Special reinforcing proven to stand up to earthquakes

Carbon-fiber reinforcements improved performance of bridge bents subjected to the University of Utah's earthquake study.

SALT LAKE CITY - The University of Utah conducted a state-of-the-art earthquake study in May and June. It was the first instrumented structural and geotechnical testing of a full-size bridge section subjected to simulated seismic shaking.

The purpose of the study was to determine whether carbon fiber composites could be used to restore a bridge to service once it had been damaged structurally by an earthquake.

"Carbon-fiber reinforcement was the main study to see how it improves the performance—and it worked," said Dr. Chris Pantelides of the University of Utah.

The study was applied to a section of the I-15 bridge in Salt Lake City. The section consisted of two concrete bents and a deck with steel girders which spanned the bents. Both bents were subjected to cyclic lateral loading intending to simulate shaking of the bridge during a major earthquake. The seismic test brought a magnitude of shaking that was equivalent to approximately 7.0 on the Richter Scale.

Three separate tests were performed on the two bridge bents. The first test was held in May on the southern bent. This test studied the bent in its "as built" condition. The bent was subjected to gradually increasing cyclic loads starting at 400,000 pounds. In this test the bent was severely damaged.

The northern bent, tested in early June, was wrapped with carbon fiber composites around the joints where the columns intersected the cap, and at the bottom of the columns. The results of the special reinforcement proved that the bent could support lateral cyclic loads 20 percent higher than those supported by the unreinforced bent.

The third test was conducted on the previously damaged southern bent after wrapping the joints with carbon fiber composites. Results showed that the carbon wrapped bent not only regained its original strength, but could also support an additional 15 percent load beyond its original ultimate capacity and at least 50 percent more lateral displacement.

"For test three, the results were equal to test two. What that represents is, say we have an earthquake and we went back and fixed [the damage] with carbon fibers, we would bring the condition of the bent to the original condition with the carbon," said Pantelides.

Testing also included the evaluation of the Geopier Foundation's short aggregate pier capacities to support reaction frame footing during and after substantial earthquake simulation shaking. The company reported that their foundations were highly ductile, with no appreciable permanent deformation resulting when the loads were removed.

The study was funded by the Utah Department of Transportation, the National Science Foundation, and the Idaho National Environmental Engineering Laboratory.

The University hopes to continue testing another section of the bridge before demolition next year. ■

Simulated shaking was equivalent to 7.0 on the Richter Scale.

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