Project Experience

Bi-directional O-Cell® testing of Skyscraper Foundations

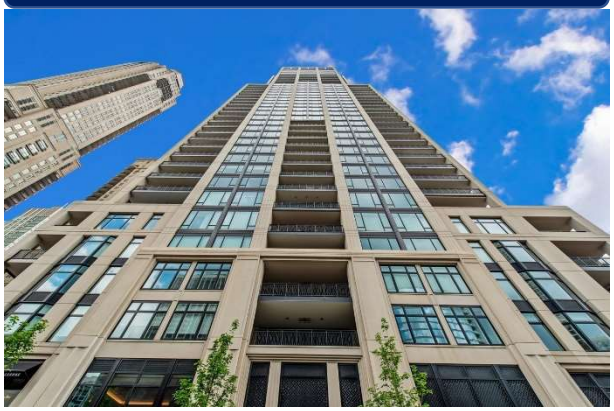
Fugro LOADTEST have been performing O-Cell® tests for Skyscraper foundations for more than 30 years and participated directly in some of most challenging projects globally. From the tallest buildings in the world to the most iconic and innovative structures, Fugro Loadtest has always been there to deliver the most professional and accurate geotechnical data.

The O-Cell method for full static load testing of the foundation capacity of piles used for skyscraper foundations provides numerous advantages over traditional top-down loading arrangements. A key benefit of using bi-directional testing is the elimination of additional anchor piles or external reaction systems.

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 often exceed 50 MN and can be applied directly to the stratum of interest, even on shafts deeper than 100 meters.

The following examples are just a small selection of some of the world class skyscrapers that have successfully used our O-Cell technology to test the foundation elements.

No. 9 Walton – USA



The 151 metres tall building offers ultra-luxury accommodation in the city of Chicago, with penthouses costing $23 million.
On a 25 by 55 metre construction site the space to execute any kind of construction activity was very limited and unreasonable to install enormous reaction frames for traditional pile testing. Therefore, the use of the O-Cell bi-directional testing was the natural choice.
To provide the necessary information, a traditional O-Cell assembly was placed at the pile tip with a reduced diameter circular bottom plate, as compared to the shaft diameter, allowing the confirmation of much higher end bearing values.
The O-Cell method proved to be an invaluable tool for foundation optimization for No.9 Walton, given the site constraints and large required test loads.

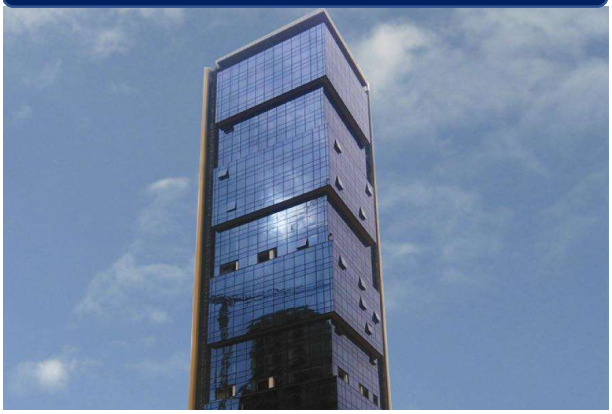
The Spire London – United Kingdom

Spire London, a 67-storey tower of 861 Suites, one, two and three bedroom apartments and Penthouses, set in landscaped open space on West India Quay by London's Canary Wharf. At 235 metre high, it is the tallest in Western Europe and a new landmark on the city skyline.
Fugro Loadtest was commissioned to test two preliminary 58 m piles into Chalk. With such a tall building on a limited number of piles, the design working loads were higher than normally expected for a structure in London (35 MN). With the use of the O-Cell methodology the 2100 mm diameter piles were tested to more than 100 MN, setting the new UK record for the highest test load mobilized in a pile.
The results were analysed using the Cemsolve® pile settlement analysis program to determine the foundation behaviour and confirm the design parameters.

Flame Towers - Azerbaijan

The Flame Towers, in Baku, are a marvellous architectonical construction that accommodates residential apartments, a hotel and offices. The building represented the elements of fire (particularly when illuminated at night) that is directly connected with the city and country. Building such a project on the hills above this city was a huge challenge and since no project of this proportion has been undertaken at this location previously the geotechnical properties of the soils in this area were not well known.
In order to prove the foundation design, bi-directional load testing was requested by the geotechnical consultant. Three preliminary 45 m long, 1200 mm diameter test piles were constructed and tested with the O-Cell methodology. All the tests provided the necessary geotechnical information to the client, allowing an optimization of the design.

Kilamba Tower - Angola



The 107 metre tall building in Luanda, one of the most expensive cities in the world. The tower was designed for mixed use offices and commercial activities.
Due to the importance of the project, the necessity to obtain geotechnical information and the small working area required for the tests, Fugro Loadtest was contacted.
O-Cell tests were performed on 4 x 30 m long, 1 m diameter test piles at this site. Two initial preliminary test piles and two working test piles were constructed. A pair of 330 mm O-Cells were installed in each test pile to provide a gross maximum loading potential of 15 MN. Working piles we grouted post test to reinstate their structural integrity.

Four Seasons Centre - Malaysia

Situated adjacent to the world-famous Petronas Towers, the Four Seasons Centre is another landmark to hit the skyline of Kuala Lumpur. Fugro Loadtest was engaged by the foundation contractor to carry out two full scale multi-level O-Cell bi-directional load tests.
The two test piles were provided with two 22 MN and two 27 MN capacity O-Cell assemblies respectively with total gross test load potential of 66 MN and 81 MN. The multi-level method allows for discrete sections of the soil to be isolated to determine the geotechnical behaviour as well as allowing for full length pile behaviour to be determined.
O-Cell multi-level technique was an excellent solution by revealing the near ultimate capacity of each of the pile sections (upper, mid and lower sections) allowing the geotechnical design to be optimized.

Lakhta Tower - Russia

Standing 462 meters tall the Lakhta Tower, in St. Petersburg, is the tallest building in Europe and an amazing structure.
To support such a huge structure a detailed geotechnical investigation of the area was required. The 85 metre deep bored piles were founded in the Vendian Clay deposits and since no previous piles of this length had been placed in these soils previously full scale static load testing was required. Fugro Loadtest was requested to test four 2000 mm diameter piles with multi-level O-Cell methodology.
By opting for the O-Cell methodology the client's complex testing programme of maintaining the load on the piles for 5 months was easily accomplished. The quality data acquired proved to be paramount to proving the geotechnical design for the project.

Elbtower - Germany

The Elbtower will be a futuristic 145 metre tall building that will be part of Hamburg's skyline.
For this German skyscraper several of the longest bored piles in Europe were constructed to a depth of 111 metres. In total four 1850 mm diameter preliminary piles were tested using the O-Cell methodology. SONICaliper technology was used to access the shaft geometry and verticality and Thermal Integrity Profiling used to access the structural integrity and geometry of the constructed piles.
The test piles were also fitted with vibrating wire strain gauges and fibre-optic sensors to determine the friction distribution.
The comprehensive testing programme provided by Fugro Loadtest, provided the required data to support the design of safe and cost effective foundations for the project.

Marina Bay Sands - Singapore

One of the most iconic buildings in the world was a construction challenge in proportions to its beauty.
With such a prestigious project and an extremely tight piling works program, the foundation contractor engaged Fugro Loadtest to carry out a working pile load test program using the O-Cell methodology. A total of six working piles and one working barrette were tested. Beside the high-test loads, another important consideration for using the O-Cell methodology was the depth of cut off level below the existing piling platform level (between 13 and 25 m deep).
Bi-directional test loads of 22.0 MN to 54.0 MN were applied to piles and since all the test piles were intended to carry structural loading, the O-cells and the annular void created by the test were grouted to reinstate the structural continuity and integrity.

The One – Canada

Located in thriving downtown Toronto, The One, a new multiutility 306 m skyscraper will fill the skyline as the tallest building in Canada.
For this project Fugro Loadtest was contacted to provide a complete test programme for a constructed 43 metre, 1500 mm diameter, pile 6.8 metre into the rock socket. By using the O-Cell methodology the test arrangement was designed to directly loaded at the bottom of the rock socket on a smaller area of 1000 mm.
Arranging the test in this manner allowed confirmation that the unit end bearing was over 3 times that used in the initial design without having to wait for high concrete strength during curing. This design calibration by testing 11 days after installation allowed a significant foundation optimization providing substantial cost savings.

World One & World Crest Towers – India

World One is the iconic masterpiece of a residential tower, shopping mall and office building development in Mumbai.
The involvement of Fugro Loadtest was initially on the World One Tower where two preliminary 1200 mm diameter piles were tested in advance of the construction of the production piles in weathered but very competent Tuff bedrock.
For the World Crest Tower, the design of the foundation piles followed that of the World One Tower as the ground condition were similar.
As the two verification proof load tests were on working piles, intended to carry structural loading once integrated into the structure, the O-Cells and the annular void created as a result of the expansion of the O-Cell were grouted to restore the structural integrity and continuity.

The Biltmore Hotel - Georgia

The Biltmore Tbilisi Hotel is the first glass 130 metre tall skyscraper in Georgia and the highest hotel in the Caucasus Region. Offering astonishing views, it is ideally situated within the historical and cultural district of Georgia's capital city.
The load testing program as specified by consultants from the Lenavi Institution required test one pile to be tested with O-Cell.
The preliminary pile test was performed on a 1.5 metre diameter, 26.5 metre long and socketed into hard weathered sandstone. The pile was programmed to be tested to a gross bi-directional maximum load of 10 MN in each direction using a single 530 mm O-cell placed 3 metres above the toe of the pile. During testing, the movements at the maximum required load were small allowing the load to be increased and a total load of 22.4 MN was mobilised.

Light-house Tower - Denmark

The Light-house Tower in Aarhus will be Denmark's tallest residential tower with a height of 143 m. To verify and improve the geotechnical design, two preliminary test piles were required.
The piles were 1860 mm and 2000 mm diameter and 70 m long. Top of concrete was left at the design cut-off level of 7.4 m below platform level thus negating the requirement of testing overburden and removing the values from the results or the use of a complicated double sleeve system to minimise the friction in this zone. The loading arrangement comprised two 690 mm O-Cells capable of providing a total gross test load of more than 70 MN.
To evaluate any long term consolidation the pile test load was maintained constant for 30 days while all aspects of the instrumentation were monitored continuously and controlled remotely with minimal personnel attendance.

Jeddah Tower, KSA

Set to be the World's tallest tower at 1000 m, in Jeddah, Kingdom of Saudi Arabia. The preliminary test results from the six multi-level O-Cell tests, during phase 1 & 2 of the project, allowed the unit friction and end bearing to be assessed in the siltstone and sandstone deposits for the most efficient foundation solution.
Three working test piles were installed to 48 m depth and one installed at 108 m depth. The excavation for each O-Cell test piles was calipered for diameter, shape, profile and verticality after final clean-out using the SONICALIPER.
The four O-Cell proof tests were performed successfully at the required test load of 75 MN and the O-cells were grouted after testing to restore the structural integrity and for incorporation into the structure.

Moscow International Business Center - Russia

The Moskva-City (also known as the Moscow International Business Center) Project is a development close to the heart of Moscow. This new international business centre consists of offices, hotels, retail and residential development.
These large high-rise projects have required foundations into the Suvorov Limestone through the Voskrensky clay. Since the behaviour of the Limestone was relatively unknown, pile tests were recommended to verify the foundation designs. Bi-directional testing using O-cells was employed to verify rock socket behaviour. Tests were performed on piles of diameters between 900 mm and 1500 mm, located on numerous separate plots, mobilising total capacities more than 60 MN.