamini. "It changes when there is damage."

The key is to test bridges prior to the storm, not just afterwards, in order to identify changes, which translates to damage. "If there's no change in behavior of the characteristics of the bridge, nothing happened, but if there is, it will give us a clue on what to do next to fix it."

IR, according to Azizinamini, is the best technique for bridge damage assessment at a local level. There are other tools available such as ultrasound.

When it comes to repairing damages to bridges once assessment is made, Azizinamini is a renowned expert in the emerging tool of accelerated bridge construction (ABC). The ABC-UTC has recently developed patented technologies that can repair damages rapidly without interruption to traffic. The effectiveness of these new technologies is such that repaired structures are even better than original structures and are completed at a fraction of the cost of other alternatives.

Credit: Florida International University

Another subject that the ABC-UTC is leading the nation in is building new bridges. When it comes to building new bridges, there are three technologies that are popular in the United States. The first uses a selfpropelled modular transporter to bring in a bridge that is built nearby and then installed once the old bridge is demolished.

The second, the slide-in-method, is the most popular method. It involves building a bridge alongside the old one. The old bridge is torn down, and the new one simply slides in.

The third option is the modular method, which requires making components of the bridge offsite in sections and then bringing those sections to the bridge site to replace the existing [structure](https://phys.org/tags/structure/).

Azizinamini hopes to gather data on existing bridges and other infrastructure so he can then work with local government and transportation officials to provide them with this much-needed information prior to a [hurricane](https://phys.org/tags/hurricane/) making landfall.

Provided by Florida International University

Citation: Testing bridges for safety after major hurricanes like Irma (2017, September 18) retrieved 26 June 2024 from https://phys.org/news/2017-09-bridges-safety-major-hurricanes-irma.html