LOADTEST
O-Cell® Technology at the Po River, Italy

Project: **Po River Viaduct**
Location: Milano-Bologna, Italy
Client: Italferr.
Foundation Contractor: Trevi Spa.

High speed train reaching speeds of 300 km/h

Construction of the bridge underway

Installation of pile cage with O-cell assembly

Pile test in progress

Project Summary

A new high speed railway line from Genoa to Milan required interconnecting the new infrastructure with the Giovi, Genoa - La Spezia, Genoa-Turin and Alessandria-Piacenza lines, and involving the inter-ports of Rivalta Scrivia and Milan South. This involved the construction of several new high speed railway lines taking trains at speeds of 300 km/h.

One section of the Milan-Bologna line between Alessandria and Piacenza required the building of a 400 metre cable stay suspension bridge over the Po River (the first of such bridges for trains built in Europe). The bridge has an open span of 192 metres.

As part of this project, Piacenza became the site for the first Osterberg Cell (O-cell) tests to be performed in Italy. Minimizing disruption and impact on the environment was of the utmost importance for the whole project. Traditional top-down static load testing would require a 50 MN test with either the construction of anchor piles or erection of kentledge and test beams. Loadtest provided an alternative solution in the form of bi-directional testing using O-cell technology.

Load testing program

Two multi-level O-cell tests were performed on 2000 mm piles installed by Trevi Spa. The piles were constructed using bentonite slurry to depths of 52.3 and 57.7 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.

Summary

By placing the O-cell at strategic elevations in the shaft, Loadtest was able to assess shear characteristics in specific zones, as well as isolate end bearing and total skin friction loads, mobilising a reaction of over 65 MN. These tests provided evidence of the technical merits, economic benefits of O-cell technology and the advantage the method can have by minimizing disruption to the environment.

The new cable-stayed railway bridge over the Po River, completed in 2006

Source: glfconstructioncorp.com

LOADTEST
O-Cell® Technology at Malpensa Airport, Italy

Project: **Malpensa Airport Expansion Project, Milan**

Location: Milan, Italy

Client: Codelfa, Spa.

Foundation Contractor: Fondamenta Spa.

Project Description:

Summary:
Redevelopment and expansion of Malpensa Airport, Milan required installation of large diameter bored piles as part of the new foundation. Pile diameters up to 1800 mm with working loads of 15 MN were specified for this project. A test load of 22.5 MN on a production pile made traditional top-down static load testing a very expensive option. Soft soils would have necessitated the need for kentledge, but with unstable soils consisting of sands and gravel, a deep cut-off and small test area, it would have been impractical. Bi-directional static load testing offered a cost effective alternative meeting all the difficult requirements with ease.

O-cell assembly

Project:
Malpensa is one of three intercontinental airports located within a 50 kilometres radius of Milan. As with most major airports in Europe, Malpensa has seen a rapid growth of air traffic over recent years, necessitating a major expansion of the airport. The construction of this third satellite terminal together with a third runway will enhance the capacity of the airport for future traffic.

The construction and redevelopment contract was awarded to Codelfa Spa, the piling and foundation works forming a major part of this project.

The 1800mm diameter test pile would be incorporated into the foundation structure post testing, once grouting of the O-cell and the annulus created around the O-cell was completed.

Malpensa Airport redevelopment

Bi-directional load test arrangement:
A single 670 mm O-cell was used to provide the 22.5 MN load required. The O-cell test assembly was welded into the instrumented steel cage at a level of 3.30 m above the toe.

This was then installed into the pile shaft which had been constructed under bentonite to a depth of 19.8 m.

Three levels of strain gauges were placed within the cage to allow calculation of unit skin friction, one level located below the O-cell assembly and two levels above.

Pile head test arrangement showing reference beam during O-cell bi-directional loading in progress.

Pile Test:
A maximum sustained bi-directional load of 14.6 MN was applied to the pile. At the maximum applied load, the displacements above and below the O-cell assembly were recorded as 5.6 mm and 24.2 mm, respectively. Using these results, a top down equivalent curve was constructed allowing a predicted settlement from the top of the pile of approximately 6.2 mm under the working load of 15 MN. These values were within the load settlement criteria and the pile was successfully incorporated into the structure.

Conclusions:
Bi-directional load testing was performed on a working pile where traditional top down static load testing would have proved to be difficult and expensive. Geotechnical information was obtained to confirm the design parameters used and to give confidence in the pile design.

With a small testing footprint and no surface loading required in soft ground conditions, bi-directional static load testing proved to be the perfect solution to the testing needs on this site.

Source: airport.malpensa.com

www.fugro-loadtest.com

LOADTEST
O-Cell® Technology in Imperia, Northern Italy

Project: **Andora – San Lorenzo, New Railway Project**

Location: Imperia, Italy

Client: RFI Rete Ferroviaria Italiana

Main Contractors: Ferrovial Agroman

Project Description:

Expansion and upgrading of the rail system in North Western Italy is a huge commitment to provide reliable public transport for the future. Construction of new railway line can be a difficult process, overcoming rugged coastline requiring multiple rock tunnels and viaducts across river valleys, simply adds to the challenge.

Nestled between the steep faces of the Maritime Alps and the Mediterranean Sea in North West Italy, is the city of Imperia. The city of Imperia was formed by the joining of the two towns of Porto Maurizio and Oneglia. Now a thriving port and industrial base, the need for direct fast public transport is essential for continued growth.

The winding narrow access roads through the villages of Imperia made the small amount of materials needed for bi-directional testing a positive advantage over other methods of load testing.

Testing of the 2000mm pile at Viadotto Imperia

Ferrovial Agroman have been constructing the new coastal railway section between San Lorenzo and Andora. The project consists of 18.8 km of line with 7 viaducts and 8 tunnels cut through the mountains, 1.4 km of the line is supported on viaducts, the remaining 17.4 km constructed as galleries and tunnels.

Bi-directional load test arrangement:

The testing requirements of the overall project were comprehensive with numerous tests required on piles as small as 1 m and up to 2 m in diameter. Bi-directional load testing was employed on three of the large diameter piles with the highest loads. Two of the auger bored piles were 1.4 m in diameter and bored to lengths of 12 m and 14 m respectively. The third test pile was 2 m in diameter and 24 m in length. All the piles were socketed into the Limestone rock to a length of three diameters. The O-cell arrangements for each pile were placed 0.5 m to 0.7 m from the pile toe.

Testing of the 1400mm pile at Viadotto Prino

Pile Testing:

The 2000 mm pile located at Viadotto Impero, was tested mobilising a maximum load of 12.3 MN in each direction using a single 670 mm O-cell. The second test was an expendable pile beside the working piles at Viadotto Caramagna, and was loaded to 17 MN. The third pile located at Viadotto Prino was loaded to a maximum of 13 MN.

Summary:

Successful testing of the limestone rock sockets on these three piles was achieved. In addition, the loading and unloading behaviour of the piles was required as if loaded in a traditional manner from the pile head and this modeled successfully using the measured components.

Testing of the 1400mm pile at Viadotto Caramagna

Artists impression of new railway track at Imperia

LOADTEST
O-cell® Technology in CFA Piles-Italy

Client:
Piaggio Aero Industries
Foundation Contractors:
Intergeo Perforazioni
Consulting Engineer:
Gianni Togliani

Airport at Villanova D'Albenga

Reinforcing cage, O-cell and instrumentation ready for Installation

Installation of the single O-cell in a 450 mm pile

Test in progress

The first CFA bi-directional pile test in Europe was performed in Villanova D'Albenga, Northern Italy. Although the loads achieved were not record breaking, proving the system could be used for small piles was an achievement Loadtest are very proud of. The installation of the single O-cell within a 450 mm diameter CFA pile was performed with simplicity and ease. The fact that the site is located in Italy, the homeland of the two major CFA equipment suppliers in Europe made the test all the more pleasing.

Project:
Piaggio Aero is building a new state-of-the-art manufacturing facility in Villanova d'Albenga, about 70 kilometers west of Genoa. Designed around the principles of lean manufacturing technologies, this plant will allow Piaggio to significantly increase production capacity, efficiency and optimize workflow. This new facility will position Piaggio Aero to meet the challenges of the market and respond to the demands of future growth.

Piaggio Aero Industries is one of the world's leading aerospace companies. The Company designs, develops, constructs and maintains aircraft, engines and aircraft structural components. Improving technology used in the aero industry is one key role in the activities of the company.

The site is located within the grounds of the airport of Villanova D'Albenga. Opened in 1922, the airport now boasts a runway of 1429 metres long and 45 metres wide. Although quiet and with little traffic during the winter months, the airport becomes a thriving gateway for the Summer visitors to the Italian Riviera. It also serves as a terminal for the export of fresh cut flowers to Italy and across Europe.

Bi-directional load test arrangement:
A single O-cell was chosen for the desired loads of up to 3 MN. To assist installation of the cage, a grout mixture was used for the test pile as it would facilitate insertion of the cage and O-cell assembly. To check that the cementitious mix was suitable, a 'dummy' O-cell arrangement of identical cross section mounted in the same manner in a similar cage was inserted in an adjacent bore.

Once confirmation from the CFA rig electronic instrumentation was obtained, indicating that the construction was satisfactory, insertion of the O-cell cage was carried out. One 230 mm O-cell was welded inside the 10 m CFA cage, 0.5 m above the toe. Two levels of Geokon sister bar strain gauges were positioned along the cage to assist in the determination of the unit skin friction.

Pile Testing:
The test was successfully carried out. Due to small size of the pile, it was not considered necessary to use a reference beam. An alternative arrangement of monitoring the pile head automatically with two independent Leica precision electronic levels was used.

Summary:
Installation and testing of the first bi-directional O-cell test in Europe was successfully achieved.