Case study

Bi-directional O-Cell® test in 80 Fenchurch Street – EightyFen London

Project
80 Fenchurch Street, EightyFen

Client:
Skanska

Piling Company:
Keltbray Piling

Location
80 Fenchurch Street, London, UK

Period
2018

Services
O-Cell® load test

Another successful O-Cell® load test project in London

Fugro LOADTEST have performed an Osterberg-cell® test on a pile at depth in central London.

Challenge

Fugro LOADTEST has successfully completed a comprehensive full-scale load-testing programme on a pile as part of the foundation design verification for the planned new 14-storey, mixed-use commercial and retail development is located in the City of London.

A single level static load test using Osterberg-cells was planned as the method and was specifically appropriate for the tests loads required given the ground stratigraphy at this location. The results allowed confirmation and potentially optimisation of the foundation design without the need for costly and time-consuming installation of the reaction piles required for conventional top down load testing.

Reinforcement with O-Cell® assembly ready for installation

loadtest@fugro.com

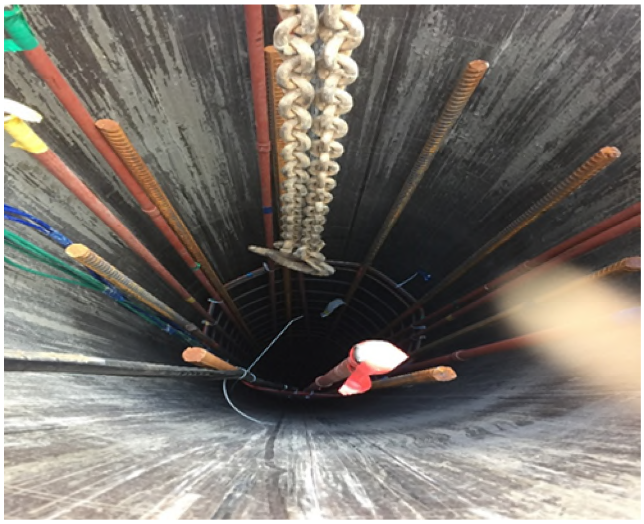
Solution

The test arrangement and instrumentation included a single O-Cell® loading assembly capable of providing 7.5 MN gross load capacity and vibrating wire strain gauges distributed along the length of the pile to assess the mobilised reaction.

The pile was located at the site of 80 Fenchurch Street in central London and socketed in London Clay. Sub-surface conditions at the test pile location consist primarily of made ground and fill at the surface, underlain by gravels to -8.5m with London Clay below.

Specialist foundation contractor Keltbray Piling constructed the 32.5 m long test pile bore with a concreted length of 23.5 m and a diameter of 900 mm. Fugro provided unique load-testing and measurement technology for the pile-testing programme.

Installation of the reinforcing cage and instrumentation into the pile



Unique to bi-directional load testing the top of concrete does not need to reach ground level

Conclusion

When a pile founded in soft strata such as London clay is tested using top down techniques, the end bearing is often not revealed as the load being transferred down the pile as the skin friction is ruptured often overwhelms the end bearing. In contrast, using bi-directional load testing, where the point of loading is much lower in the pile, with the O-Cell® location placed at the balance point of reactions above and below the O-Cell® assembly, the full end bearing componant can be determined.

The O-Cell® test performed on this site was able to safely mobilise both the skin friction and end bearing componants, revealing the full geotechnical behaviour of the pile. These results were critical for the foundation designers. The bi-directional load-testing results and comprehensive pile instrumentation provided by Fugro will help the design firm to understand the ground’s deformation behaviour and the piles bearing capacity to design a safe and cost-effective foundation design for the new commercial and retail development in London.

O-Cell® test in progress. The steel beam is for reference only

Case study

Bi-directional O-Cell® tests for Combwich Jetty

Project
Combwich Jetty

Consultants:
ByrneLooby / Jacobs

Piling Company:
CMP Thames

Location
Combwich, UK

Period
2021

Services
O-Cell® load test

O-Cell® pushout load tests of Steel piles grouted into Mudstone rock sockets

Fugro LOADTEST have performed Osterberg-cell® tests on steel pipe piles in Combwich, UK

Challenge

A comprehensive full-scale load-testing programme on two steel pipe piles were required as part of the foundation design verification for the new upgrading of the current wharf in the south west of England. The project will create a new berth hardstanding that allows vessels to be unloaded when the tide is out.

Two single level static load tests using Osterberg-cells were planned as the appropriate method to evaluate the tension behaviour of the 22.5 m long steel 900 mm pipe pile grouted in the lower 13.9 m of a 27.8 m deep 1,220 mm diameter bore into Mudstone.

O-Cell® assembly on the bottom of the steel pipe pile ready for installation

Solution

An O-Cell® test can be used to evaluate the upward friction in compression directly and by grouting an additional length below the test pile into the rock socket it allows sufficient reaction to be avalable to push the full length of the test pile upwards.

Instrumentation systems were fitted on the piles together with a single O-Cell® loading assembly capable of 7.7 MN attached to the bottom of the full length of the steel pipe pile to be tested.

In this case the pipe piles were not filled internally so a cruciform was welded to the inside to resist and spread the load to the walls of the pipe pile without deformation. Extensometers fitted down the inside of the tube measured the compression of the pile so the elastic deformation in tension could be estimated.

Conclusion

In a similar way to how the equivalent top of pile behaviour is computed from the bi-directional results for downward movement, the upward movement in tension can also be derived from the results whilst making allowance for the elastic extension of the pile.

Additional correction to the displacements was required to remove the influence of tide on the movements recorded.

These results were critical for the foundation designers confirming the design length of the grouted section in the rock socket would have sufficient friction.

The results allowed confirmation and potentially optimisation of their foundation design without the need for costly and time-consuming installation of the reaction piles used in traditional load testing.

Installation of O-Cell® assembly and its instrumentation into the pipe pile

Pipe pile and O-Cell® assembly ready for installation into the bore and grouting

O-Cell® test in progress.

Case study

Bi-directional O-Cell® load testing of working piles for a triple decker roundabout

Source:
https://www.roadtraffic-technology.com/

Project
A19 A1058 junction improvement

Client:
Highways England

Piling Company:
Bauer Technologies

Location
Testo’s roundabout A19 A1058 in North Tyneside, UK

Period
Testo's roundabout finally completed July 2021

Services
O-Cell® load tests

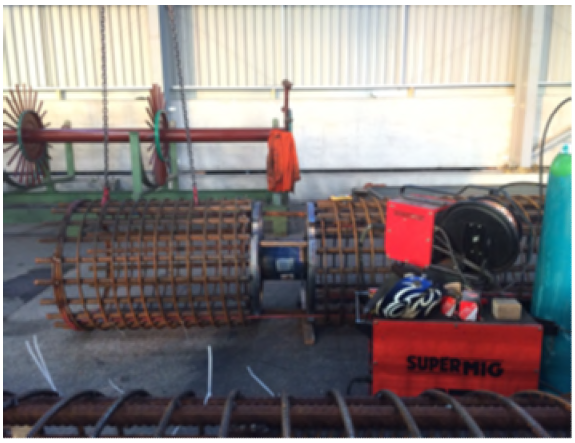
Working pile O-Cell® load tests

Fugro LOADTEST working pile load tests at the A19 Road Improvement Works near Newcastle using the Osterberg Cell® methodology

Challenge

Highways England is upgrading the A19/A1058 Coast Road junction, one of the busiest stretches in North Tyneside, UK, to a triple-decker roundabout to ease traffic congestion and improve the journey time reliability.

The proposed £75m upgrade project will ease the congestion by upgrading the existing roundabout to a fully grade-separated three-level interchange junction. The A19 will be realigned by dropping it beneath the existing roundabout, which will provide a free-flowing link for the people using the road.



O-cell assembly made at the cage fabrication facility

Sub-surface conditions at the test pile location consist primarily of glacial till overlying sandstone (coal measures) and full scale load tests would be required.

The requirement was for no overhead reaction kentledge or steel reaction beams thus minimising the risk to live flowing adjacent traffic. This feature of O-cell® bi-directional testing, made this the preferred method of choice for Bauer Technologies and Highways England.

Solution

Bauer Technologies Ltd completed construction of two 1180 mm, 22.00 metre deep piles and one 1580 mm diameter, 25 metre pile working test piles. The Osterberg method was considered to the optimum solution due to the restricted working space and live traffic flow in proximity to the site. Further, with such a congested site, the footprint required for loading using kentledge would be unreasonable and the logistics of mobilising the reaction system a major obstacle.

Installation of one of the working test piles

A loading arrangement with a capacity of 7.8MN was installed at a design depth where approximately equal reaction would be available above and below the O cell® assembly.

Fugro Loadtest used the Osterberg cell® bi-directional method to test the three working piles. The maximum sustained gross load applied to the smaller piles, positioned at the North and South Abutments, was approximately 4 MN. The third larger pile which was positioned in a central position to the flyover bridge and mobilised approximately 7.35 MN. Since the piles were working piles, the piles were grouted after testing to reinstate their structural integrity and allow them to be integrated into the working structure. The annulus created at the break point at the bottom of the O-cell® devices and the interior of the O-cell® devices and hydraulics were grouted to allow compressive loads to be transmitted to the section below the O-cell® level.

Testing in progress – pile head and reference beam

Conclusion

Testing the piles using the bi-directional static load testing technique allowed the pile construction technique to be verified, loading directly into the founding strata of the sandstone coal deposits, where the geotechnical parameters of the material under loading were hitherto unknown. The small testing footprint on a very congested site with live traffic flow in close proximity allowed construction works to continue unhindered and safely without road closures or site restrictions.

Case study

Bi-directional O-Cell® testing for safely mobilising high test loads in piles in Aberdeen

Project
Aberdeen Harbour Extension, Nagg Bay

Client:
Dragados

Piling Company:
Cimentalia

Location
Aberdeen Harbour, Scotland

Period
2019

Services
O-Cell® load tests

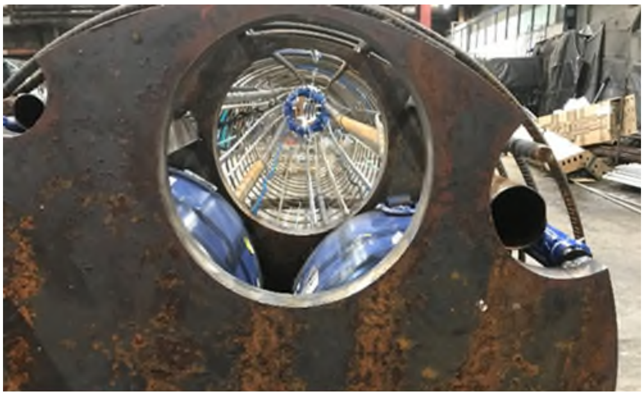
Another successful set of O-Cell® tests founded in rock sockets in Scotland

Fugro LOADTEST have performed two Osterberg-cell® tests on piles in Aberdeen, Scotland.

Challenge

Fugro has successfully completed two comprehensive full-scale load-testing programmes on piles as part of the foundation design verification for the planned Nigg Bay harbour extension in Aberdeen, Scotland. The £350 million South Harbour expansion is the largest marine infrastructure project underway in the UK, and the largest in Trust Port history, it is the most ambitious development for trade around the North Sea

A single level static load test using Osterberg-cells was specified by consultants ARUP as the method and was specifically appropriate for testing the hard rock sockets that the piles were founded in to significantly high loads.



Reinforcement with O-Cell® assembly ready for installation

loadtest@fugro.com

Solution

The results allow confirmation and potentially optimisation of their foundation design without the need for costly and time-consuming installation of the reaction piles used in traditional top down load testing. Several instrumentation systems were fitted on the piles in Aberdeen, which had concreted lengths of over 18 m and 48 m. The instrumentation included one level of two O-Cell® devices in the loading assembly capable of a gross load in excess of 40 MN, placed directly within the rock socket.

Installation of the reinforcing cage and instrumentation ready for into the pile

Vibrating wire strain gauges were distributed along the length of the piles above the O-Cell® elevation to assess the load distribution along the shaft.

The piles were located on the West and Northern quays in the bay, with one socketed in granite and the other in the Gneiss bedrock Cimentalia constructed the 18 m and 47.5 m long test piles with a diameter of 1500 mm. Fugro provided unique load-testing and measurement technology for the pile-testing programme.

O-Cell® test installed and concreted

Conclusion

The O-Cell® tests were able to safely mobilise the end bearing directly, revealing the geotechnical behaviour of the rock socket materials. The O-Cell® method allows a degree of loading above rated capacity with a total gross load of over 58 MN applied to one of the piles.

This testing program would have been almost impossible by conventional top down static load testing methods which would have required a large amount of anchor piles and a huge expensive reaction frame. Overloading to such a degree is not possible for top down techniques, meaning the loading would have ended before revealing any significant geotechnical behaviour.

O-Cell® test in progress. The steel beam is for reference only

The bi-directional load-testing results and comprehensive pile instrumentation provided by Fugro will help the consulting engineer ARUP to understand the rock socket behaviour under load to design a safe and cost-effective foundations for the new extension to the harbour in Aberdeen.

FUGRO

SPIRE LONDON

Fugro GeoServices Limited's Loadtest division have recently tested two piles at The Spire, London site breaking the UK static load test record at over 100 MN.

BACKGROUND

When completed, Spire London will be a 67 storey tower of 861 suites, apartments and penthouses, set in landscaped open space on West India Quay by London's Canary Wharf. At 235 m in height it will be the tallest residential tower in Western Europe and a new landmark on the city skyline. The tower, built by the Shanghai based Greenland Group has already been dubbed 'The Flower Tower' due to the orchid inspired design, with three petals forming the spire creating faceted glass facades and nautical style "prow" and "bow" contours.

PROJECT SUMMARY

To provide valuable data in order to improve the design for the foundation scheme, two preliminary test piles were required by consultants Robert Bird Group. With such a tall building on a limited number of piles, the design loads would be higher than normally expected for such a structure in London at approximately 35 MN. To meet the load requirements it was required to found the piles in the Upper Chalk strata, which sits below the Thanet Sands in the London Basin.

The twin 2100 mm test piles were installed by piling engineers Soletanche Bachy Limited, under bentonite slurry to depths of approximately 58 metres. To meet the load capacity requirements, a bi-directional loading arrangement consisting of three 670 mm diameter O-cells placed between steel bearing plates to form the loading

PROJECT DETAILS

Project: The Spire
Location: London, United Kingdom
Foundation design and construction: Soletanche Bachy
Geotechnical consultant: Robert Bird Group
Developer: Greenland Group

'sandwich', were installed at a design depth where approximately equal reaction would be available above and below the O-cell assembly.

Instrumentation consisted of O-cell expansion transducers and telltales to measure pile base movement and compressions, together with sister bar strain gauges to estimate the load distribution along the pile

TEST RESULTS

The maximum sustained gross load applied to the first pile was just short of 108 MN, setting a new UK record for the highest test load mobilized in a bored pile. The second pile reached a sustained gross load of 104 MN.

The results from each pile were analysed using the Cemsolve® pile settlement analysis program to determine the ultimate skin friction capacities, end bearing characteristic and the pile head movement prediction achieved by combining the results in Cemset®.

CONCLUSIONS

It has been several years since the last UK static load testing record was set at 80 MN, also in chalk, this was exceeded thanks to the opportunity given by Robert Bird Group and Soletanche Bachy Limited.

Although this was not the first time Fugro had performed a bi-directional test in chalk, it was certainly the highest loaded with a requirement to reach at least 2.5 x Design Load at 87.5 MN.

Having reached the required minimum load requirement the test load was increased to achieve over 100 MN for the first time in the UK on both test piles, allowing the chalk behaviour to be better characterized and the foundation design scheme to be optimised.

The bi directional technique is the only static load testing method capable of testing bored piles to such magnitude. With over 25 years' experience performing bi-directional static load testing, Fugro's O-cell is still breaking records.

Installation of the reinforcement with three 670 mm O-cells for the first test pile.

Artist impression of Spire London (courtesy of Spirelondon.com)

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FUGRO
O-CELL® TECHNOLOGY

The Mersey Gateway Bridge Project is a major scheme to create a new six-lane toll bridge over the River Mersey between the towns of Runcorn and Widnes. Fugro carried out preliminary pile load testing using techniques including bi-directional O-Cell technology to provide key inputs to the foundation design.

The new Mersey Gateway crossing is part of a strategic regional regeneration project. It will relieve congestion on the Silver Jubilee Bridge which carries ten times more traffic than it was designed for.

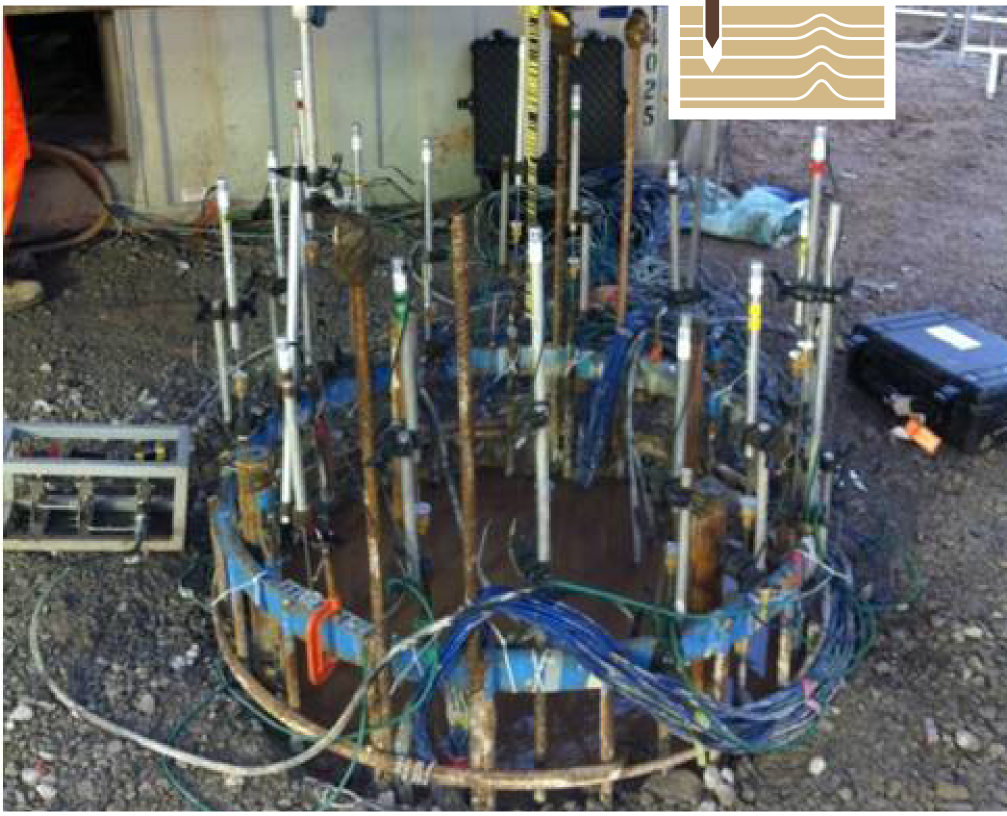
A wide range of options have been considered for the design of the bridge and that of the second Severn Crossing, a cable-stayed structure, served as an ideal design as this will bring maximum benefits for users and make less impact on the estuary and the local environment.

In contrast, to the Severn Crossing, the Mersey Gateway Bridge Project design has three towers, the central being the shorter (80m high) than the north tower (110 m high) and the south tower (125 m high). It will be 2,130 m long (including the approach viaducts on each side) with a river span of 1,000 metres.

To verify the suitability of the foundation design at the viaduct approaches, the designers commissioned Fugro to carry out a preliminary pile load test. Four preliminary test piles were load tested.

Artist Rendering of Mersey Gateway Bridge
Source: www.merseygateway.co.uk

O-cell assembly made at Rom-Tech's cage fabrication facility in Sheffield



O-cell pile testing in progress to 57MN

Bi-directional testing was carried out on a 1050 mm diameter pile bored to 18 m and two 1500 mm diameter piles of 32 m and 48 m.

A further pile was installed and tested by traditional top down loading techniques.

The first 1500 mm test pile at the Northern Approach Viaduct was installed using two O-cells of 630 mm diameter which mobilised approximately 57 MN. The second 1500 mm pile at the Southern Approach Viaduct with two O-cells of 630 mm installed 6.5 m above the base mobilised a load of 39 MN.

A pair of 430 mm diameter O-cells was incorporated into the reinforcement cage for the 1050 mm pile which was installed at the site of the Astmoor – Bridgewater Viaduct.

A fourth pile was installed at the same location, this time six metres longer at 24 m. A top down test was performed to verify the results from the bi-directional test and also to provide suitable anchorage for the reaction piles. The additional 6 m pile length allowed a load of 17 MN to be applied at the pile head.

Strain gauges were incorporated at strategic elevations along each of the pile shafts as well as a series of paired telltale mechanical extensometers to assess the mobilized unit skin friction in the various soil layers.

The embedded instrumentation allowed the distribution of load and estimation of skin friction along the pile shaft to be defined for each of the test piles. The addition of extensometers to complement the strain gauges provided an independent means to derive these parameters.

The analysis of the strain gauges from the top down test allowed the load distribution and skin friction parameters to be compared between the bi-directional method and the conventional top down testing method. There was an excellent correlation between the two sets of results, showing that skin friction measured during the bi-directional test method was the same as the skin friction measured by top down loading methods.

Installation of one of the preliminary test piles

Traditional top down test (large 17MN reaction frame on 4 reaction piles)

Artist rendering of Mersey Gateway Bridge with the Silver Jubilee bridge in the foreground
Source: www.merseygateway.co.uk

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FUGRO

THE STAGE, LONDON

Fugro GeoServices have recently tested what is believed to be the deepest 900 mm diameter continuous flight auger pile in the UK at 33.61 m.

The Stage is situated in the East London's up and coming Shoreditch area. The 412 suites, apartments and penthouses, complete with an array of private lifestyle facilities and 32nd level sky bar and terrace, will combine to provide one of London's most prestigious residential properties.

The two striking buildings, the Hewett and the Bard, will also provide premium business accommodation.

The Stage is set to attract a vibrant collaboration of prime retail including restaurants, bars and fashionable boutiques within brand new commercial premises and beautifully restored Victorian viaducts.

Project Summary

To validate the geotechnical design and the pile installation method on this site, one preliminary test pile was specified. Many O-cell tests have been undertaken in the USA on continuous flight auger (CFA) piles (auger-cast) and several in Europe, however, this was believed to be among the deepest 900 mm diameter CFA piles installed in the UK (33.61m).

The Osterberg method of load testing was considered to be the ideal solution for this site as it would require no anchors or Kentledge, an important consideration as the pile would be installed within an excavation and the loading test would be performed from 3 m above the top of the pile.

Testing in progress – monitoring pile head movement.

CASE STUDY

A single O-cell is preferred for CFA pile installation as the reinforcing cage is required to be plunged into the wet concrete or grout once the auger is extracted. To assist installation, the cross sectional area taken up by the O-cell assembly is minimized by using triangular section castellations to weld the O-cell within the reinforcing cage.

Instrumentation consisted of O-cell expansion transducers, strain gauges and telltales to measure pile base movement and compressions.

A bi-directional loading arrangement using a single 620 mm diameter O-cell was installed at a design depth where approximately equal reaction would be available above and below the O-cell assembly within the London Clay deposits.

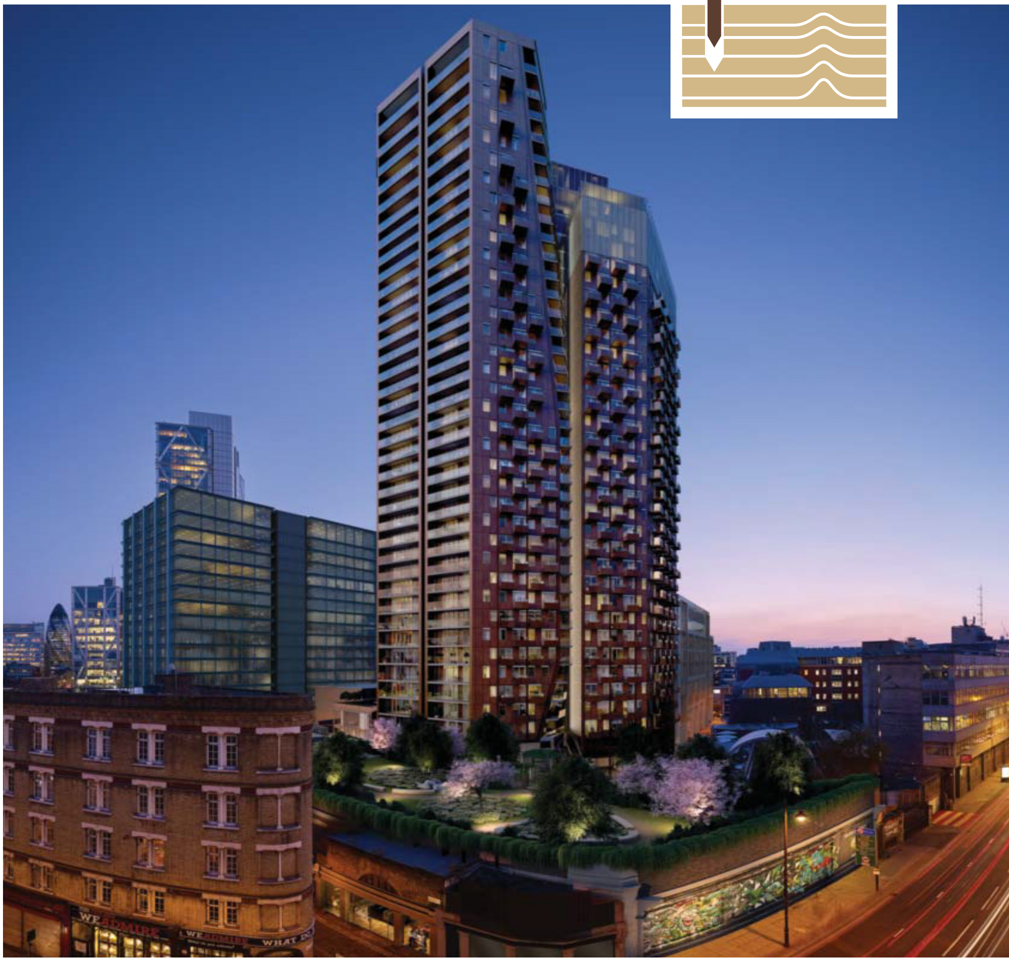
Test Results

The maximum sustained gross load applied to the pile was just above 16 MN, setting a new UK and European record for the highest test load mobilized in a CFA pile.

The results were analysed using the Cemsolve® pile settlement analysis program to determine the ultimate capacities and the pile head movement prediction combining the results in Cemset®.

Conclusions

The bi-directional method of load testing is ideally suited for foundation elements in clays and other soft materials since the loading schedule can be modified to ensure the test can measure both the skin friction and end bearing with more certainty than traditional top down techniques. This is particularly the case in a bi-directional load test as the end bearing is a larger proportion of the downward reaction.



Artist impression of The Stage (courtesy Galliard Homes)

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FUGRO LOADTEST
Osterberg Cell Technology in London, UK

LONDON

City of London

The history of London, a truly global city, goes back over two millennia when it was first founded by the Romans who named it Londinium. Nowadays, the modern London is a truly cosmopolitan city consisting of a diverse range of peoples and cultures, over 300 different languages are said to be spoken within its boundaries. With a population of over 8m residents and many more coming in and through the city daily, the infrastructure and facilities are in constant need of upgrading and updating.

Canary Wharf, London

Several major projects have called upon the services of Fugro Loadtest and O-cell technology to assist with load testing and design optimisation in typically tight and congested construction sites across the London area.

HEATHROW AIRPORT T5

The first bi-directional load test project undertaken was at the initial construction phase at the site of T5 terminal at Heathrow Airport. To assist the designers in understanding of the nature of the soils and their characteristic behaviour under loading, O-cell testing was included as part of a comprehensive testing program.

The Completed T5 Building at Heathrow

New Providence Wharf

The East End of London was, for many years, a site of pollution and dereliction, being the area used for coal gas production and cheap social housing to fulfil the housing needs of the workers at London's once thriving docklands.

New Providence Wharf

New Providence Wharf was the site for the second Osterberg Cell test in the United Kingdom. This project formed part of the redevelopment of the Isle of Dogs area of London with the construction of luxury apartments providing easy access to the City Centre and the commercial heart of the banking district of Canary Wharf. As part of a value engineering program undertaken by Stent Foundations Ltd. (now BBGE), a 670 mm diameter O-cell was installed 0.65 metres above the 1100 mm pile, 36.2 m long test pile.

The pile was loaded to a combined skin friction and end bearing of more than 18.3 MN

THAMESLINK PROGRAM
Farringdon Station Redevelopment

Artist Impression of the completed ticket hall.

Farringdon sits at the heart of a major investment in London's railway network. From this station passengers will be able to traverse the city on the brand new Crossrail and Thameslink trains, and access some of our country's major international gateways. The new integrated ticket hall will link the city's north/south Thameslink trains with Crossrail's east/west services and London Underground. This will bring passengers from areas such as Barnet and Croydon closer to Heathrow, the City and Canary Wharf - vastly improving travel across London and beyond.

Installation of one of the preliminary test piles

Positioning of the piles proved a demanding challenge for the piling, construction and design teams from Expanded Piling Co. Ltd., CoLOR (Costain Laing O'Rourke JV), Network Rail and Atkins Ltd. The piles needed to avoid the Thameslink tracks, London Underground existing tunnels, the proposed route for the Crossrail Project and the main sewers below.

www.fugro-loadtest.com

FUGRO LOADTEST
Osterberg Cell Technology in London, UK

To validate the geotechnical design concept, one preliminary test pile was specified to loads beyond the scope of traditional top-down methods. Further, with such a congested site, the footprint required for loading using kentledge would be unreasonable and the logistics of mobilising the reaction system a major obstacle. Sub-surface conditions at the test pile location consist of London Clay, Lambeth Group and Thanet Sand overlying the chalk. The preliminary 1500 mm test pile, constructed under bentonite, was 45.5m deep with a penetration into the chalk of 13.5m, and fitted with an O-cell arrangement capable of loading to 52MN. During testing, the O-cells were loaded above their rated capacity to a gross loading of 80MN

O-cell assembly made at Rom-Tech's cage fabrication facility in Sheffield

The results were analyzed using Cemsolve® and the Cemset® pile settlement prediction analysis program to determine the ultimate capacities and identified that the design has scope for optimization without compromising the factor of safety.

The requirement for no overhead reaction kentledge or steel reaction beams, a feature of O-cell bi-directional testing, was also found to be very attractive for a working pile test performed on a smaller 750 mm diameter pile in close proximity to both the live London Underground and Network Rail tracks. Post test grouting of the test pile allows the pile to be integrated into the structure.

Testing in progress – pile head and reference beam

<u>FRANCIS CRICK INSTITUTE</u>

The Francis Crick Institute is a unique partnership between the Medical Research Council (MRC), Cancer Research UK, the Wellcome Trust, UCL (University College London), Imperial College London and King's College London. Situated in the Kings Cross area of London, the new Francis Crick Institute buildings will provide an ideal location for research, situated within close proximity of a host of scientific, research and medical communities and major domestic and international rail links.

Two 1500 mm preliminary test piles were installed on the site, founding in the Thanet Sands below London Clay. Two 610 mm O-cells were fitted in each of the 40 m long test piles. Test loads of up to 18 MN were obtained on each of the test plies.

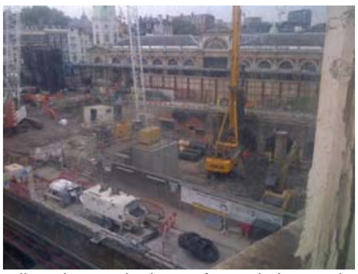
Lifting of the pile cage with O-cell assembly

<u>CROSSRAIL Projects:</u>

Fugro Loadtest were delighted to be asked to perform bi-directional O-cell testing on a number of the Crossrail sections. The ability of the testing system to be installed in inner-city sites without the need for kentledge or reaction frames allowed us access to some of the most congested piling areas in London.

London's new East-West rail link, which includes the construction of 26 miles of tunnels under the capital, is Europe's largest infrastructure project and on a scale nearly twice the size of the London 2012 Olympics.

Piling in the heart of London provides many difficulties. The existence of old foundations, archeological remains, centuries of buildup of unknown made ground materials, underground services, underground tunnels, ancient sewers and proximity to buildings, including listed buildings of national importance, made the project one of the most challenging ever.



O-cell testing made the perfect solution on the congested sites at Crossrail

FUGRO LOADTEST
Osterberg Cell Technology in London, UK

C430 – Farringdon Station

Works on this section of the Crossrail project were undertaken by the Laing O'Rourke Strabag Joint Venture, with Expanded Piling and Züblin providing the piling expertise. Two 405 mm O-cells were installed 2.5 m above the toe of the 52.65 m long 1200 mm diameter working test pile. A feature of the O-cell testing methodology allows the concrete to be stopped anywhere in the pile bore, negating the need to remove the excess concrete as excavation to design level progresses. Since the design top of concrete elevation for the piles installed was some way below the piling platform level, the bore above the concrete was filled with pea gravel to provide safe access.

Instrumented cages ready for lifting

A bi-directional gross O-cell load in excess of 10MN was applied to the working pile allowing confirmation of the design and settlement criteria required. Inclusion of vibrating wire sister bar strain gauges monitored during testing indicated that there was considerably more skin friction in the Thanet Sands than had previously been expected. The O-cells were grouted after testing to allow integration into the foundation design.

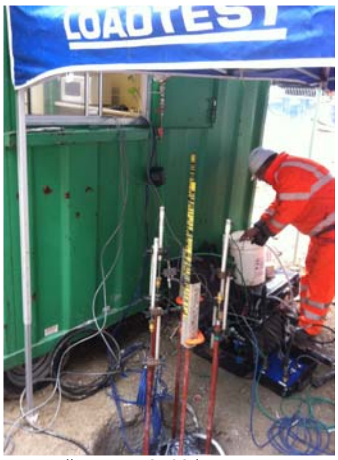
Test pile prior to testing

C123 Fisher Street Access Shaft

This section of the Crossrail works is located within one of the most congested parts of London. The piling program required Martello Piling to mobilize two low headroom piling rigs together with crane and equipment on one of the smallest working areas on the Crossrail works. Co-ordination of the rigs and safe working practices were paramount. With space at a premium, even the use of a reference beam was an issue. Load testing the two 600 mm test piles would be a challenge for any method other than the O-cell bi-directional technique, despite the relatively low loading requirements.

Single O-cell cage installation

Cages were instrumented at Kierbeck in Barking. The 33m long piles were constructed under dry conditions, the technique for placing the single 230 mm O-cell was modified and castellation's were used to attach the O-cell to the reinforcement cage instead of the normal bearing plates. The concrete was then poured from above the O-cell elevation situated 11m above the pile toe. Pile head movements were recorded using twin precision Leica levels rather than a conventional reference beam system due to the lack of space around the test locations.



Pile test at C123 in progress

Gross bi-directional loads of more than 1.25 MN were applied with only small displacements being recorded. Since the piles were to be used for future undetermined construction use after completion of Crossrail, the capacity of the piles would already be known allowing use of the space to be optimized without compromising the integrity of the adjacent shaft. Both piles were grouted ready for inclusion into the foundation.

C435 Farringdon Crossrail Works

Adjacent to the site at C430, this project forms part of the Farringdon Station main works on the Crossrail project. A 2100 mm diameter working pile was constructed by Skanska Cementation to a depth of 31.63 m and founded in the Thanet Sands. The pile was base grouted after installation prior to testing. A bi-directional test load of 18 MN was applied using two 610 mm O-cells positioned approximately 2 m from the pile toe.

LOADTEST
O-Cell® Technology at Farringdon Station, London

Project:	Thameslink Programme, Farringdon Station Redevelopment London, UK
Client:	Network Rail Expanded Piling Co., Ltd.
Consultants:	Atkins Ltd
Contractor:	CoLOR (Costain Laing O' Rourke JV)
Piling sub contractor:	Expanded Piling Co Ltd

Project Description:

Farringdon sits at the heart of a major investment in London's railway network. From this station passengers will be able to traverse the city on brand new Crossrail and Thameslink trains, and access some of our country's major international gateways.

The new integrated ticket hall will link the city's north/south Thameslink trains with Crossrail's east/west services and London Underground. This will bring passengers from areas such as Barnet and Croydon closer to Heathrow, the City and Canary Wharf - vastly improving travel across London and beyond.

Artist Impression of the completed ticket hall.

Project Summary:

The design of the foundations for the ticket hall are challenging in terms of the locations available for new piles and the loads required. Locations of the piles being a particular issue as they needed to avoid Thameslink tracks, London Underground tunnels, the proposed route for Crossrail and the sewers below. Further, a friction free double casing arrangement was required to transfer all the load to depths greater than 18m.

To validate the geotechnical design concept, one preliminary test pile was specified to loads beyond the scope of traditional top-down methods. Further, with such a congested site, the footprint required for loading using kentledge would be unreasonable and the logistics of mobilising the reaction system a major obstacle. Sub-surface conditions at the test pile location consist of London Clay, Lambeth Group and Thanet Sand overlying the chalk. The test pile, constructed under bentonite, was 45.5m deep with a penetration into the chalk of 13.5m.

O-cell assembly made at Rom-Tech's cage fabrication facility in Sheffield

The Osterberg method was considered to the optimum solution and a loading arrangement with a capacity of 52MN was installed at a design depth where approximately equal reaction would be available above and below the O-cell assembly within the chalk layer.

The requirement for no overhead reaction kentledge or steel reaction beams, a feature of O-cell bi-directional testing, was also found to be very attractive for the working pile test performed on a smaller 750 mm diameter pile. Post test grouting of the working test pile allows the pile to be integrated into the structure.

Installation of one of the preliminary test piles

Test Results:

The 1500mm preliminary pile test was loaded beyond the rated capacity of the O-cells to over 40 MN in each direction, thus mobilising approximately **80 MN** in total.

Placement of strain gauges within the pile shaft allowed the mobilised unit skin friction to be assessed in the various soil layers and in addition, a set of compression telltales in the friction reducing sleeves confirmed that they were working very effectively as no detectable compression of the top 18m length was observed.

The results were analyzed using Cemsolve® and the Cemset® pile settlement prediction analysis program to determine the ultimate capacities and identified that the design has scope for optimization without compromising the factor of safety.

Testing in progress – pile head and reference beam

Conclusions:

The testing program allowed the geotechnical design characteristics to be determined with the preliminary test and optimization of the design.

The test produced the highest static load applied to a single foundation test pile in the United Kingdom.

LOW HEADROOM STATIC LOAD TESTING
O-Cell® Technology at 22 BISHOPSGATE, LONDON, UK

Project: 22 Bishopsgate, London, UK

Client: Martello Piling

Consultants: WSP

Contractor: Brookfield Multiplex

According to City A.M. The new building "fills an obvious gap" in the City, its developers said (Source: Axa Real Estate) www.cityam.com

Martello's low headroom rig in action

Installation of the O-cell and reinforcing cage for the test pile

Project Description:

The site at 22 Bishopsgate started construction as The Pinnacle Tower. But, with only 7 storeys being constructed, the project was abandoned due to the property crisis. Since then it had acquired the nickname 'The Stump'. New owners, AXA Real Estate have taken given the project new life with a 62 story tower with capacity for more than 12,000 people with office space, restaurants, bars and retail, as well as a viewing gallery which will be free to the public.

Project Summary:

The issue for the new constructors was how to deal with the existing building 'stump' and transform the site to the new design. With several basement levels already constructed as well as the above ground structure, placing new piles would be a challenge. Martello Piling were given the task of drilling new bores of 1050 mm diameter in excess of 30 m length in the lower basement, some three stories from ground level. One of their mini-rigs fitted the bill perfectly, working in only 4.5m of headroom.

However, with such restrictions, the issue of pile verification was raised. The new working piles required load testing to meet the requirements of the piling specification set by WSP. Anchor piles would be very expensive to construct and fitting them into the space restrictions in the building footprint would be very difficult. For obvious reasons, kentledge was out of the question.

The O-cell technique was perfect for this type of application. Only the test pile requires construction with no ancillary works necessary for the load test. A loading arrangement with a capacity in excess of 12MN was installed at a design depth where approximately equal reaction would be available above and below the O-cell assembly within the London Clay. The working pile design did not require full length steel, and so the reinforcement was only constructed to O-cell level in order to place the assembly at the correct balance point within the pile shaft. However, this still required 9 cages of 3m in length, with the associated 8 cage splices, hydraulics and cabling.

Test Results:

The test was carried out successfully to ICE SPERW for working piles to a gross load of 8.34 MN. The O-cell and the surrounding annulus formed during testing, were then grouted to reinstate the structural integrity of the pile to take the compressive load over the full pile length and to incorporate the pile into the building

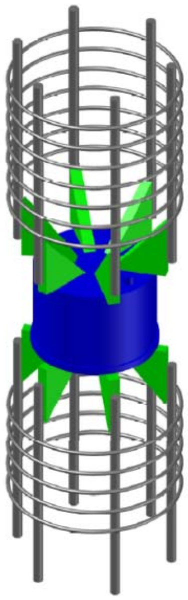
Conclusions:

The O-cell bi-directional testing method proved to be the most appropriate method of testing a low headroom working pile to loads of this magnitude, proving the method's applicability and ease in cases of restricted access and headroom.

LOADTEST First UK use of O-cell Technology in a CFA pile Brighton Marina

Project:	**Brighton Marina Development**
Location:	Brighton, East Sussex, UK
Developer :	Brunswick Developments
Main contractor:	J Reddington
Piling Contractor:	Miller Piling Limited

Project Description:



3D rendering of reinforcing cage with attached O-cell assembly

Lifting of full length reinforcing cage .

The current Brighton Marina development will create a major economic boost for the Brighton area. When completed, the development will boast 11 tall towers creating 853 new homes with 1,600 berths spread over 126 acres. The complex is also scheduled to be host to 25 restaurants and bars, 26 shops and a boutique hotel. With an estimated cost of £250m, this is a major investment in the area.

At the time of testing, Phase 1 of the complex was already well underway. The testing program was developed to pave the way for the future Phase 2 and Phase 3 works.

The main issue for piling contractor Miller Piling was how to verify that the underlying chalk strata would perform as per expectations once Phase 2 piling works started. The complication was that Phase 2 piling would take place beyond the breakwater once land had been reclaimed at a much later date. Only a small plot of land was available on land for trial drilling and pile testing.

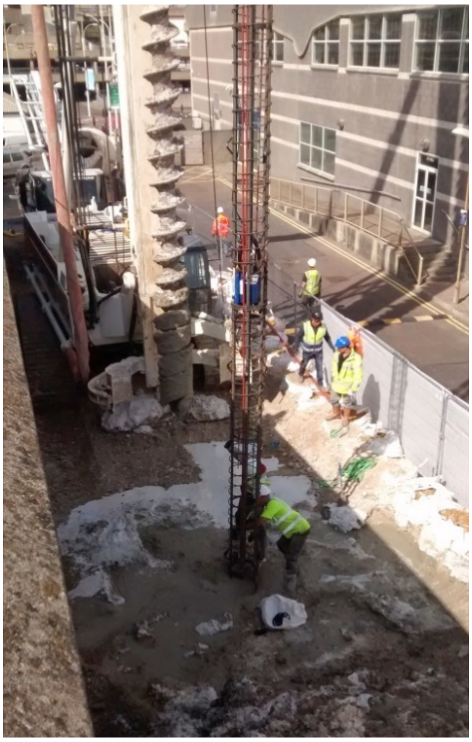
It was considered that the O-cell bi-directional static load test would be the ideal solution, as there would be no requirement for anchor piles and large beams or kentledge which would suit the site conditions perfectly. Further the reference beam was also not required and two instead two electronic Leica levels were used to monitor the top of pile movement.

The piles to be installed would be of CFA construction, 600 mm nominal diameter and lengths of approximately 20 metres. Soft alluvial clays overlay chalk which was of unknown quality and strength.

Many O-cells tests have been undertaken in the USA on continuous flight auger piles (auger-cast) and several on continental Europe, this was to be the first to be performed in the UK. A single O-cell is preferred for CFA pile testing since the reinforcing cage is required to be plunged into the wet concrete or grout. To assist in this, the cross section is minimized by using triangular section castellations welded to the O-cell (see illustration) and the assembly is then welded within the cage.

LOADTEST First UK use of O-cell Technology in a CFA pile Brighton Marina

Photographs showing the congestion in the site



Instrumentation such as expansion transducers, strain gauges and telltale compression extensometers are then attached to the reinforcing cage.

Miller Piling undertook trials using grout instead of concrete on a project in London to understand the requirements and calibrate their on-board instrumentation system for when pumping grout before using the system at Brighton Marina.

The site footprint was completely filled during piling works with the piling rig, concrete pump, delivery trucks and the crane for the cage which was located on the road to the fishing pier at a higher level due to restricted access. The 20.1 metre long CFA bore was constructed without incident and the cage gently lowered into the bore until the bottom of the cage rested on the toe of the pile.

Testing:

After a 21 day curing period, the single 320 mm O-cell, located 4.10 metres above the pile toe, was pressured in 19 nominally equal increments to achieve a maximum net load of 7.88 MN applied to the pile. This proved to be far in excess of the anticipated 5 MN maximum capacity expected. The pile capacity both above and below the O-cell was significantly higher than expectations indicating skin friction values above those anticipated by design.

Conclusion:

The O-cell bi-directional method of static load testing is equally suited to all types of bored piles, including CFA piles. Where a restricted site profile or unstable ground is present, the O-cell technology can remove design uncertainty.

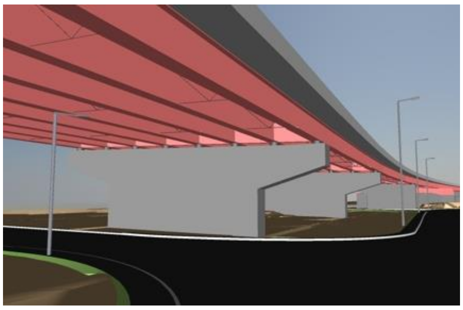
Courtesy of opportunities.greassets.co.uk at Brighton Marina

Fugro GeoServices Ltd (LOADTEST Division)
O-cell Technology in Cardiff, Wales

Project:	**The Eastern Bay Link Project**
Location:	Cardiff, Wales, UK
Client:	Dawnus Ferrovial Joint Venture (DFJV)
Piling Contractor:	Bauer Technologies Ltd
Project Description:	

The Cardiff Eastern Bay Link Project is a new dual carriageway providing a more direct route between the east of the city (Roverway) and Cardiff Bay (A4232 Butetown Tunnel). This project aims to alleviate the congestion around Tyndall Street by reducing traffic which currently uses the Ocean Way to Central Link via Tyndall Street route as well as improving access to Cardiff Bay and Cardiff Central Enterprise Zone. Construction started in the summer of 2015, the new road will include a 700 m bridge and 300 m embankment.

Source: www.bbc.co.uk



Artist Rendering of the 700 m Bridge
Source: www.dawnus.co.uk

To verify the bridge foundations, piling contractor, Bauer Technologies Ltd, sought Fugro GeoServices Ltd to carry out working pile load test program using the Osterberg Cell bi-directional testing method. A total of three piles out of the total 252 production piles were tested, located in three strategic locations.

Test pile depths ranged from 24.23 m to 30.81 m for the 1180 mm diameter bored piles. A single O-cell of either 330 mm or 430 mm was incorporated into the reinforcement cages, according to the loading requirements. The maximum required test load was 8.25 MN. All three test piles easily met the settlement criteria at DVL+ 50%SWL.

O-cell assembly made at AMCS's cage fabrication facility in Kent.

Preparation of the pile cages was performed in the ACMS manufacturing facility in Kent and transported to site for installation. As the piles were working production piles, the instrumentation was kept to a minimum with no strain gauges required.

With no reaction piles or heavy kentledge, the simplicity of the bi-directional testing method was ideally suited to the site location.

The three working piles were post-test grouted to restore their compressive structural integrity and incorporated into the bridge foundations.

Installation of one of the working test piles