Project Experience

Bi-directional O-Cell® testing of Railway Foundations

Fugro LOADTEST have been performing full scale static load testing using O-Cell® methodology for the foundations of structures associated with rail projects for more than 30 years, participating directly in some of the most challenging projects globally. From ultra-modern high speed rail projects to simple upgrades around the Globe.

The O-Cell method of static load testing the foundations provides several key advantages over traditional top-down methods. One major benefit of using bi-directional testing is the elimination of additional anchor piles or external reaction systems which are even more challenging and costly to assemble along the length of railway projects, which, due to the nature and location of the projects, are often remote and for river crossings, often positioned over water

As the technology for drilled shafts/piles develops and larger loads are demanded from each foundation element, the need to verify these design capacities increases. Loads applied using the O-Cell method often exceed 50 MN or even 100 MN and can easily be applied to either preliminary test piles or working piles which can be incorporated into the structure once testing is completed.

The following examples are just a small selection of some of the world class rail projects that have successfully been completed using O-Cell technology to test the foundation elements.

San Lorenzo - Andora Line – Italy

Expansion and upgrading of the rail system in North Western Italy is a huge government commitment to provide reliable public transport for the future. Construction of a new railway line can be a difficult process, overcoming a rugged coastline requiring multiple rock tunnels and viaducts across river valleys, simply adds to the challenge. In the city of Imperia, three test piles were executed using O-Cell methodology.
The local access to these sites was extremely difficult with no major roads in the location making the O-Cell method the perfect choice. Two auger bored test piles of Ø1,400 mm were installed to lengths of 12 m and 14 m. The third test pile was Ø2,000 mm and 24 m in length. All the piles were socketed into Limestone rock to a length of three diameters. The test piles were loaded to between 12.3 MN and 17 MN, allowing the acquisition of essential geotechnical data and the understanding of the limestone rock sockets behaviour under load.

High Speed 2 – United Kingdom

The high-speed rail line (HS2) was designed to take passengers from the heart of the capital to the cities of Birmingham, Manchester and beyond at up to 250 miles per hour. The project is being undertaken in several phases and passing through very challenging geotechnical founding materials on the way. Little knowledge of how these soils would behave under load was known. Since the loading capacity of the O-Cell test is only limited by the strength of the strata, the method proved to be the best approach for optimising the design for the higher loaded structures on this project with several sections in Chalk, Mudstones and other Rock strata.
Many tests have been carried out by using O-Cell assemblies with loading capacities of up to 60 MN. Tests have been used for both the new rail lines and the stations which form the key assets of the project.

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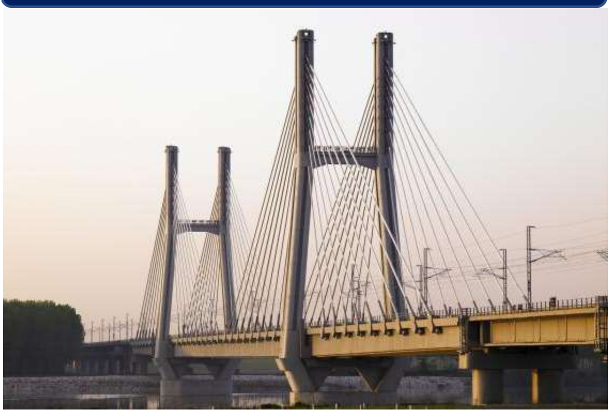
Leipzig Station - Germany

Leipzig Railway Station lies at the heart of the train system in Eastern Germany. The station was very much a terminus, with all trains from across the region stopping here on over 30 platforms. To improve the efficiency of the system, a through line was planned, travelling under the station which includes a large shopping centre. The risk to the building due to undermining and destabilising the existing foundations was considered to be very high and a series of tests were undertaken using O-Cells in new piles adjacent to the existing foundations. The test piles were loaded below the excavation zone replicating the existing building load and the load held while the skin friction element of the piles was enhanced by jet grouting techniques to assess the affect on the pile capacity. Once the tests were completed, the designers were able to plan excavation works with confidence.

Tilikum Crossing – Portland Oregon, USA

Portland, also known as the City of Bridges, is the new home of America's first car-free bridge. Built to accommodate trains, buses, bicyclists and pedestrians, this $135M project is also the first new bridge built across the Willamette River in four decades.
The two main towers for this railway bridge required O-Cell tests on 3,000 mm diameter test piles drilled into the Troutdale formation. Troutdale is a hard till (often partially indurated) of cobbles, gravel and some volcanic sands deposited eons ago by ancient rivers. The load requirements were dominated by the railway design.
Both test piles were completed to almost maximum capacity of the O-Cell arrangement with little movement, proving the suitability of the design for the bridge foundations and was sufficient for both vertical and lateral / torsional loading.

Milano - Bologna Line – Italy



Following the completion of the construction of the new high-speed railway between Genoa and Milano, several interconnecting railway lines were updated or freshly constructed. For the connection between Milano and Bologna, a new 400 metre cable stay suspension bridge crossing the Po River was required. As part of this project, Piacenza became the site for the first O-Cell test to be performed in Italy.
Two multi-level O-Cell tests were performed on Ø2,000 mm piles with depths of 52.3 and 57.7 metres.
The tests allowed the assessment of the side shear characteristics in specific zones, as well as isolating end bearing and total skin friction load. The tests mobilised a reaction load of over 65 MN. The O-Cell technical and economic merits were proven while minimizing disruption to the environment.

Crossrail London - UK

Crossrail, now formally known as the Elizabeth Line, names in honour of Queen Elizabeth II who opened it in her jubilee year, was a complex project of rail lines under and through the heart of London. Given the location and the already complexity of infrastructure, the localised sites were of very small footprint and of difficult access. To add to the challenges, Transport for London required the top of access shafts sites to include new buildings in their design to mitigate the overall costs.
The O-Cell bi-directional static load test method proved invaluable on several of the sites, where testing by other methods would have been very difficult. One location situated between the Thameslink and mainline routes at Farringdon Station provided a new static load test record at the time for a 1,500 mm pile with over 80 MN total applied load.