Project Overview

The Louisville-Southern Indiana Ohio River Bridges Project is a major design-build infrastructure project intended to improve road safety and alleviate traffic congestion by connecting highways across the river to provide major economic stimulus to the entire region. The project includes both the Downtown and East End Crossings over the Ohio River along with the associated highways that connect them. With a project budget at approximately $2.5 billion, this will be the largest transportation project ever constructed connecting the two states.

Project Summary

The foundations for both the Downtown and the East End Crossings were tested using O-cell® bi-directional static testing technique to confirm the geotechnical parameters and allow for both economising of the design and risk management.

Geotechnical conditions throughout the bridge location indicated the presence of a significant layer of high strength limestone into which the bridge bearing piles could be founded. Accommodating the lateral design loading of the bridges required a minimum rock socket length. With a standard geotechnical design approach, the axial design loads required socket lengths deeper than those required for the lateral loading conditions. As the conventional design was thought to be over conservative, the design and build team sought to overcome some of this conservatism by carrying out a full scale load test. The O-cell® bi-directional load testing technique was the ideal technology to be able to achieve their goal.
Bi-directional load test arrangement
The test pile required at the Downtown Crossing was to not only test the pile capacity but also the piling technique. The dedicated test pile was drilled through overburden soils and socketed into the underlying limestone. The loading arrangement configuration in the test pile used four 860 mm diameter O-cells arranged in a single level located 1.1 metres above the pile toe to provide the maximum test load required of 213 MN at rated capacities.

Test results
Fugro Loadtest performed the bi-directional static load test using the O-Cell® method and exceeded the rated load capacity and achieved a maximum test load of 322 MN by overpressurising the O-cells, creating a new World Record for a static load test of a single foundation element.

Conclusions
Although a new World Record load was achieved, the rock was far from failure and additional pile capacity was available, and illustrates the magnitude of conservatism often used in pile design in rock.

Using the O-cell technique it is possible to achieve very high average unit skin friction and end bearing resistances in hard rock formations. This allows the design to be optimised, resulting in shorter rock sockets, more economical foundation construction and reductions in program time.
I-70 Bridge over the Mississippi River

St. Louis, Missouri

Massman, Traylor Bros. and Alberici, JV

With a main span of 1,500 feet, the new Mississippi River Bridge in St. Louis, Missouri will be the third longest cable-stayed bridge in the United States. But it did set a new world record for the highest load ever recorded during a static load test. The previous world record of 62,700 kips (278 MN) was set in South Korea by Loadtest at the site of the new Incheon Bridge. The old record was surpassed by 9,400 kips on July 17, 2010. The maximum load applied during the St. Louis load test was 72,100 kips (320 MN).

The Mississippi River crossings in downtown St. Louis and southwestern Illinois are some of the busiest in the U.S. where several interstates carry traffic across the river. The new bridge is expected to transport up to 55,000 vehicles daily, re-routing Interstate 70 from an overly-congested nearby bridge.

When the massive eight-lane original bridge design was deemed uneconomical, co-owners Missouri DOT and Illinois DOT opted for a sleek 1,500ft main deck carrying four lanes across the Mississippi, although the design calls for room to restripe to six lanes as needed.

The $640 million project includes the 1.22-mile bridge, supported by symmetrical cable-stayed delta towers, over 400 feet tall. Two large concrete footings, one near each bank, anchor the bridge below. Each pier rests on a series of concrete-filled drilled shafts, extending over 100 feet socketed into the limestone bedrock.

Massman, Traylor Bros. and Alberici (MTA) presented an Alternative Technical Concept that included plans for six 11.5 ft. diameter drilled shafts, as opposed to the fourteen 10 ft. diameter shafts initially proposed. This new design, using fewer but wider supporting columns, is significantly more cost-effective since it halves construction time for the bridge foundation. The design has the additional advantage of a reduced environmental footprint with fewer drilled shafts.
Bi-directional load test arrangement
To perform the world record test, a 119ft deep test shaft was drilled into the sub-surface, which consisted primarily of sand and gravel underlain by solid rock. A core barrel roller bit and core extractor were used to excavate the rock socket, which was then airlifted after drilling was completed. A SONICALIPER was then used to profile the shaft excavation sidewalls.

Four 34in O-cells attached to a steel reinforcing frame were installed at the base of the 11.5ft diameter drilled shaft and reinforced concrete poured in to fill the socket and encase the cell. After concrete curing, the O-cell assembly was pressurized, loading the shaft in 19 loading increments with each successive load increment held constant for eight minutes.

The shaft was loaded to a maximum bi-directional load of over 18,000 tons, mobilizing a combined end bearing and side shear resistance of 36,067 tons (321 MN).

Summary
As is the case on many projects, the results of the O-cell test confirmed the use of an optimized engineering design, by verifying MTA’s alternative technical concept and allowing them to utilize a much more economical alternative than the original conventional design. Additionally, the testing footprint was minimal, despite the record-breaking loads applied. Loadtest’s company objective, which is to provide an accurate, high-quality tool for value-engineering, proved to be an invaluable benefit to this project.