FUGRO
BI-DIRECTIONAL O-CELL® TESTING

The O-Cell test provides full scale static load testing of deep foundations in a safe and cost-effective manner.

THE OSTERBERG CELL®

Dr. Jorj O. Osterberg, Professor Emeritus of Civil Engineering at Northwestern University (USA), invented and developed a deep foundation load testing device to meet the construction industry's need for an innovative effective method of testing high capacity drilled shafts, piles and barrettes.

Professor Osterberg's invention, the Osterberg Cell, or O-Cell, has radically changed the way foundation load tests are designed, performed and interpreted.

No longer do engineers need to rely on small, scaled down test piles due to the expense of traditional load tests on large diameter piles.

Testing full-size production piles can eliminate non-conservative scaling errors even if loads exceed 300 MN.

The O-Cell is a purpose built, hydraulically driven, calibrated, sacrificial jacking device installed within the foundation unit. By virtue of its installation within the foundation member, the O-Cell load test is not restricted by the limits of overhead structural beams and tie-down piles or anchors.

Instead, the O-Cell derives all reaction from the soil. Each test is balanced so that end bearing and lower side shear provide equal reaction for the upper side shear portion of the O-Cell load test and specific elements can be isolated by use of multi-level techniques.

Installation of reinforcement with O-Cell arrangement

Load testing with the O-Cell continues until one of three things occur: ultimate bearing capacity upwards or downwards is reached, or the maximum O-Cell capacity or expansion is achieved. Each O-Cell is specially instrumented to allow for direct measurement of the cell's expansion. By also measuring the top of shaft movement and compression, the downward movement is determined.

O-Cells range in capacity from 0.4 MN to 27 MN. By using one or multiple O-Cells on a single horizontal plane, the available test capacity can be increased to more than 250 MN. By utilizing multiple cells on different planes, distinct elements within a shaft or pile can be isolated for testing.

The O-Cell load test method has elevated the application of deep foundation load testing, from expensive, time-consuming, small-scale field tests, to state-of-the-art, efficient, full scale static load testing of both dedicated and production shafts and piles.

Patents US 7,353,714; US 2,006,021,446; US 8,443,677; US 8,511,176;

O-CELL ADVANTAGES

- Design: provides quality geotechnical parameter evaluation, allowing foundation redesign, optimization and value engineering.
- High test load capacities: test loads exceed 10 MN on a routine basis.
- Reduced work area: required work area (overhead and laterally) is greatly reduced compared to any other static load testing systems. Testing has been performed inside buildings, under overpasses, in narrow highway median strips, in low headroom conditions, both on land and offshore.
- Time: testing can be performed once concrete has reached suitable strength (which typically takes 7-14 days from pile installation).
- Improved safety: no reaction system is required at ground level and the test energy is safely buried well below ground.
- Rock sockets: high test loads can be applied directly on deeply buried rock or soil formations without load shedding in overlaying soils, which eliminates the need for de-bonding techniques.
- Deep cut-off levels: O-Cell tests can be performed with the top of concrete far below ground, eliminating the need for pile extensions to ground level, pile head preparations or provision for zones of reduced shear.
- Piles with plunged columns: where steel columns have been cast in the top of the pile, these often interfere with top-down testing techniques, and the O-Cell testing method is likely to be the only cost-effective way of performing full scale static load tests.
- Accuracy: No anchors, reaction piles or reaction mass is required. The influences, in terms of modified test pile performance, resulting from the construction and use of anchors, reaction piles or a reaction mass required in top-down static testing, are eliminated.
- Economy: The O-Cell method becomes more economical as loads increase, unlike traditional top-down static tests.
- Shear / end bearing components: the O-Cell test is designed to separate the test pile into two or three pile sections; thus automatically measuring the reaction of each component.

- Automation / static creep effects: The O-Cell test is a static maintained load test and uses automatic data acquisition maintenance for accurate, efficient data processing and creep measurements.
- Production / working piles: post-test grouting techniques allow for testing of production pile/shafts and barrettes for their integration into the structure.
- Performance: The subsequent performance of O-Cell tested production piles will be similar to the non-tested production piles due to the lower amount of generated residual stresses in the pile, as compared to applying full test loads "top-down".
- Offshore: The O-Cell test method particularly excels in offshore testing environments due to its convenience and numerous advantages listed above. Tests have been performed with piles completely submerged under water.
- Foundation behaviour analysis: numerous advanced analysis techniques including Cemset®/ Cemsolve® & Timeset® enhance the interpretation of the pile behaviour.
- Industry expertise: all genuine O-Cell tests come with planning, installation, testing, analysis and reporting services performed by the world's leading experts in static load testing of deep foundations.

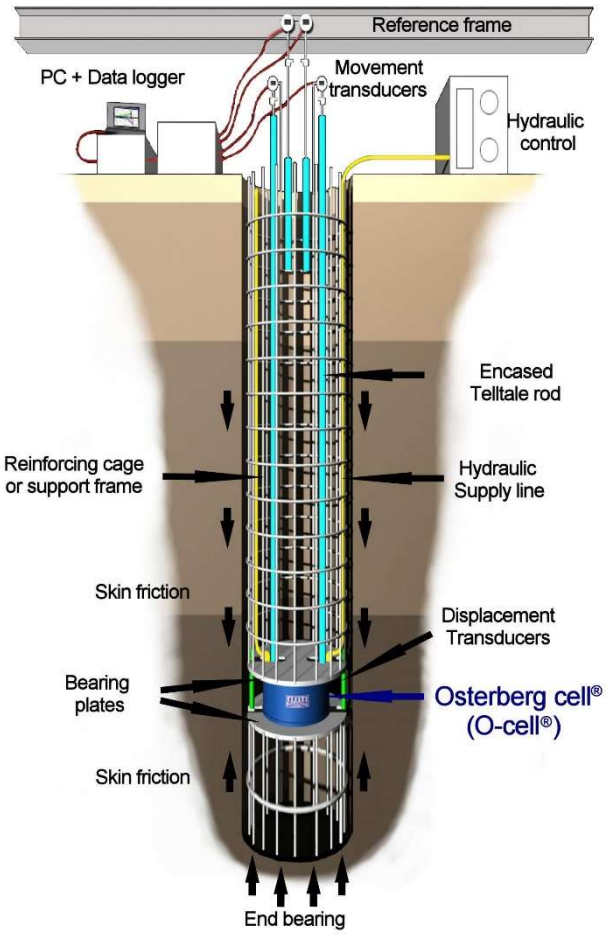
TEST RESULTS

Since the end bearing and the upward shear resistance are measured independently, there is no guesswork in establishing how much load was carried by each component.

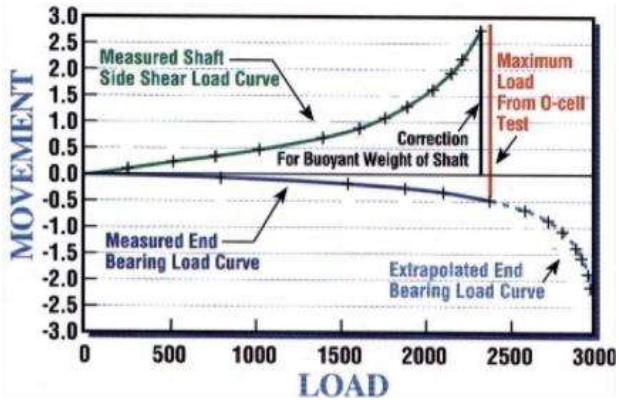
Testing is typically performed until the ultimate capacity in either shear upwards or shear and end bearing downwards is reached, so the maximum load can be applied.

The addition of strain gauges within the shaft/pile can help in determining the distribution of load throughout the shaft length.

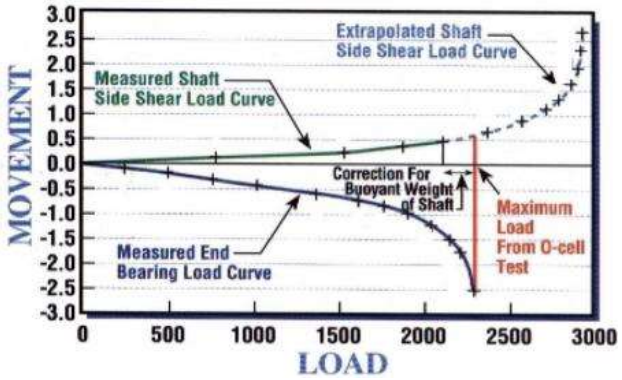
The equivalent top load movement curve is determined using several well developed proprietary methods of analysis to determine the pile behaviour under load. This has resulted in numerous commissions as expert witness and consultancy.



Schematic of an O-Cell installation



A typical bi-directional load test where the ultimate side shear capacity was reached



A typical bi-directional load test where the ultimate end bearing capacity was reached

SUCCESSFUL BI-DIRECTIONAL LOAD TESTING WORLDWIDE

More than 5000 O-Cell load tests have been performed in over 68 countries, each expanding on Fugro Loadtest's unmatched record of success. O-Cell tests are fully compliant with the ASTM D8169/D8169M-18 specification, EN ISO 22477-1-E and ICE specification for Piling and Embedded Retaining Walls (Third edition).

Drilled shafts

The O-Cell can be used in drilled shafts or bored piles either attached to the reinforcing steel cage or placed using a steel beam carrier frame. Multiple O-Cells can be used in the same shaft, either in the same plane to increase the available test capacity or in multiple levels to isolate distinct soil or rock strata.

Driven piles

Load testing can be performed on steel pipe piles, pre-cast concrete piles, battered /raking piles and cylinder piles. For driven piles, a rugged design has ensured that even O-Cells driven to refusal conditions of 80 blows/100 mm perform flawlessly.

Rock sockets

Steel tube piles installed using drill drive drill systems or grouted into rock sockets can be tested successfully using the O-Cell technique.

CFA/Auger cast piles

O-Cells can be inserted into the fresh concrete/grout immediately after drilling to depths in excess of 50 m.

Slurry walls / barrettes

Multiple O-Cells have been placed in panel Sections efficiently at depths beyond 95 m and in multilevel configurations mobilizing more than 360 MN.

Additional Services

Traditional top-down load testing: Using completely automated hydraulic control and data recording systems, where the safe progress of the test can be supervised by remote control and comprehensive instrumentation.

Thermal integrity profiling

Integrity of the cast concrete is evaluated by monitoring the manner in which it hydrates in time.

Lateral load testing

Lateral testing of soil and rock formations for modulus determinations can be performed with O-Cells modified for placement within a single shaft or pile. Fugro also conducts traditional lateral load tests with or without simultaneous axial loading.

Crosshole sonic logging (CSL)

Fugro provides complete CSL testing services and expert interpretation/ consultancy.

Borehole calipering

SONICALIPER® provides a full high resolution 3-D image of bored shaft excavations.

Low and high strain tests

Pile driving analysis, dynamic load tests and integrity tests.

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