FUGRO LOADTEST
Osterberg Cell Technology in Lagos, Nigeria

LAGOS

The port city of Lagos is the second fastest growing city in Africa and the seventh fastest in the World with almost 14 m residents. Protected by sand spits from the ravages of the Atlantic Ocean, Lagos metropolitan area is made up primarily of islands separated by creeks. The geological formation of these islands has resulted in a complex soil profile with layered strata of sands and clays. The load bearing capabilities of these layers are not well understood making pile testing and research an important part of the total construction program for optimizing foundation design and for the expansion of Lagos.

Lagos

BANK OF NIGERIA

The first bi-directional load test project undertaken was in the financial district for the reconstruction of the office buildings for the Central Bank of Nigeria in Lagos. Construction of the 19 floor, 100 m tall building was undertaken by Julius Berger Nigeria Plc.

Two 1500 mm test piles were installed in soils consisting of layers of stiff clays and sands. The first test was 50 metres deep with the single 510 mm O-cell placed one metre from the toe of the pile in dense sand. The pile was constructed using full length temporary casing and excavation by grab. The second test would be identical but with a pile length of only 40 m.

Central Bank of Nigeria Artist rendering

The testing program involved testing the piles with an additional reaction system at the pile head to take the load should the pile friction be mobilized upwards and ensure that sufficient reaction would be available to test the end bearing. Anchors were constructed around the test piles to hold the reaction beams. Prior to testing, a small load of 100 kN was applied by the jacks to ensure contact between the pile head and reaction system. To assist with the load distribution analysis, 5 levels of strain gauges were placed along the pile shaft. A single O-cell of 510 mm diameter would provide a maximum loading of 20 MN and no additional reaction at the pile head was mobilised.

Pile head with additional reaction beam

ROSE OF SHARON TOWERS

The Rose of Sharon Towers project, overlooking the Kuramo Waters, was the location for two multi-level bi-directional test piles. Placing two levels of two 510 mm O-cells provided the opportunity to test isolated sections of the complex soil strata, potentially giving a maximum combined pile loading of 60 MN. During the testing a maximum sustained combined bi-directional load of 18 MN was achieved on the first test pile and 11 MN on the second test pile. Analysis of the data would indicate that the soil load bearing capacities were lower than predicted.

Multi-level O-cell cage ready for installation

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PALAVA YARD RESEARCH PROGRAM

Although load testing had been performed on similar soils previously, the effect on the load bearing capability of different pile installation techniques had not yet been investigated. A complex testing program was undertaken by Bilfinger Berger Spezialtiefbau GmbH in conjunction with Julius Berger, Nigeria in an attempt to better understand the geotechnical properties of the soils and to compare pile construction techniques and their effect on the load settlement characteristics.

`Kugelgrab' and casing excavation

Testing Program

Three dedicated piles were constructed for load testing using O-cell bi-directional methods. Two piles were constructed using the 'Kugelgrab' drop grab and casing method and were fully cased to the toe using an oscillator, one of which was base and shaft grouted prior to testing. A third pile was constructed with casing only in the top section of the pile. All three piles were constructed in close proximity to have approximately the same soil profile and were constructed to the same diameter and length.

The tests were performed as multi-level tests with two levels of O-cells each consisting of 2 x 510 mm O-cells. Each pile was tested dynamically after the full scale Osterberg static test for comparison of results.

An additional pile was constructed shorter than the other three for dynamic load testing purposes to give a comparison of the response of the pile section down to the upper O-cell assembly. The use of Geokon 3911 full bridge strain gauges rather than the conventional 4911 vibrating wire type allowed the gauges to be monitored both during the O-cell testing and the subsequent dynamic load testing to assess load distribution.

Pile reinforcing cage for TP02, with O-cell and grout pipes, being installed

Conclusions

The testing program gave Julius Berger a much better understanding of the load – settlement behaviour of piles founded in the stratified sand and clay layers present in this region of Lagos and the benefits and advantages to the various construction methods used.

All four test piles in view

NESTOIL PROJECT

Nestoil PLC has grown over the past few years to become the leading Nigerian Engineering, Procurement and Construction (EPC) provider for major International Oil Companies in Sub-Saharan Africa, boasting clients such as Nigerian National Petroleum Company (NNPC) Shell, Exxon Mobil, Chevron and Total. The Nestoil project is providing much needed new office space.

A multi-level test using two 510 mm O-cells was undertaken. This provided another opportunity to test isolated sections of the complex soil strata. A maximum sustained combined bi-directional load of 18MN was applied to the pile shaft. The inclusion of strain gauges along the pile shaft allows the load distribution to be ascertained.

Cage preparation at Julius Berger steel yard