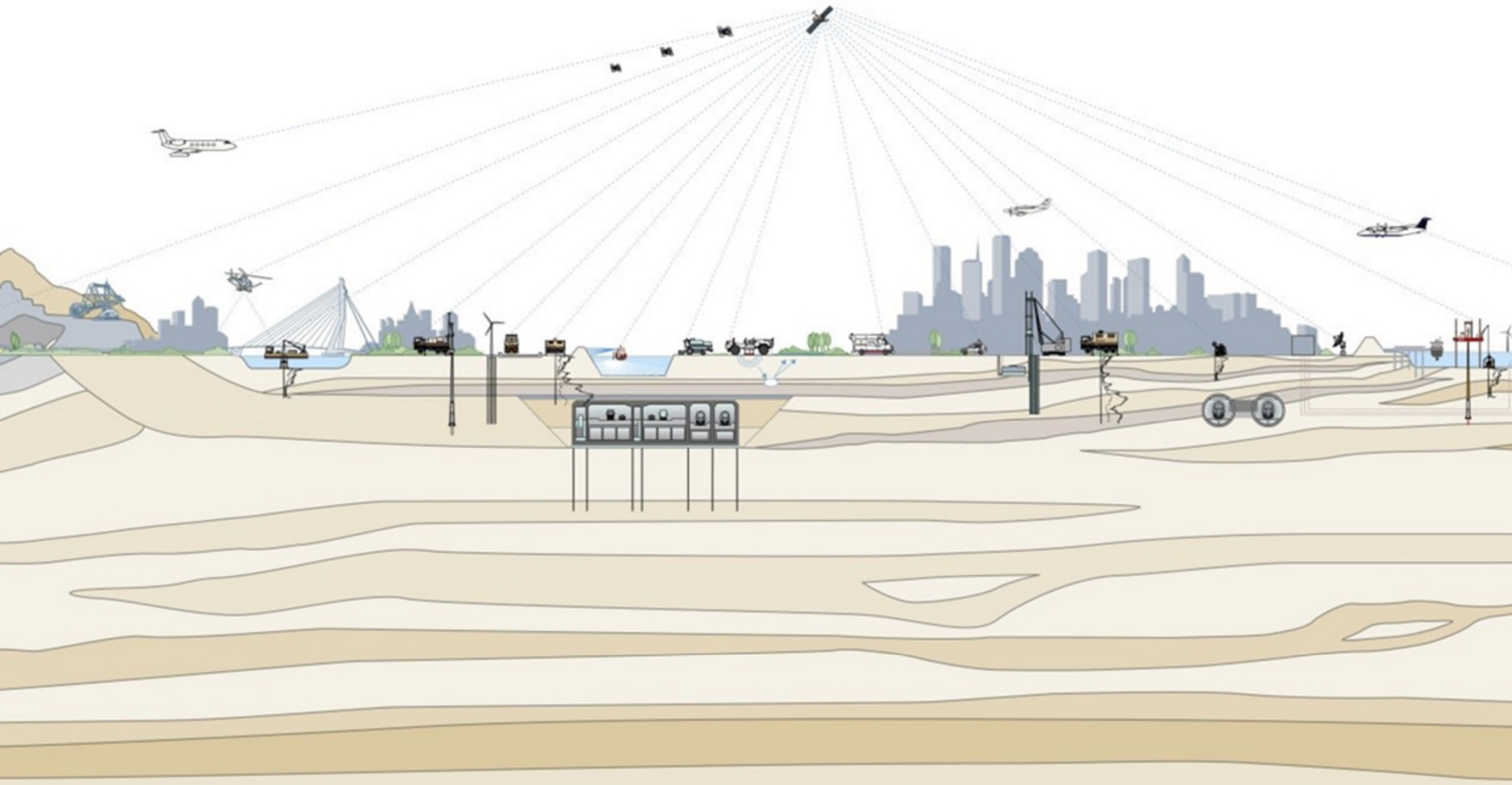


ILLUSTRATED GUIDE TO O-CELL® TESTING

Fugro Loadtest

Europe & Africa:

Fugro NL Land B.V.
Veurse Achterweg 10,
P.O. Box 63, 2260 AB Leidschendam,
The Netherlands
Phone: +31703111333
Mobile: +31622934237

United Kingdom:

Fugro GeoServices Limited
(Registration number 1284352)
Registered Office: Fugro House,
Hithercroft Road, Wallingford,
Oxfordshire, OX10 9RB, UK
Phone: +44 (0) 1932 784807

Americas:

Fugro USA Land Inc.
2631-D NW 41st St
Gainesville, FL 32606, USA
Phone: +1 352 378 3717

Middle East & India:

Fugro Geotech (India) Pvt. Ltd.
P.O. Box 100706, Mumbai, India.
Phone: +(91) 22 61989500

Central and South East Europe:

Fugro Consult Kft.
Kelenfoldi utca 2
Budapest, 1115 Hungary
Phone: +36 1 382 0042

Asia:

Fugro Singapore Land Pte. Ltd.
29 Loyang Crescent
Singapore 509015
Phone: + 65 6861 0878

E-mail: loadtest@fugro.com

Internet: www.fugro-loadtest.com

DEEP FOUNDATION TESTING, EQUIPMENT & SERVICES • SPECIALIZING IN OSTERBERG CELL (O-Cell®) TECHNOLOGY

INTRODUCTION

This illustrated guide is intended of describe the different phases and activities that constitute a full scale bi-directional static load test using the Osterberg methodology. This guide also illustrates numerous variations and adaptions to meet specific project requirements.

Items to be provided by		
Phase	**Client**	**Fugro Loadtest**
Test Design	• Geotechnical Information • Pile/barrette characteristics • Additional instrumentation requirements • Loading requirements • Reinforcement drawings • HSE requirements	• Method Statement • Bearing plates drawings • Pipework schedule • Cemset® design verification
Assembly	• Reinforcement steel cage(s) • Bearing plates • Welding personnel • Welding equipment • Hand tools • ½" steel pipes and connectors • Steel rebars • Lifting equipment (e.g. crane)	• Osterberg Cell(s) • Hydraulic hoses • Instrumentation (LVWDT, SG, etc.) • Hand tools • Consumables
Install	• Pulleys • Rope • Grease • Metal cutting tool • Lifting equipment (e.g. crane) • Hand tools	• Hand tools • Consumables
Testing	• Reference beam and supports • Test cabin • Stable 220/120 V power supply • Compressor (min. 8 bar) and hose • Car battery • Tent/shelter • Surveyor's level tripod • Clean Water (min. 100 litres) • Suitable lighting	• Test instrumentation • Surveyor's electronic level (e.g. Leica) • Hydraulic pumps • Telltale rods
Reporting	• Concrete results	• Preliminary field report • Final report

Pile/barrette and geological Information

Stratum	Type	Unit weight γ / γ' [kN/m³]	Drained shear strength φ' [°]	Drained shear strength c' [kN/m²]	Undrained shear strength c_u [kN/m²]	Oedmoetric modulus E_s [MN/m²]
A	Loose to medium dense SAND to silty sand.	16 / 8.5	30 to 32.5	-	-	7 to 14
B	Soft to medium stiff sandy, clayey SILT, interlayered with very soft organic clay (peat).	18 / 9.5 (15 / 5)*	25 to 30 (12.5 to 17.5)*	5 to 10 (2 to 4)*	20 to 40 (10 to 25)*	3 to 8 (0.5 to 2)*
C1	Medium dense to dense SAND to silty sand, locally interlayered with gravelly sand.	16 / 10.5	32.5 to 35	-	-	15 to 30
D	Very soft to soft organic CLAY (peat), lean and fat clay (mud).	15 / 5	12.5 to 17.5	2 to 4	10 to 25	0.5 to 2
E	Medium stiff sandy, clayey SILT interlayered with medium dense sand.	18 / 9.5 (18 / 10)**	27.5 to 30 (30 to 35)*	2 to 5 (-)**	40 to 60 (-)**	8 to 12 (60 to 100)**
F	Very dense SAND.	19 / 11	32.5 to 37.5	-	-	90 to 160

Stratum	Type	Bored piles: Characteristic shaft friction $q_{s;k}$ [kPa]	Bored piles: Characteristic base resistance $q_{b;k}$ [kPa]
A	Loose to medium dense SAND to silty sand.	25	-
B	Soft to medium stiff sandy, clayey SILT, interlayered with very soft organic clay (peat).	10	-
C1	Medium dense to dense SAND to silty sand, locally interlayered with gravelly sand.	80	-
D	Very soft to soft organic CLAY (peat), lean and fat clay (mud).	5	-
E	Medium stiff sandy, clayey SILT interlayered with medium dense sand to silty sand.	20	320
F	Very dense SAND.	95	3,000

To ensure the success of the testing, Fugro will assist at all stages, recommending and assisting with the development of the most reliable and successful test program to reveal the required information.

It is important to define if the test will be executed on preliminary or working piles, the maximum test load to be applied and if a conventional bi-directional loading test is required or a push-out test.

Key to the test success is to define the elevation of the O-Cell assembly.

The maximum test load will be obtained at the balance point, where the upward mobilised skin friction is equal to the mobilised downward skin friction and end bearing. No safety factors or limiting values should be used in this assessment.

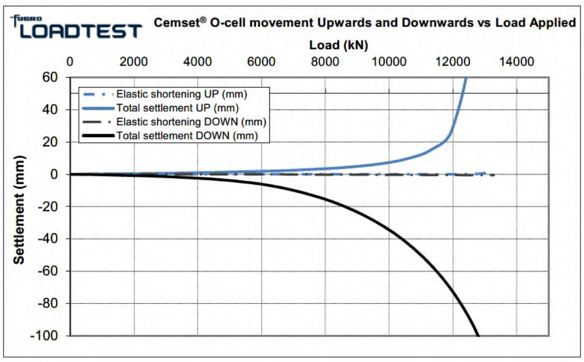
The client may wish to define the position of the O-Cell assembly with their own design information. If this is not possible or the client wishes Fugro to assist, we will require the following information:

- Geology of the test area, preferably local borehole or STP/CPT logs.
- Geotechnical Pile design
- Desired maximum test load.
- Elevations of the piling platform, cut-off elevation and depth of shaft.

Fugro can then provide an estimated simplified design where the O-Cell elevation is preferred. This design will need to be verified by the client's geotechnical engineers or consultant.

Optimum elevation

Depth of O-cell® level below Piling Platform Level (m)	33.50
Elevation of O-cell level (m OD)	-8.00
Estimation of soil resistance below O-cell level (kN)	12,278
Estimated soil resistance above O-cell level (kN)	12,887
Buoyant weight above O-cell level (kN)	789
Gross available test capacity for testing below O-cell level (kN)	27,960
Gross available test capacity for testing above O-cell level (kN)	27,960



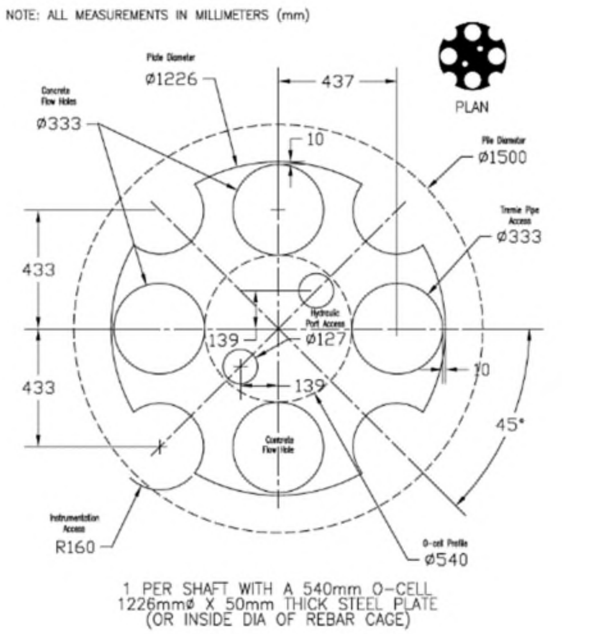
Testing arrangements are normally single level tests where one or more O-Cells are positioned at the same elevation.

Fugro will either review the assessed balance point or assist with the estimation of O-Cell assembly elevation to maximise the geotechnical information that can be obtained from the testing.

Once the design elevation has been assessed, the expected movements can also be assessed by use of Cemset®.

On occasions, it may be necessary to place two or more O-Cell arrangements within the shaft at different elevations to obtain specific information. For more information on multi-level testing, please ask. It may also be a requirement to evaluate the push-out resistance in lieu of a tension test.

Best O-Cell arrangement for the specified maximum test load



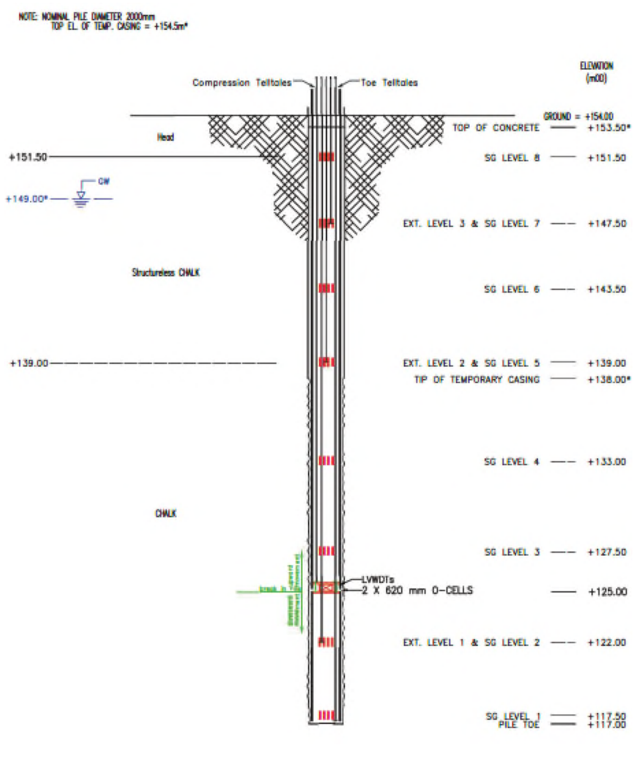
O-Cell sizes range from Ø180 mm through to Ø860 mm, providing loading capacities of between 0.92 MN and 27.4 MN in each direction at rated pressures. One or more O-Cells may be placed at a single or multiple elevations according to the maximum test load requirements, tremie pipe size and shaft geometry.

The maximum O-Cell ram travel is 225 mm.

Several O-Cell assembly options may be available to provide the required test load at the rated capacity and these options will be included in our proposal.

The selection of the O-Cell assembly option will be influenced by the maximum test load required, shaft geometry, reinforcing cage dimensions, concrete cover and tremie pipe size/location as well as cost.

Instrumentation design



Fugro recommend that strain gauges are sister bar type (Geokon 4911-4-3) and are positioned in pairs per level or fours for large diameter piles. Barrettes normally require 6 per level.

It is recommended that strain gauges should be placed at least 1.5 diameters away from the points of loading such as O-Cell top or bottom plate, the pile toe and top of concrete.

Placing strain gauges within the spliced section of the reinforcement should also be avoided.

Once all the information stated above has been obtained and the O-Cell arrangement and position determined, the test instrumentation can be planned (if not already specified).

Standard instrumentation may consist of:

- Expansion transducers across the O-Cell assembly;
- Compression and toe movement telltales;
- Concrete cut-off or design level telltales;
- Additional pipes are required to vent and equalise the pressure at O-Cell elevation when the O-Cells are opened.
- Strain gauges placed along the shaft to determine load distribution.

Expansion of the O-Cells is measured using displacement transducers generally set across the bearing plates illustrated in the drawing above.

Additional instrumentation might include:

- Additional extensometers to measure compression such as between the top of pile and top of rock or at changes of strata or at several elevations along the shaft.
- Thermal Integrity Testing / TIP wires to determine both the integrity of the concrete during curing and estimate the pile profile. The position of the reinforcement within the shaft can also be determined.

Pipework requirements

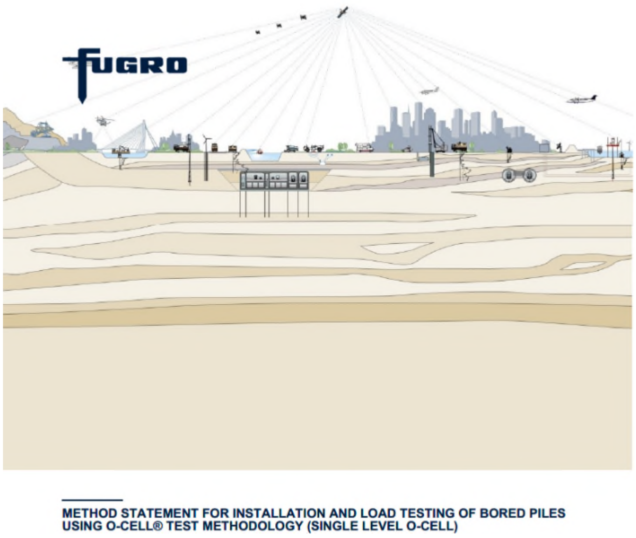
1/2" Black SCH 40 or Galvanised Pipe Requirements (Threads on Both Ends)										
Pipe Type	Net Unit Length	Qty. of Net Unit Lengths	No. of sets	Total Net Pipe Length	Qty. of Coupler per Set	Total Qty. of Coupler	Qty. of Union per Set	Total Qty. of Union	Qty. of End Cap per Set	Total Qty. of End Cap
	[A]	[B]	[C]	[D = A x B x C]	[E]	[F = C x E]	[G]	[H = C x G]	[J]	[K = C x J]
PTT	6.00 m 2.00 m 0.49 m	8 ea. 1 ea. 1 ea.	2 ea. 2 ea. 2 ea.	96.00 m 4.00 m 0.98 m	5 ea.	10 ea.	5 ea.	10 ea.	2 ea.	4 ea.
			Subtotal	100.98 m		10 ea.		10 ea.		4 ea.
VENT	6.00 m 1.00 m 0.49 m	7 ea. 1 ea. 1 ea.	2 ea. 2 ea. 2 ea. 2 ea.	84.00 m 2.00 m 0.98 m 0.00 m	5 ea.	10 ea.	4 ea.	8 ea.	2 ea.	4 ea.
			Subtotal	86.98 m		10 ea.		8 ea.		4 ea.
COMP	6.00 m 0.49 m	7 ea. 1 ea.	2 ea. 2 ea. 2 ea.	84.00 m 0.98 m 0.00 m	3 ea.	6 ea.	4 ea.	8 ea.	2 ea.	4 ea.
			Subtotal	84.98 m		6 ea.		8 ea.		4 ea.
DESIGN CUT-OFF										
			Subtotal							
			Total	273.00 m		26.00 ea.		26.00 ea.		12.00 ea.

To determine absolute elevations of key levels within the shaft, ½" pipework is used, of either galvanised or mild steel. The pipework will need to be supplied by the client locally and Fugro will supply details of the minimum requirement for the pipework and connections to match the cage layout drawings provided by the client and the overall test requirements.

Pipes can typically be supplied in approximate 6 m lengths and be threaded at each end.

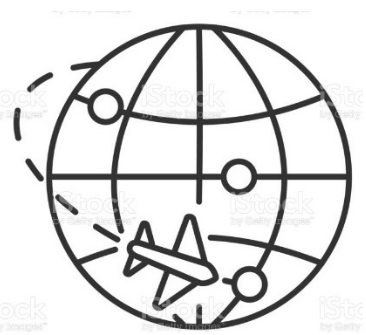
Cutting of exact lengths required will be done during the assembly phase.

Method Statement preparation



Once the contract has been agreed, a full and details method statement inclusive of generic risk assessment will be provided appropriate to the specific test requirements. The Method Statement will include the bearing plate design details as well as the loading and instrumentation arrangements, recommended or specified loading schedule and any other relevant details.

Procurement



The materials required will be procured from our suppliers. Once ready, the client can either use our shipping agent or can arrange for their own agent to collect from our O-Cell supplier in Rhode Island USA. If using Fugro's freight forwarder, the materials (Osterberg Cells, Geokon instrumentation and hydraulic hoses) will be shipped directly to the nearest international airport for the client's shipping agent to clear customs and deliver to the place of assembly. This process normally takes 28 days from pre-payment to delivery and a program of works should allow for this as a minimum duration.

O-Cell(s), test instrumentation and bearing plates

O-Cell(s), hydraulic hoses and test instrumentation will be delivered either to the cage manufacturing yard or directly to site for assembly. It is more efficient and preferred to perform the assembly at the cage fabrication yard since it is dry, overhead cranes are readily available and welders would normally be available to assist.

Reinforcing cages, bearing plates and the ½'' steel pipework and fittings are the responsibility of the client to source locally and should be ready and available prior to our engineer's arrival on site or fabrication yard.

All the equipment will be calibrated by the manufacturer and the hydraulic hoses pressure tested prior to dispatch to ensure the highest possible quality assurance.

The bearing plates are designed specifically for the reinforcing cage dimensions. Fugro will provide the manufacturing details for the bearing plates with predetermined locations for the O-Cells, instrumentation, access holes for the tremie pipe and concrete flow, where applicable. The material of the plates is not critical so long as they are of a reasonable quality, flat and are of weldable steel. They do not need to be made to a high precision (<±3 mm).

O-Cell assembly preparation and installation

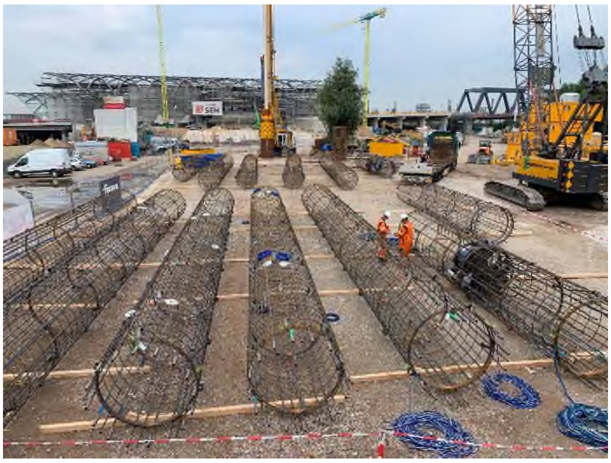
Fugro will require a welder (and assistant/s) and the use of a crane or other appropriate lifting methods.

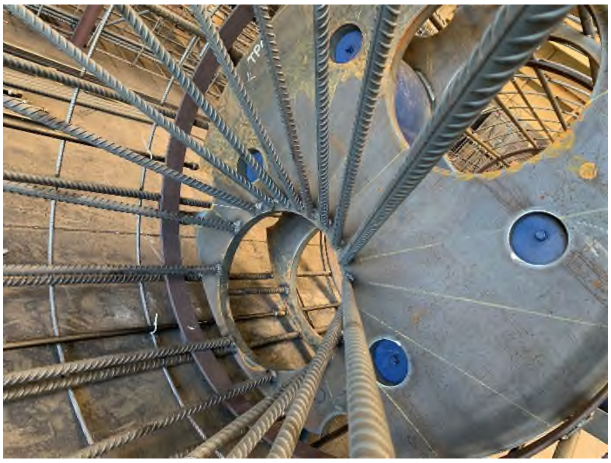
The O-Cell(s) will be welded to the top and bottom steel plates. The correct alignment of the O-Cell assembly in the reinforcing cage is vital and this operation will be supervised by the Fugro engineer.

Steel bars (3 or 4) will need to be supplied and will be welded between the two bearing plates to prevent stress to the O-Cell welds during handling and lifting. These bars will be cut when the cage is being inserted in the bore at time of installation.

The reinforcing cage in which the O-Cell assembly will be positioned can either be made in two parts or be cut. The completed O-Cell assembly will then be fitted to the reinforcing cages and welded into the correct position under Fugro instruction.

For preliminary tests a carrying frame can be used. This will be constructed specifically to locate the O-Cell assembly at the desired elevation.

		Extreme care should be taken when welding the O-Cell(s) near instrumentation. All welding operations should be completed before fitting strain gauges and hoses to avoid damage which may not be noticed during the assembly. No welding to the O-Cell(s) prior to the arrival of Fugro to supervise these activities is allowed. Damage may occur which might require replacement of the O-Cells at client's cost and cause unnecessary delay to the testing program.
Assembly of reinforcing cages		Where the depth of the shaft requires the reinforcement to be in several sections, they can be spliced together during installation. All cages will need to be identified, clearly marked and prepared ready to be instrumented. A suitable dry and flat surface with access to all the cages is necessary. Safe access will be needed to both sides of each cage and they should be securely chocked to prevent them from rolling. Crane access will be needed where assistance in turning is required.
O-Cell assembly preparation and installation	 	The O-Cell methodology has been applied to bored piles, barrettes, diaphragm wall panels, CFA piles, steel pipe piles, driven piles and Fundex piles. The Osterberg cell assembly will be set perpendicular to the reinforcement before being fully welded into position. Occasionally, the bearing plates may need to be butt welded to the vertical reinforcing bars where space is restricted. Where necessary, the concreting / grouting method may be modified to allow for positioning of a single O-Cell without the use of conventional bearing plates. For CFA (auger cast) piles the instrumented reinforcing cage is plunged into the wet concrete/grout with a single O-Cell being held in the reinforcement by means of welded castellations. For deeper CFA piles the use of grout is recommended. For rock socket tests, a single O-Cell covering nearly the entire cross section may be used. For barrette or diaphragm wall panel load tests, the O-Cells can be distributed along the length of the panel or placed in "T" shaped panels.

Tremie guide funnel construction	 	For bored piles, a guide for the concrete tremie pipe will be required to get passed the O-Cell assembly. A funnel will be created above the O-Cell assembly constructed of steel bars of a minimum of 25 mm diameter. This funnel will ensure the concrete tremie will slide past the O-Cell assembly without any difficulty and without disturbing any instrumentation or hydraulic connections. The positioning of the tremie funnel will depend on the pile dimensions and O-Cell arrangement within the assembly. According to the configuration, the tremie pipe can be placed either centrally or offset and the funnel will guide the pipe into the correct location. For some barrettes multiple concrete tremie pipes can be used. The tremie pipe below the O-Cell assembly should be of a slick construction without joints to ensure the pipe does not get caught on the O-Cell plates, but in specific cases a funnel below the Osterberg cell assembly might also need to be constructed. For multilevel assemblies a concrete tremie guide funnel is required for each assembly. Careful attention should be made regarding the location of stiffening rings close to the O-Cell assembly as these may reduce the effective internal diameter of the reinforcing cage and prevent the O-Cell bearing plates from entering the reinforcement cage.
Test instrumentation setup	 	After the bearing plates have been welded into the reinforcement and the funnel has been fixed, expansion transducers will be placed within cannisters which are normally welded to the bottom plate and secured to the top plate to measure the O-Cell assembly expansion directly. Usually, 4 expansion transducers will be fitted for a pile and 6 for a barrette but this may vary depending in shaft size and O-Cell configuration. Details will be defined in the Method Statement together with positioning and number of strain gauges and other instrumentation. All instrumentation placed within the shaft below ground level will be vibrating wire gauges since the calibration is not dependent on cable length as would be the case for full bridge or resistive gauges.

Temperature monitoring strings for Thermal Integrity Profiling (TIP) may also be fitted (this is usually performed on site prior to installation of the reinforcement into the excavation).

All cables will be routed and secured along the reinforcing cage and temporarily fixed inside the top of each cage.

Hydraulic system setup

Hydraulic hoses will have been manufactured specifically for the reinforcing cage arrangement or carrying frame proposed for the test.

Each individual hose will be pressure tested by the manufacturer prior to shipping. To guarantee the integrity of the hoses through the working pressure range, they should be stored safely and out of the influence of weather and/or extreme temperatures or welding activities.

Each Osterberg Cell will be connected with a pair of hydraulic lines. Each hydraulic line will be long enough to reach the top of the pile plus extra length to reach the test equipment.

Each of the reinforcing cages will be fitted with the appropriate hose sections and made ready for connection during the cage splicing at installation where appropriate. When multiple O-Cells are installed, the Fugro engineer will colour code the hoses.

Telltale casing installation

Telltales will require casings made of ½" steel pipe. The extensometer rod (or telltale rod) consists of 6 mm steel rod which is inserted down the pipe prior to testing (see testing section).

Extensometer casings are installed from platform elevation to the top of concrete, top of bearing plate, and toe/base of shaft. In addition, a vent pipe is fitted connecting to where the fracture plane will occur.

When specified, extensometers to different elevations within the pile will also be installed.

All pipe casings are fitted in pairs as a minimum.

At each splice level, union couplers will be fitted to the pipes to make rapid connections while installing the reinforcement.

Assembly of pulleys		Length of instrument cables are bespoke, made specifically for the test pile and reinforcing cages to avoid needing to make additional cable splices during installation. When multiple cages need to be spliced together, the cables from the lower cage will need to be threaded through the following reinforcing cage(s). Pulleys will be installed at the top of any cages that will be spliced. They will allow the safe and efficient pulling of the instrumentation cables up and over the top of each cage section. Depending on the location, these pulleys will either be supplied by Fugro or will need to be constructed locally by the welder. The safety and security of the pulleys during installation should be assessed and safety lines (e.g. lanyard) provided so that in the event of failure, they do not accidentally fall from their location.
Pre-install Check		Once the assembly is completed, a final check will be made before transportation or lifting to ensuring no loose components or steel bars are left in the cages and that all pipework and cabling is secured. Instrumentation readings will be taken once the assembly is completed and again prior to lifting of the cages before installation. All readings will be recorded and any changes for each phase noted.
Reinforcing cages inspection		When instrumented cages have been assembled at a location remote to the construction site and are to be transported to site, the cages need additional checking before installation. Care should be taken during loading onto trucks to avoid damage. Care is needed in the location of wooden timbers to ensure they do not bend or damage gauges or pipework. All the instrumentation, hydraulic hoses and steel pipes should be checked to ensure that they are secured firmly to the cage on delivery. Any damage resulted from the transport process should be communicated to the Fugro engineer so it can be rectified prior to final installation.

Reinforcing cage lifting	  	Particular attention is needed to plan the lifting of the instrumented cages to ensure they do not flex unduly which may disturb or break the delicate instrumentation. Due regard for the additional weight of the O-Cell assembly or assemblies and that the reinforcing cages need to align exactly and the splicing method is appropriate to the additional weight and so the cages cannot move vertically with respect to each other. The use of a lifting beam or several pick points together may be used. The use of a spreader beam is advised to ensure the top of the cage is not disturbed during the lifting. The cages should be lifted safely by the client's team according to a prepared plan which should take into consideration the weight and placement of the O-Cell assembly. The lifting should be smooth and stable to prevent the damage of the cages and test instrumentation. Ideally two cranes should be used to avoid the bottom of the cage scrapping along the ground during lifting. The specific orientation of each cage needs to be addressed so all the instrumentation from each cage is aligned correctly. Markers will be clearly placed during assembly to help with this and to ensure the pipework is aligned in the correct place. All personnel not directly involved with the lifting operations should be kept clear of the area. These operations are the responsibility of the foundation contractor.
O-Cell assembly final preparation		The installation of the O-Cell cage in the bore should be paused when access to the O-Cell elevation is possible as it is necessary to cut the bars holding the assembly together for transportation and lifting purposes. The cage MUST first be safely supported and held at the assembly level to allow safe access to the O-Cell assembly with the lower cage inside the excavation. The temporary vertical bars between the two bearings plates should be cut just above the bottom bearing plate. This operation should be executed safely by

		approved personnel with the adequate training and tools (cutting torch or blade). Instrumentation at the O-Cell level should be protected during the cutting of the safety bars. After the cutting of the bars, the instrumentation will be reinspected and the top of the bottom plate greased to aid development of the fracture plane at this level. Grease should be made available on site for this process.
Reinforcing cage splicing		The splicing of each reinforcing cage is the responsibility of the foundation contractor. The use of single 'U' bolts is strictly prohibited. After completion of the splicing of the cages, Fugro engineers will connect the ½'' steel pipes and hydraulic hoses. The instrumentation cables will then be pulled through the attached upper cage using the pulley and rope system and secured as the cage is lowered.
Preparation for concreting		After completing the installation of all reinforcing cages, the cables and hydraulic hoses will be secured safely and protected in plastic bags prior to concreting activities. Care should be taken when placing the tremie pipe mount, guides and tremie pipe and hopper so not to damage cables, hoses or pipework.
Tremie Pipe installation		Installation of the tremie pipe for concreting should be performed with care. It should be lowered gently inside the excavation to prevent damage to instrumentation placed on the reinforcement. The installation descent should be slower as the tremie pipe bottom approaches the O-Cell elevation and gets guided by the funnel guide. On occasion, the tremie might not pass the O-Cell assembly first time. Under no circumstances should it be forced passed, a gentle rotation of the pipe with some vertical movement is normally all that is required.

		The installation of the concrete hopper should be carefully made to avoid disturbance and damage to the steel pipes, cables and hydraulic hoses at the top of the reinforcing cage. A slick concrete tremie pipe with no joints should be used below the O-Cell assembly wherever possible to avoid snagging of joints on the bearing plates as it passes through in either direction.
Concreting operation	 	Concrete design should be considered with the O-Cell test in mind. A high flow concrete with small aggregate will ensure all instrumentation, hoses and O-Cells are fully embedded. The concreting should be carried out following the client's best practice, keeping the tip of the concrete tremie pipe submerged in wet concrete at all times. Wherever possible, the concrete tremie pipe tip should remain below the O-Cell assembly while pouring until the concrete is 2 m or more above the O-Cell assembly before lifting the tremie pipe, being observant that the cage does not lift as the concrete flows past the O-Cell assembly. The lifting of the tremie pipe should be made gently to avoid damaging the instrumentation and to avoid disturbance to the O-Cell assembly. It is recommended that numerous concrete level checks are made during pouring and logged with respect to the volume delivered.
Top of concrete elevation		With the O-Cell test method, it is not a requirement to bring the concrete up to platform level. Where the top of concrete is left below the platform level, the reinforcing cage will need to be extended or a suitable 'dummy cage' will be required above the concrete cut-off level to above ground level to support the instrumentation cables, hydraulic hoses and steel pipes. Where there is a deep cut-off and concrete will not be bought to platform level, the cables should be pulled through plastic piping to prevent damage to the cables. The remaining bore can be filled with dry sand after concreting has been completed. The use of spoil or gravel is not permitted.

Casing removal		Removal of the temporary the casing, should be made carefully to avoid disturbing or damaging the steel pipes, cables and hydraulic hoses. It is important NOT to rotate the casing as this may cause the O-Cell and/or instrumentation to be damaged. Any untoward disturbance of the reinforcing cage during the casing extraction should be noted and reported to Fugro.
Concrete post pour organization	 	Once the installation and concreting works have been completed, the hydraulic hoses, pipes and cables should be washed to remove any concrete residue. The area around the top of the shaft should be made safe so that post-pour readings can be taken for the embedded test instrumentation. Wherever possible, rebar safety caps should be installed on top of each rebar to avoid any hazard due to exposed unprotected rebar. Cables and hoses should be protected as well as possible from site traffic interference, theft and the elements (placement of casing or protective barriers over/around the pile head is desirable). Note that the full scale static load testing may commence approximately 28 days after the pile construction for preliminary tests and sooner for working piles. Testing dates should be confirmed by Fugro in advance.

Setup for testing

Prior to the Fugro engineer's arrival, the test area should be clean and clear of obstructions and loose spoil.

It is recommended to stop all site activities around the test area that may have an influence on the test readings. Piling works or road haulage and plant movements can all disturb the delicate test instrumentation during the testing and an exclusion zone should be discussed with the Fugro test engineers.

Around the entire test area, a safe area should be created and cordoned off with barriers or tape to avoid external interference.

Piling operations should be a minimum of 20 metres from the test location and any transport routes redirected away for the duration of the test.

Prior to starting the test, the client should provide the concrete test results, usually taken at 7, 14 and 28 days, to ensure the concrete has reached sufficient strength to start the test and to allow the test analysis to be completed swiftly.

After the concrete reaches the required minimum specified strength, the test may be started. Fugro recommend that any preliminary pile test is not commenced until 28 days after concreting. This is to allow, not only structural concrete strength to be obtained, but also redistribution of lateral earth pressures (set-up period). This will ensure the best possible results can be obtained.

For offshore and nearshore tests, safe and secure structures should be present around the test pile to allow the safe movement of the engineers and placement of the test equipment.

A suitable water rescue plan, including rescue boat where necessary or other safety measures, should be in place prior to setting up the test.

Provisions for backsights during the testing should be considered prior to test set-up.

Reference beam setup	 	The quality of the test setup is vital to the successful and accurate results. On-shore, the preferred reference beam should be a steel H beam and of sufficient length to ensure the supports are at least 3 to 5 pile diameters from the test. The reference beam should be placed over the top of the pile/panel on rigid and stable supports, preferably at least a day before commencing the test to allow for any settlement of the supports. A small diameter roller should be placed under one end of the beam to allow for thermal expansion and contraction of the beam during testing. The reference beam should be completely shaded during the test where practical and/or painted white to minimise the influence of the sun on the beam. The reference beam should be placed over the centre of the test pile, avoiding any pipework, allowing for at least 250 mm clearance for the possible upward movement of the pile head/reinforcement during testing, 400 mm for a multi-level test. For offshore tests the reference beam should be supported on the surrounding piles.
Independent measurement of the reference beam or pile/barrette head	 	An independent optical electronic level monitoring system will be used to monitor the reference beam movement for any vertical movements to 0.01 mm. The level should be placed at least 10 metres from the centre of the pile/barrette and it should be shaded and protected from rain/wind. The test area allocated should allow for provision of this distance together with a secure and stable backsight position. Where a reference beam cannot be used, a twin Leica electronic level setup should be used. With this setup two electronic levels will record the movement of two separate invar staffs placed on top of the pile head. This setup is useful for tests over water, where the placement of a reference beam is difficult/impossible or where the test footprint does not permit a reference beam.

Test cabin setup		A cabin suitable for personnel should be placed next to the test shaft so the Fugro engineers can locate the test equipment out of influence of the weather and temperature changes. The cabin should be suitably air conditioned, or heated, where needed and table and chairs made available for the duration of the test. Electrical power needs to be supplied (120 or 240 VAC) to the cabin in order to run the laptop and test system. All external power to instrumentation will be 12 VDC.
Telltale rods installation		If not previously installed, steel telltale rods (6 or 8 mm) need to be coupled together and inserted into to the previously installed ½'' steel casing pipes. The telltale rods will allow very precise measurement of the movements at different elevations. Installation will be made by Fugro personnel. The top of the telltale rods will be cut to the desired length to suit gauge positioning.
Pile/barrette top setup	 	All displacement sensors necessary to read the movements of the telltales and the pile/barrette head will be fitted at the top of the pile/barrette once the telltales rods are in place. These gauges will be set vertical to the pile head and parallel to the telltale rods with the aid of mirrors to ensure best accuracy of the readings. All cables will be secured in a tidy manner and connected to the data logging system which will be placed either inside or outside of the cabin depending on cable length and cabin layout. The hydraulic hoses will be flushed with clean water. Pressure sensors connected to the datalogger will be used to monitor and control the pressure during testing.

Hydraulic system and pumps setup

The client will be responsible for the supply of continuous power, clean potable water and an appropriate air compressor necessary to run the hydraulic pumps.

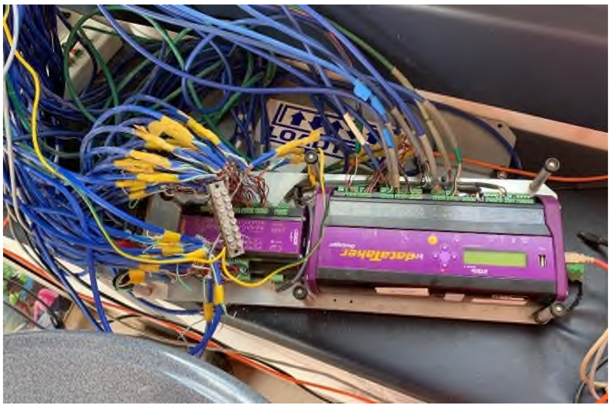
Inside the test cabin two pumps will be set up to run the test. The hydraulic medium for these pumps is water to ensure no possible pollutant fluids can enter the ground water system.

The hydraulic pressure will be measured by three separate instruments:

- On the line near the pumps, a mechanical high-pressure Bourdon gauge will be used as a visual guide to the applied pressure to the input to the O-Cells.
- On the return line, a calibrated electronic vibrating wire pressure transducer will be connected to the datalogging system and a full balanced bridge pressure sensor connected to the automated pressure control system.

It is important to monitor both the input pressure and the output pressure of the hydraulic system to ensure they are the same and that there are no blockages within the hydraulic system.

Data acquisition system



The datalogger (normally a DT85g from Datataker systems) will be programmed to collect the readings from the various test instruments. The data will be transmitted to the test computer for live monitoring.

The logger should be placed in a secure area to avoid damage or external interference. Ideally this will be inside the cabin if cable lengths permit.

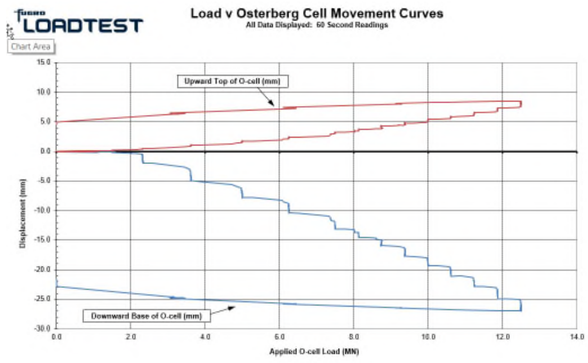
Test control and monitoring

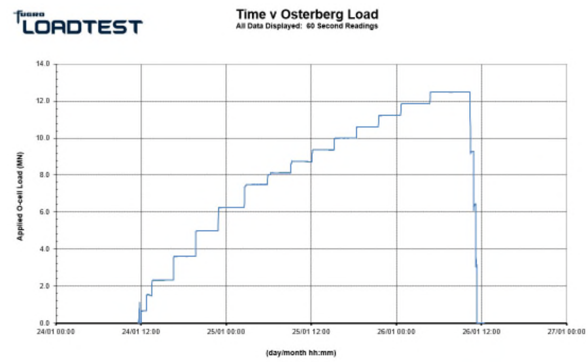
A pressure control system and a testing computer will be programmed to control all the test variables during the test. With these two systems the Fugro engineer will control the hydraulic pumps, monitor settlement rate and adjust the load applied to the pile/barrette according to the test loading schedule.

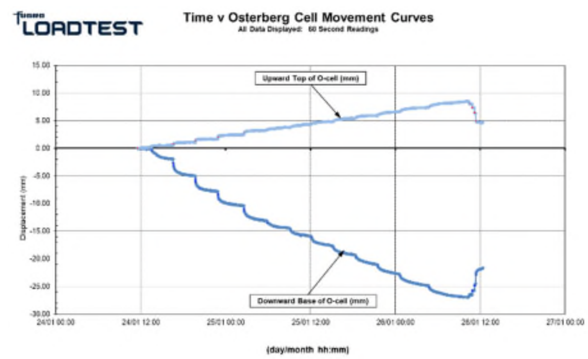
A laptop will be used to display in real time, results from all the sensors and instrumentation and present them in both graphical and tabular form.

The data from the precision level will also be collected by the laptop.

Test







Fugro will propose the optimum testing schedule to maximimise the information which can be obtained in the shortest total test duration without compromising any geotechnical information.

The test duration may be several days and provision for attendance during the night should be made prior to starting the test. The compressor, generator and lighting will need to run continuously during the testing.

Security and emergency assistance will need be provided during out of hours testing periods. Where it is not possible to attend during these hours, remote testing may be undertaken on agreement.

Alternatively, the test may be halted overnight and the loading system shut off. It should be noted that this will increase the length of the test considerably.

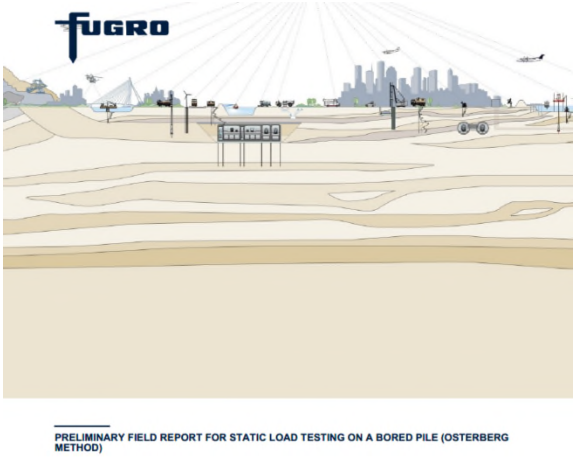
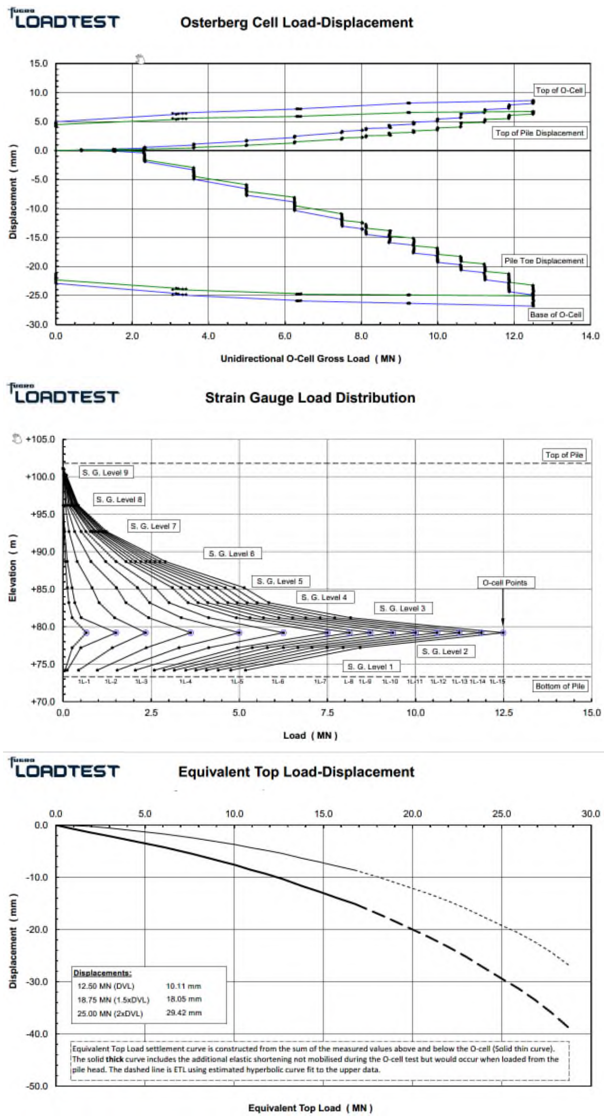
The test will start by pressurising the O-Cell(s) to break the tack welds that hold them together during installation and separate the two elements of the test shaft. Effectively there are two full scale static load tests occurring simultaneously, one upwards and one downwards.

Loading increments will then be carried out according to the loading schedule detailed in the approved method statement.

The test will conclude when one of the following conditions is fulfilled:

- A predetermined maximum test load has been applied;
- The maximum O-Cell travel (225 mm) is reached or, a predetermined limited expansion (as might be desired for working piles);
- The capacity of the shaft section above or below the O-Cell assembly has been fully mobilised.

On completion of the test, all test equipment will be removed and the area handed back to the client so that construction activities can continue.

Preliminary Field Report		After the completion of the test, a preliminary report will be issued to the client, normally within 24 hours of test completion. This report will include the basic RAW data from the test without processing or detailed analysis. It will allow for a first assessment of the test results prior to the detailed final report and analysis. The digital data obtained from the test is available on request from the test engineers.
Final Report		A final report will be compiled with all the information and data from all the phases of the test. The data obtained during the bi-directional test will be processed and analysed to provide, if moved sufficiently, full geotechnical assessment for a preliminary test pile or to provide compliance for a proof test. The test data will be presented in graphical form against both time and load. It is essential that the client has previously shared as built information regarding pile/excavation depths, dimensions, concrete test results, etc. to ensure the report can be finalised swiftly after test completion. The equivalent top load displacement is carried out as the sum of the measured behaviour and as the sum of the modelled behaviour if the movements have been large enough using Cemsolve® for back analysis and Cemset® for the pile/barrette head load settlement prediction. On completion of the final test report, the processed tabular data is available in Excel format should the client or consultant wish to perform their own analysis. For working piles, those which will be integrated into the structure, the O-Cell and annulus produced during the testing should be grouted to reinstate the structural integrity of the pile/barrette. Details on mix and how to perform this will be available in the final report. It is recommended grouting is not performed until the final report is completed.