CASE STUDY

Bi-directional O-Cell® load testing 1915 Çanakkale Bridge, Turkey

Images | Press Room | 1915Çanakkale (1915canakkale.com)

Fugro LOADTEST have performed O-Cell tests for the 1915 Çanakkale Bridge Project (Asian and European shore), a suspension bridge located in Turkey featuring the longest mid span in the world.

Source:
www.1915canakkale.com

Project
1915Çanakkale Bridge

Clients:
ZETAŞ Zemin Teknolojisi A.Ş.
KASKTAŞ A.Ş.

Location
Çanakkale Bridge

Period
2019

Services
O-Cell® load tests

O-Cell® pile tests on both sides of the bridge and for the cable anchor

Project Summary

Situated just south of the coastal towns of Lapseki and Gelibolu, the Çanakkale bridge spans the Dardanelles, about 10 km (6.2 mi) south of the Sea of Marmara. The bridge was officially opened by President Recep Tayyip Erdoğan on 18 March 2022 after roughly five years of construction. The 2,023 m span made it the longest suspension bridge in the World at the time of opening and the second tallest.

Challenge

With such a free length of bridge, several geotechnical and structural challenges needed to be overcome by designers COWI A/S and design verifiers ARUP. The sub-surface stratigraphy at the bridge support location consisted of sands and fatty clay deposits underlain by mudstone and sandstone. The remote location meant no previous large structures had been built in the vicinity, so no local geotechnical knowledge was available.

A suspension bridge of this magnitude requires detailed and well-designed cable stays and towers.

As part of an extensive testing programme, the first objective was to test the anchor blocks for the cables on the Asian side which were contained by barrettes.

The second challenge would be to determine the load / settlement characteristics of the tower piles.

Solutions

To assess whether the ground was suitable for such tensile loads, an initial O-Cell barrette test was designed, founded entirely in the fatty clay deposits. The 6,575 mm wide barrette element, equipped with 5 number 430 mm diameter O-Cells and highly instrumented with strain gauges and extensometers was installed to assist the designers in determining the skin friction parameters essential to the design.

The use of O-Cells enabled a 'push out' test of the section above the O-Cell elevation, with the lower section providing the reaction. Top of concrete elevation was left at design cut-off level, some 5 m below platform level. The results of this test were then used to determine the tensile capacity of the panel within the fatty clay.

Reinforcing cage, fitted with 5 Nr 430 mm O-Cells

For the piled foundations, O-Cell technology proved a perfect solution for static load testing of these test piles since the load bearing rock strata was nearly 37 m below the platform level. Full scale static load tests using O-Cell technology were performed on both the Asian and European sides of the bridge.

Sister bar strain gauges were again placed at multiple levels along the shaft on each of the test piles in order to assess the load distribution mobilized during the testing. By use of Cemsolve® pile load movement analysis, the total ultimate skin friction capacity and ultimate end bearing load and stiffness could be determined, and by combining upward and downward models, a Cemset® prediction of the pile head load / settlement could be made.

Conclusion

Determining the tensile reaction parameters for the cable anchors was essential to the completion of this project. Use of O-Cell technology made this assessment possible without the use of multiple anchors required for tension testing, which would have been extremely difficult and potentially created a zonal influence on the test barrette.

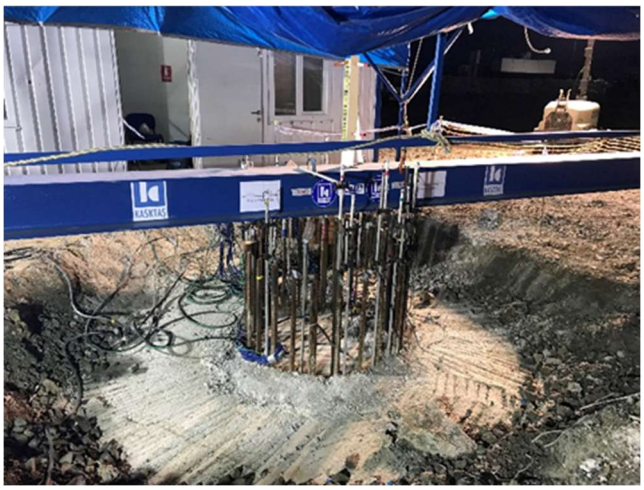
The full scale static pile load testing enabled the test load to be placed directly into the rock socket. The test results revealed both the upward behaviour of the skin friction above the O-cell assembly, and the downward skin friction and end bearing characteristics under loading. All five pile tests proved to be excellent.

The O-Cell tests were able to safely mobilise the underlying rock fragment base, revealing the geotechnical behaviour. These results were critical for the tower foundation designers, allowing design confirmation and providing vital feed-back for further analysis.

Full-scale static load testing was able to be carried out using O-Cell methodology without the need to provide multiple rock anchors or large and potentially unsafe, reaction frame, revealing the geotechnical behaviour of the base of the piles as well as the skin friction parameters along the pile shaft.

These results were critical for the project foundation designers, demonstrating the actual in-situ behaviour within the rock socket, enabling improvements to be made to the working pile design and providing confidence in the design of the World's longest cable stay suspension bridge.

Reinforcing cage, O-Cell® and instrumentation being installed into the pile bore (Asian side)



O-Cell® test in progress on the European side. The steel beam is for reference for the measurement of vertical movements