Project Experience

Bi-directional O-Cell® testing of steel pipe and PHC piles

Fugro LOADTEST has been performing O-Cell® tests of steel pipe and Pre-stressed spun High strength Concrete (PHC) piles providing design verification and optimisation of the full scale foundations and to evaluate their ultimate capacity.

The O-Cell method of testing the foundation capacity of piles is a favoured solution used for foundation tests of steel pipe and driven piles as it provides numerous advantages over traditional loading arrangements. One of the key benefits of using bi-directional testing is the elimination of additional anchor piles or external reaction systems which are challenging and costly to assemble. Also, the centre section of the pile does not need to be concreted.

As the technology for drilled shafts/piles develops and larger loads are demanded from each foundation element, the need to verify these design capacities increases. Loads applied using the O-Cell method can reach levels greater and in a safer way than by traditional technics. The O-Cell method can also be used to evaluate upward friction directly.

The following examples are just a small selection of some tests that have successfully used the O-Cell technology to test steel pipes and PHC piles which have been either grouted or concreted into a rock socket or pushed out with the placement of the O-Cell assembly at the bottom of the test pile using either an additional length of reaction pile below the test pile or directly at the base if the end bearing is sufficient as described by *England, M. (2012) "On the subject of piles in tension", Geotechnical Special Publication, GSP 227 Full-Scale Testing and Foundation Design, honours Bengt H. Fellenius ed. Hussein M., Massarsch K., Rainer K., Likins G., Holtz D. pp 680–693.*

Saint Brieuc Wind Farm - France

This project was the validation of the design for 62 offshore wind turbines, 20 km offshore and spread over an area of 75 km^2 in the English Channel off the Northwest coast of Brittany which became one of the biggest commercial-scale offshore wind farms in the world.
To obtain the necessary geotechnical information to support the extremely sensitive designs for this project, 14 steel pipe test piles were drilled, grouted into very hard bedrock, a red sandstone formation which is expected in parts of the offshore windfarm area.
The test piles were installed on land at the Routin Quarry near Cap Fréhel, Brittany. Nine of the larger piles were load tested bi-directionally with O-Cells up to 40MN. An additional requirement was for extensive rapid cyclic loading requiring in excess of 1000 cycles to simulate and assess both wave and wind loadings effects.

Arabianesirakentaminen - Finland

Due to reclamation of the coastal area using a variety of fill material over unstable glacial deposits, the area of Arabia in Helsinki suffers from continuous settlement. Since the pile design relies solely on end bearing, with significant consolidation, ensuring long term suitability of the pile base capacity was the goal of this static load testing program.
Taking into consideration all the challenges, the use of the O-Cell methodology was clearly the best option as it allowed the test piles to be tested several times without disturbing developments on site.
Two 530 mm driven cast in situ piles were installed with 330 mm O-Cell assemblies at the base of the elements. After the initial loading tests the piles were retested 6 months later from a different ground elevation to determine any changes in performance over time and evaluate any downdrag from the consolidating reclaimed land.

FUGRO LOADTEST®

Sommerset – on shore full scale load test (UK)

As part of a temporary aggregate landing jetty. An initial design required a preliminary load test to verify the anticipated geotechnical parameters. This was carried out on land on a smaller diameter test pile loaded to 35 MN to verify the design for the nearshore piles.

The sub-surface stratigraphy at the general location of the test pile and for the jetty is reported to consist of weathered mudstone becoming more intact with depth.

The loading assembly consisted of one 530 mm diameter O-Cell capable of providing a gross load of 20 MN in each direction at rated capacities. The O-Cell was located 5.98 m above the bottom of the bore at an elevation of -12.49 m CD mounted on a cruciform to engage the full cross section of the end bearing and ensure the elevation of the loading arrangement was as designed.

Sommerset offshore proof load tests (UK)

After completion of the preliminary test on shore – in the foreground of the photo, and verification of the design parameters, the working test piles could be constructed over water.

The Jack up barge and piling rig are shown in the photo in the distance over water from where a 29.56 m long pipe working test pile was constructed with a grouted length of 10.49 m into mudstone with the remaining steel test pile freestanding above.

The bore length was extended below the O-Cell arrangement to include an additional length of reaction pile section beneath the compression test pile proper.

In addition, a fully instrumented full-scale lateral loading test between two of the pipe piles was also carried out over water with purpose-built loading arrangements fitted to the pile heads.

Bridge inner harbour – Copenhagen, Denmark

A new Inner harbour bridge to enhance the links around the various sectors of the Copenhagen port was constructed.

The sub surface stratigraphy at the pile location consisted of sand, sandy silt, sandy clay, clay, upper limestone and lower limestone.

The 1000 mm test pile excavation was constructed to a depth of 17.5 m of which 10.5 m was below the seabed, the steel tube was inserted into the excavation and concreted into place with the top of the steel pile and concrete at approximately 3.0 m below water.

A 510 mm O-Cell was used and all instruments, telltales and top of pile connections were brought to above the water level and tested with a reference beam cantilevered off the adjacent wharf. The test pile was completely submerged and tested this way.

Curtis Island, Gladstone, Queensland, Australia

Two 1500 mm diameter tubular steel piles driven to depths of up to 35 m below sea level were load tested using O-Cell bi-directional maintained load test push out method as an alternative safer and more cost effective than setting up a reaction system at the pile head.

The tests were carried out on preliminary piles ahead of the installation of production piles for the Jetty construction to characterise the soil parameters for the foundation design. Soil conditions comprised soft alluvial soils overlying a Mudstone bedrock stratum.

Upon driving each steel test pile casing, soil was excavated to below casing toe level for construction of the concrete reaction pile and tension socket (tension pile only). The O-Cell loading assemblies were fixed to the reinforcing cages before being lowered into the test piles and concreted.

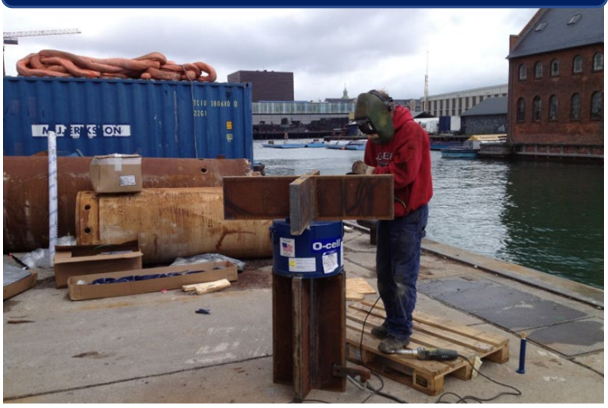
Terminal Oceânico in Barra do Dande, Angola

Due to uncertainties from the results of soil investigations in the mooring areas, four push-out pile load tests were conducted with the O-Cell methodology to validate and optimise the design of the foundation piles.
The 700 mm diameter cased bored piles, ranging from 31 to 43 metres in length, were built over water and tested using the bi-directional full scale loading method.
Based on the client's high load requirements and pile dimensions a single O-Cell assembly was located at the bottom of each test pile length. This allowed the upwards load to be directly and precisely measured in the pile section desired.
To have sufficient reaction below the O-Cell required the construction of an additional reaction pile length below the O-Cell.

Combwich Wharf – UK

The Combwich Wharf infrastructure in the Southeast of England was subject to significant refurbishment and modernisation. The project created a new berth hardstanding that allows vessels to be unloaded when the tide is out.
To obtain geotechnical information for this sensitive project two tubular piles grouted into Mudstone rock socket were tested using the O-Cell methodology. Both piles were constructed by installation of 711 mm diameter steel pipe piles inside a 1070 mm excavation.
An additional length below the test piles was constructed to allow sufficient reaction to be available to push the full length of the steel test pile upwards.
A single O-Cell was used in each test to apply approximately 7 MN upwards directly on the steel pipe pile to evaluate the skin friction.

Christians-havns Kanal Bridge, Denmark



To enhance the links around the various sectors of the Copenhagen port a canal bridge was constructed. It is an opening bridge type for cyclists and pedestrians connecting the inner harbour to Christianshavn.
Two 980 mm steel piles were tested concreted into limestone sockets:
One preliminary raking pile at an inclination of 1:8 was tested with a 430 mm O-Cell at a depth of 21.5 m of which over 16 m was below the seabed, with the top of the steel pile approximately 3.0 m below water.
The test pile was fully instrumented and completely submerged with the required connections brought to above the water level.
A second raking test pile at an inclination of 1:6 and a vertical 500 mm bored pile of a depth of 17.5 m were proof tested from ground level with 230 mm O-Cells.

PHD driven piles in Busan, Korea

O-cell tests have been carried out on 600 mm diameter Pre-stressed spun High strength Concrete (PHC) driven piles on several projects.
Although not a steel driven pile, the same method is easily applicable to PHC piles.
These precast segmental circular piles are initially driven to the required depth or set with a specially designed driving shoe attachment at the tip.
A reinforcing cage or carrying frame was inserted into the hollow internal section of the PHC pile and then deployed on the expendable shoe which is concreted into place to create a single composite pile.
Several tests on PHC driven piles driven to depths of 30 m to 34 m were loaded to over 3.6 MN using a 330 mm O-cell with a loading capacity of 3.8 MN were utilized.