LOADTEST
O-Cell® Technology, Bridges over the Zambezi River, Mozambique

Project:	**Caia Bridge**
Location:	Caia, Mozambique
Client:	Mota-Engil / Soares da Costa
Foundation Contractor:	Trevi Spa.

Cage and plate preparation

Internal view of O-cell assembly

Pile installation in progress

Test in progress

The new bridge over the Zambezi River, completed in Sept 2009

Project Overview

Caia is a town on the south bank of the Zambezi River in Sofala Province, Mozambique. It is a relatively small town with few modern facilities. In March 2007, construction commenced on what would be the longest road bridge to span the Zambezi. The bridge over the Zambezi was officially opened on August 1, 2009, and with some controversy, was named after the current president of Mozambique, Armando Emilio Guebuza. With a length of 2.376 Km and a width of 16 m it is longer than the bridges at Tete and Katima Mulilo, exceeded only by the Dona Ana Bridge, which has been restored as a rail only bridge. The anticipated bridge was crucial in linking the Sofala Province and the Zambezia Province. The Caia bridge cost an estimated US$80 million.

Load testing program

A single-level O-cell test was performed on a 1500 mm pile, installed by Trevi S.p.A. who began construction on the dedicated test pile. The nominal test pile was excavated to a toe elevation of -35.60 metres under bentonite slurry. After desanding the drilling fluid, the bottom two reinforcing cages with attached O-cell assembly and four subsequent cages were spliced together and lowered into the excavation and temporarily supported at the surface. Concrete was then delivered by tremie through a 270 mm O.D. pipe into the base of the pile until the top of the concrete reached an elevation of +24.75 metres. Sister bar vibrating wire strain gauges were placed at levels along the pile shaft allowing a profile of net unit skin friction to be determined as mobilised along the pile shaft.

The single 540 mm diameter O-cell, with its base located 5.19 metres above the base of pile, was pressurized to a bi-directional gross O-cell load of 10.89 MN.

Summary

The O-cell method is particularly advantageous over water or in congested construction areas. As there is no reaction system above ground it is particularly suitable for use in remote locations where the requirement to construct additional piles as anchors and mobilise steel reaction beams or to provide kentledge and its transportation would prove difficult and costly.

Additionally, the method is not only applicable to preliminary expendable test piles, but also for working test piles; post test grouting allows for the integrity of piles to be restored and subsequently integrated into the structure.

This test provided evidence of the suitability of the geotechnical design and the technical merits, economic benefits of O-cell technology and the advantage the method can have by minimizing disruption to the environment.

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Project:	**Tete Bridge**
Location:	Tete, Mozambique
Client:	Mota Engil
Foundation Contractor:	Trevi Spa.

Map showing planned route of new bridge over the Zambezi river

Installation of pile cage with O-cell assembly

O-Cell Pile test in progress

Lateral test in progress

The partly built bridge over the Zambezi, to be completed in Sept 2014

Project Overview

Tete is the capital city of Tete Province in Mozambique. It is located on the Zambezi River and is the site of only one of three bridges across the river in the entire country. A Swahili trade centre before the Portuguese colonial era, Tete continues to dominate the west-central part of the country and region and is the largest city on the Zambezi.

As part of this project, three preliminary pile load tests were required; two on one side of the river and the third on the opposite bank. One of the piles was also to be tested laterally. Minimizing disruption and impact on the environment was of the utmost importance for the whole project. Traditional top-down static load testing for the 20 MN tests with either the construction of anchor piles and reaction beams or erection of kentledge would have been extremely difficult. Loadtest provided an alternative solution in the form of bi-directional testing using O-cell technology.

Load testing program

In ground conditions where the end bearing may be comparable or greater than the friction, the O-cell may be located at or near the bottom of the pile and the test will then measure end bearing and skin friction directly and independently. Three single-level O-cell tests were performed on 1200 mm piles installed by Trevi Spa. The piles were constructed using bentonite slurry to depths of 56.5, 50.2 and 25.2 metres. Sister bar vibrating wire strain gauges were placed at levels along the pile allowing the load distribution of skin friction to be determined along the pile shaft.

The purpose of the lateral test was to confirm the suitability of the parameters estimated from the site investigation and to validate the design assumptions. In addition to lateral pile head movement, an inclinometer string comprising several gauges were installed inside the pipework fitted during pile construction. These were monitored to provide inclination measurements along the pile shaft as the load was applied. These measurements were then used in the calculation of bending moment and to determine the lateral deflection profile along the pile shaft.

Summary

By placing the O-cell at a strategic elevation in the shaft, Loadtest was able to assess the governing geotechnical parameters, as well as isolate end bearing and total skin friction load-displacement characteristics so that the foundation design could be optimised. These tests provided evidence of the technical and economic benefits of O-cell technology, especially in remote locations, and the advantage the method can have by minimizing disruption to the environment.