# 181 Fremont

San Francisco, CA

*The Lower Rebar Cage Arrives on the Job Site*

## Changing the Skyline in San Francisco

181 Fremont, designed by Heller Manus Architects, will be a mixed use skyscraper with retail space on the lower 33 floors and residential space on the upper 15 (Park 181). The tower will have 54 stories altogether. Including the spire, the building will be 802 feet tall. The building will be located near the Transbay Transit Center and the Market section of downtown.

*Drilling the Test Shaft*

Loadtest provided full scale load testing equipment and services for the deep foundation drilled shaft on the 181 Fremont project. City and Engineer considered load testing vital to the project due to the large loads, project significance and uncertainty with regard to soil and rock capacities.

| Project Info | |
|---|---|
| Owner: | Jay Paul Company |
| Client: | Malcolm Drilling |
| Prime: | Level 10 Construction |
| Engineer: | ARUP |
| Project Cost: | $500,000,000 (est.) |
| Completion Date: | 2016 |

**Services Provided**

- O-cell Test Design
- Assembly and Installation of O-cells and Instrumentation and Integration into Drilled Shafts
- Testing, Analysis and Reporting of Load test Results

Very little is known about the carrying capacity of the complex rock system at depth. The foundation system as designed, consists of multiple deep drilled shafts, some as deep as 270 feet. The test shaft construction was started by oscillating down a segmental casing to a depth of nearly 100 feet. The shaft was then drilled with an auger and bucket under polymer slurry to a depth of 262 feet.

Loadtest assisted in the early test design phase. The production shaft was designed to be incorporated into the foundation system. Making design and planning even trickier, the reinforcing cage was to be assembled over the excavation in multiple spliced sections. The successful installation and concreting ended up taking over 24 hours.

In December, 2013, Loadtest tested the 262 feet deep drilled shaft. The 6 feet diameter shaft was socketed 30 feet into rock (Franciscan Formation, Mélange) with the O-cells located 20 feet above the shaft base. Using three 24-inch O-cells on a single plain Loadtest applied a load of 18,400 kips. Maximum movements above and below the O-cells were 3.4 and 0.6 inches respectively. The displacement, strain gage and load data was analyzed to obtain t-z curves in 16 zones and q-z curves. The load test reports and the contained data and analyses allowed ARUP to redesign the foundation for maximum economy, safety and functionality.

# COLUMBUS HILTON DOWNTOWN

COLUMBUS, OHIO, USA

**The Hilton Hotel in downtown Columbus is expanding its capacity by adding a 28-story tower across N. High Street next to the Greater Columbus Convention Center. The new 450-room tower also improves the previous Convention Center pedestrian bridge and access to the Nationwide Arena.**

Construction of the tower was challenging due to the site being located on a tight footprint between the Convention Center, North High Street and Convention Center Drive. The new foundations would reach into the site's subsurface of brown silty sand with gravel and a silty gravel with sand.

The drilling contractor, Geottle, constructed 24 and 18 inch diameter test piles with an auger-cast drill rig to an approximate 50-foot depth. Fugro provided O-Cell® testing on the test piles. Placement of the O-Cell and instrumentation was managed with a structural member that centered the assembly in the constructed auger cast pile. Strain gauges and O-Cell were strategically located to provide subsurface response characteristics to allow for design optimization. Goettle maintained schedule even with unseasonal heavy rains and flooding which allowed the testing to occur as planned.

O-Cell testing reduced deep foundation uncertainty by providing valuable information on end bearing and side shear characteristics. The design calibration and measured performance allowed the designers to optimize the foundation design with shafts of shorter lengths which delivered project savings in construction effort, time and materials.

## PROJECT INFORMATION

- Owner: Hilton Hotels
- Prime: Turner
- Drilling Contractor: Goettle
- Completion Date: January 2022
- Project Cost: $220 million
- Maximum Load: 2,560 kips

## SERVICES PROVIDED

- Two single level O-Cell load tests
- Assisted in the load test program design and test shaft design

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# Fuller Warren Bridge

Jacksonville, FL


## Helping Jacksonville's Traffic Problems!

The Fuller Warren Bridge was originally built in 2002 to connect the San Marco and Riverside areas of Jacksonville. Jacksonville is very much a city on the move with a 20% increase in traffic expected over the next 20 years so the decision was made to expand the Fuller Warren Bridge. The finished expansion will include a new lane of traffic in each direction and also a Shared Use Path (SUP) for pedestrians and cyclists.

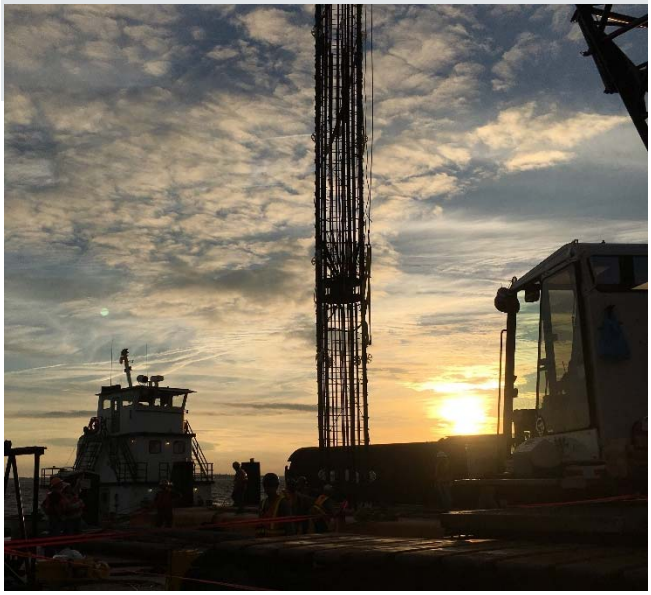
Subsurface stratigraphy in the river area mainly consists of weathered limestone underlain by a layer of hard Calcareous Silty Sand (Marl). Drilled Shafts were constructed to support the new expansion. Loadtest assisted Archer Western in the construction of the test piles which consisted of 4 dilled shafts varying from 60 to 135 feet in length and 60 to 84 inches in diameter. Loadtest provided one O-cell® assembly and between 5 and 12 levels of Strain Gages for each shaft. Loadtest also completed a SONICALIPER profile of the shaft to confirm the shape and verticality of the shaft.

After the concrete had gained sufficient strength, Loadtest returned to site to conduct the O-cell® test. The goal of the load test was to provide side shear and unit end bearing values for the rock socket. Through the use of the Strain Gages and the SONICALIPER profile, Loadtest were able to determine these values accurately providing the design engineers reliable information on which to base their design.

| Project Info | |
|---|---|
| Owners: | Florida DOT |
| General Contractors: | Archer Western |
| Geotechnical Consultants | Universal Engineering Sciences |
| Drilling Contractor: | Case Atlantic |
| Project Cost: | $126 million |
| Completion Date: | Summer 2020 |

**Services Provided**

- 4 Single Level O-Cell® Load Test.
- Load Test Program Design
- SONICALIPER Shaft Profiling



O-cell Load Testing

# Gerald Desmond Bridge

Long Beach, CA

*Lifting the Assembly*

## Port of Long Beach Gets Ready

The $1.3 billion Gerald Desmond Bridge Replacement Project will feature one of the tallest cable-stayed bridges in the country, carrying traffic across the Cerritos Channel to Terminal Island at the Port of Long Beach. The wider, taller design of the new superstructure, over 500 feet (50 stories) tall and spanning 1,000 feet across, will easily accommodate large post-Panamax ships as well as allow for smooth high-volume traffic flow.

The bridge's foundation includes nearly 350 cast-in-drilled-hole piles drilled into layers of interspersed silt, clay and sand. Loadtest was utilized in carrying out the full scale load testing for this signature bridge. Testing was initially performed on a 71" diameter pile 177 feet in length. The tip of the shaft was injected with high pressure grout in order to increase the allowable end bearing pressure. The loading assembly consisted of three 3,000 kip O-cells® located approximately 7 feet above the shaft tip.

Loading was performed in two cycles, with the first cycle applying a bi-directional load of 2,746 kips and the second cycle achieving a bi-directional load of 5,991 kips. A maximum unit side shear value of 10.3 ksf was calculated using strain gage data and a maximum unit end bearing pressure of 189 ksf was achieved.

After testing of the initial test shaft was completed, six additional shafts were tested over the next nine months. Tests shafts ranged from 59 inches to 98 inches in diameter and between 157 feet and 188 feet in length.

| Project Info | |
|---|---|
| Owner: | Caltrans |
| Design Build Team: | Shimmick-FCC-Impregilo J.V. |
| Engineer: | Group Delta |
| Completion Date: | 2017 - 2018 |
| Project Cost: | $1.3 billion |
| Maximum Load | 26,200 kips |

### Services Provided

- Single and Multi-Level O-cell Test Design
- Assembling Instrumentation and O-cells
- Installation of Rebar Cage into Test Shaft
- Testing, Analysis and Reporting of Load test Results

*Late Night Pour*

O-cell Load Testing

High pressure tip grouting was performed on all piles prior to testing. The loading assemblies consisted of three O-cells located on single plane for four test piles, four O-cells on a single plane for one test pile, and one multi-level configuration consisting of three O-cells each on two planes.

Total test loads ranged from 8,481 kips to 26,177 kips. Maximum unit end bearing pressures of the tip grouted piles ranged from 110 to 266 ksf.

The testing of multiple piles allowed precise analysis of the different soil conditions encountered on the site. The testing program also provided much needed data with respect to the effects of tip grouting on the capacity of the piles. Modifications and improvements were made to the grouting procedures between each test to refine the procedures. The data provided by Loadtest allowed the pile lengths for the individual bents to be refined to account for the actual side shear and end bearing capacity of the soils.

*Lower Cage Section Being Lifted with O-cell and Base Grouting Device Attached*

The test piles utilized sectional oscillated casing that reached the tip of the piles. When this method is combined with a tip-grouting device, it is often assumed the piles can remain open for an extended period of time without sacrificing capacity in end-bearing. Loadtest results indicated otherwise. The test piles that showed the best end bearing values were constructed in a manner that did not allow for any wasting of time between reaching tip, installing the rebar cage, and pouring the pile. The dependency on stiffening piles by applying load through a tip-grout device shouldn't allow for maneuverability around sound construction techniques.

Subtle differences in the construction of the test piles can potentially be used to describe anomalies in the test results. Expertise in quality control, drilled pile inspection, etc., during all phases of construction during the Loadtest programs and in production becomes extremely important.

# HUDSON YARDS

MANHATTAN, NEW YORK, USA

Referred to as 'The Final Frontier' in real estate market, Hudson Yards is transforming is 28 acres of western Manhattan into a dream city. Viewed as the largest private real estate development in the history of the United States, Hudson Yards brings together culture, commerce & cuisine, with an engineering marvel that pairs style with sustainability and a convergence of parks and public space.

Upon completion, the site will include more than 17,000,000 ft² of commercial, residential developments and 14 acres of open park space. Also included are a cultural venue, 750-person public school and 200-room luxury hotel.

The Hudson Yards subsoils are primarily near surface soft clay and silts underlain by a bedrock of Gneissic Schist. Loadtest assisted East Coast Drilling New York (ECDNY) in testing 6 test caissons; 48-inch diameter, a 42-inch rock socket and varying lengths from 66 to 150 feet.

Fugro Loadtest worked with the team to acquire the geotechnical information needed for design optimization. The goal was to gather information about the side shear and end bearing values in the rock socket. A program was planned to provide instrumented O-Cell® assemblies located at the shaft tips to evaluate the compression capacity. These assemblies included special bond-breaking casing to isolate the upper portion of the rock socket shear resistance limiting the applied loading to the lower rock socket area. Lateral load tests were then carried out in 3 additional shafts using the

## PROJECT INFORMATION

- Owner: The Related Companies L.P., Oxford Properties Group Inc.
- Architect: Kohn Pedersen Fox
- General Contractor: Tishman Construction, Tutor Perini
- Completion Date: December 2022
- Project Cost: $1 billion (Estimated)
- Geotech Consultants: Langan; Mueser Rutledge Consulting Engineers
- Capacity Achieved: 17,200 kips

## SERVICES PROVIDED

- 3 single level O-Cell load tests
- 3 lateral load tests
- Load test program design

O-Cell axially tested caissons as reactions. The static and lateral tests were performed one week after concrete placement.

The axial O-Cell tests indicated average combined side shear and end bearing resistance of 17,600 kips was available for design optimization. The lateral tests yielded an average maximum load of 250 kips. The geotechnical engineer then used this information to optimize (value engineer) the deep foundation design retrieving value for their client.

*O-Cell assembly*

*Lateral load test setup*

*Installing the O-Cell assembly*



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# HUDSON'S SITE

DETROIT, MICHIGAN, USA

**For decades, the iconic J.L. Hudson's flagship store occupied the entire 1200 block of Woodward Avenue and stood as the tallest department store/retail building in the world. The building no longer stands but construction is now underway on redeveloping the site. The new development will also set a record. At 912 feet, it will be the tallest building in Michigan's history.**

The two below grade levels will be constructed mostly for parking inside the existing walls of the former Hudson's Store and Premier Garage. Retail, commercial, cultural and office space will occupy the remaining floors up to a height of 14-stories for the Block structure. A 62-story high-rise hotel/residential tower housing up to 500 units will stand above the street at the south end of the site for the structure.

The boring logs for the site showed that ground conditions consisted of approximately 120 feet of lean clay underlain by 8 feet of hardpan and a limestone bedrock.

Foundations will consist of caissons drilled into the hardpan and limestone bedrock so the aim of the O-Cell test was to provide as much information as possible for these layers.

The O-Cell test was performed on the test caisson in November 2018. The test used a reduced diameter bottom plate on the base of the O-Cell assembly. By doing so, engineers were able to apply the load over a smaller area allowing the test to prove much higher unit end bearing values. The engineer was then able to use these values in their design reducing the foundation construction costs by an estimated $500,000.

## PROJECT INFORMATION

- Owner: Bedrock Detroit
- Architect: SHoP
- Engineer: SME
- Drilling Contractor: Rohrscheib Sons Caissons, Inc.
- Project Cost: $909 million
- Completion Date: Summer 2022

## SERVICES PROVIDED

- Single Level O-Cell load test
- Load test program design

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# US95 / CC-215 Interchange

Las Vegas, Nevada

*Shaft reinforcement with O-cell assembly.*

## O-cell® Testing of the US 95/CC 215 Interchange

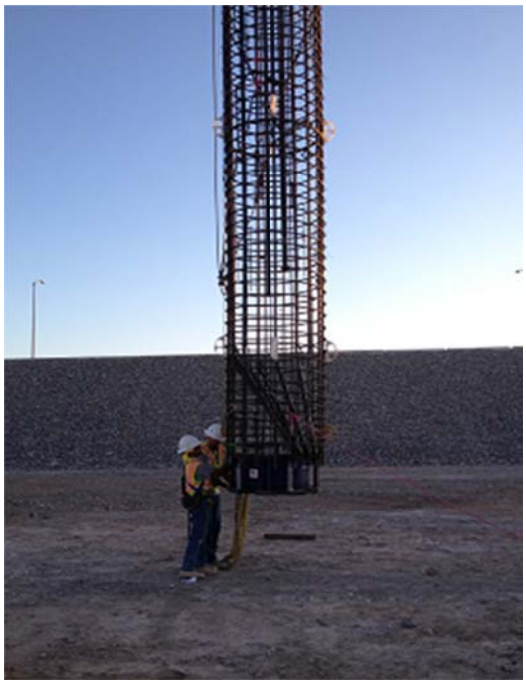
The Nevada Department of Transportation's US 95 / CC 215 Northern Beltway Exchange is part of the $525 million Northwest Corridor Improvements Project that will be completed in several phases over multiple years. Major elements of the Northern Beltway Exchange consist of two new ramps, including a 70-ft high, two-lane flyover bridge built with ten piers, as well as a collector-distributor road that will handle vehicles entering and exiting the interstate.

Once completed, the Northern Beltway will provide high occupancy vehicle (HOV) lanes in addition to greatly increasing capacity and safety. Designers also plan to incorporate images and patterns from the nearby Tule Springs fossil site, including a nearly full scale depiction of a Columbian mammoth.

| Project Info | |
|---|---|
| Owner: | Nevada DOT |
| Client: | Hayward Baker |
| Prime: | |
| Designer: | |
| Project Cost: | $225 -$287 million |
| Est. End Date: | 2017 |

**Services Provided**

- O-cell test design
- Assembly and Installation of O-cells and Instrumentation and Integration into Drilled Shafts
- SONICaliper® profiling
- Testing, Analysis and Reporting of Load Test Results



*Assembly readied for installation.*

Loadtest was utilized to provide testing experience and equipment on two drilled shafts to optimize the design parameters for the highway overpass. Testing was performed on both sides of the highway with each shaft being approximately 100 feet in length and 5 feet in diameter.

The load tests redefined the design parameters as well as increased the allowable design co-efficient provided by the LRFD method. Test loads exceeded 9,000 kips on both tests. Shaft profiles were taken of the drilled shafts using the SONICaliper and strain gages were installed at multiple elevations to allow analysis of load transfer to different soil strata layers.

# MERCEDES-BENZ STADIUM

ATLANTA, GEORGIA, USA

**With a maximum seating capacity of 83,000, the two million square foot Mercedes-Benz Stadium in Atlanta will continue to host the Georgia Dome's teams and events. The new iconic multi-purpose stadium will be home to the NFL's Atlanta Falcons and NCAA SEC Championships and Peach Bowl, as well as the Atlanta United FC, a new Major League Soccer team.**

The multi-purpose stadium hosted premier events such as the 2018 College Football Championship Game, the 2019 Super Bowl and was scheduled for the 2020 NCAA Basket Ball Final Four (prior to the COVID19 Pandemic). The versatile state-of-the-art facility is a $1.5 billion, public-private partnership (P3), that replaced the Georgia Dome in 2017.

The new stadium incorporates many innovative and versatile design elements, including a retractable eight-piece roof petal system that opens and shuts like a camera lens. The unique roof structure, designed to mimic a falcon wing shape, and other stadium features required twelve mega-columns to support the substantial structural loads. Large diameter drilled shafts, embedded into the bedrock, support the mega-columns massive compressive, tension and lateral forces. Design assumptions were calibrated through axial and lateral testing with Loadtest technology to characterize the foundations behavior at these large loads.

Subsurface conditions include surface fill and sand underlain by partially-weathered rock and gneiss bedrock. The two dedicated test shafts were constructed by ABE Enterprises with a rock auger and core barrel under polymer slurry. A

## PROJECT INFORMATION

- Owner: Georgia World Congress Center Authority
- Client: ABE Enterprises
- Engineer: Langan Engineering
- Completion Date: 2017
- Project Cost: $1.5 billion
- Maximum Load: 10,813 kips bi-directional

## SERVICES PROVIDED

- 2 single-level axial O-Cell® tests
- 1 lateral load test
- SONICaliper shaft profile
- MiniSID

SONICaliper™ and Mini-SID were used to inspect the excavations prior to installation of the O-Cell® assembly. The SONICaliper generated precise, 360° profiles of the shaft excavation sidewalls and excavation alignment and plumbness are germane to interpreting load distribution along the shaft during the load test. The Mini-SID provided bottom cleanliness information to assure end bearing load transfer occurred.

Test Shaft 1, excavated at 65-inch diameter and 55 feet long, had a loading assembly consisting of two single-level 26-inch diameter O-Cells located 1.5 feet above the shaft base and corresponding instrumentation. After concrete placement and curing, the O-Cells were used to load the shaft in 10 nominally equal increments, for a maximum bi-directional load of 3,711 kips applied to the shaft above and below the O-Cells.

Test Shaft 2 was also excavated at 65 inches in diameter but to a depth of 58 feet with a rock auger and core barrel. The two 26-inch diameter single-level O-Cells used were located 0.7 feet above the shaft base. The maximum sustained bi-directional load applied was 10,813 kips.

After its axial test, a lateral test was also performed on Test Shaft 1. The lateral test used a single 16-inch O-Cell loaded in ten increments to a maximum lateral load of 903 kips.

The structure used a combination of drilled piers, augercast piles, aggregate piers and spread footings for foundation supports. The load test program results allowed for site and design calibration to optimize foundation construction and allow for site variability while taking advantage of high strength of the bedrock.

*Aerial view of the stadium's retractible roof*

*O-Cell Load plate assembly*

*O-Cell assembly at tip of reinforcing cage*

*O-Cell axial shaft set up for subsequent lateral testing*

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# MIAMICENTRAL STATION

MIAMI, FLORIDA, USA

All Aboard Florida is building a massive all-inclusive ground transportation hub that combines several modes of transportation into one sleek package known as MiamiCentral. The new two-story station, located in the heart of downtown Miami, is designed as a "one-stop shop" for riders of Tri-Rail, Amtrak, Metrobus and Metrorail, and will also include a Metromover for transportation to the Miami airport.

Initially developed as part of Brightline, Virgin MiamCentral is the southern station of a planned 235 miles express passenger rail service to provide expedient, affordable travel between Miami and Orlando. The station's elevated five-track train platform does not interrupt surface street traffic. The station design creates retail space for high-end shops and restaurants below the elevated tracks and plans three residential and office towers to 51 stories above it. The 11-acre landmark project encompasses three million square feet.

The iconic multimodal hub follows history set by early 20th century railroad magnate Henry Flagler, who placed the original downtown Miami train station at the same site over 100 years ago. The line uses another Henry Flagler engineering innovation – the existing Florida East Coast Railway corridor between Miami and Cocoa.

The station design required over 1,600 piles ranging in depth from 60 to 115 feet. Fugro Loadtest performed O-Cell® testing on six dedicated test piles for pile design

## PROJECT INFORMATION

- Owner: All Aboard Florida - Stations LLC
- Client: HJ Foundation
- Engineer: Skidmore, Owings and Merrill
- Completion date:Early 2017
- Project Cost: $3 billion
- Maximum Load: 3,267kips

## SERVICES PROVIDED

- Six single Level O-Cell® load tests and reports

optimization. HJ Foundation constructed four 24-inch diameter test piles and two 30-inch diameter test piles with the continuous flight auger method. Site subsurface conditions consisted of limestone layers, fill and loose to medium dense sand.

A single 16-inch O-Cell was used in each of the 24-inch piles and a single 20-inch O-Cell was used in the 30-inch piles. The reinforcing cages, containing the O-Cell assembly and instrumentation, were inserted into wet grout immediately after pile construction.

For the testing the O-Cell supplied loading in nominal increments. The maximum bi-directional load was recorded at 3,267 kips, with a 20-inch O-Cell. Fugro Loadtest's program measured actual foundation performance and capacity resistance distribution giving the foundation design engineer information to optimize the foundation for the most efficient and cost-effective design possible.

*O-Cell*

*Stress sensors on cage*



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# MORTON PLANT HOSPITAL DOYLE TOWER

CLEARWATER, FLORIDA, USA

**Morton Plant Hospital celebrated its 100th anniversary with the addition of a $200 million multi-story patient and surgical tower.**

The Doyle Tower added more than 200,000 square feet to the existing hospital which include new patient rooms and clinics, a second main hospital entrance and separate all-inclusive floors for surgery, women's care and orthopedics.

Since the Doyle Tower directly connects to five existing buildings, disruption to the busy working hospital had to be minimized. Noise and vibration mitigation, inherent in the O-Cell® load testing method, allowed for minimal construction impact during this early construction phase of the new tower.

Case Atlantic excavated the 36-in. diameter, 76-ft. deep test shaft into typical Florida subsurface conditions consisting mainly of sand and clay layers underlain by limestone.

The excavation was inspected with SONICaliper™ to generate precise 360-degree profiles of the shaft excavation sidewalls, alignment and verticality prior to installation of the O-Cell assembly. This accurate profile is very germane to proper interpretation of load test results for foundation design optimization. The loading assembly consisted of two single-level 13-in. diameter O-Cells located 25 feet above the shaft base, along with corresponding instrumentation. After concrete placement and curing, the loads were applied in 24 nominally equal increments, resulting in a maximum bi-directional load of 2,596 kips applied to the shaft above and below the O-Cell assembly. Loadtest technology was used to prove foundation design optimization, efficiently reducing uncertainty and potential cost, while simultaneously limiting disruption.

## PROJECT INFORMATION

- Owner: BayCare Health System
- Prime: JE Dunn Construction Company
- Client: Case Atlantic Company
- Engineer: Driggers Engineering
- Completion date: 2016
- Project cost: $200 million
- Maximum load: 2,596 kips

## SERVICES PROVIDED

- Single level O-Cell® load test
- SONICaliper™ shaft profile

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*Image courtesy Hartshorne Plunkard Architecture*

# NO. 9 WALTON

## CHICAGO, ILLINOIS, USA

No. 9 Walton, an ultra-luxury condominium tower in Chicago's historic Gold Coast that's raising the high-rise condominium living standard. It is a $275 million ultra-luxury condominium tower on the corner of State and Walton that is designed for the top housing market. Part of a Chicago Near North Side construction boom, it is a powerful stone-clad 35 story building with just 67 exclusive units. As a "six-star" condominium community it will be unparalleled, a true Chicago-looking tower, housing condo units ranging from $1.85 million for a two-bedroom unit to $24 million for the penthouse.

A main project challenge was the ultra-compact jobsite, only 90 by 185 feet. The O-Cell® test method, a natural solution, as it eliminates the large ground level reaction system by utilizing the skin friction of the shaft as reaction. This frees tight jobsite space for other construction activities to continue simultaneously. This innovation assures the project foundations may be optimized with load test results.

Case Foundation Company has developed a technique for attaching the O-Cell assembly after the reinforcement cage is lifted into a vertical position. This eliminates need for a second crane, which, on tight jobsites is critical. The versatility of the O-Cell allowed the test shaft to be installed while a secant wall was being installed at the jobsite's North and East sides simultaneously. The adaptability of the O-Cell test method proved valuable as a design optimization tool in a challenging environment.

### PROJECT INFORMATION

- Developer: JDL Development
- Design: Hartshorne Plunkard Architecture
- General Contractor: Lend Lease
- Drilling Contractor: Case Foundation
- Completion Date: 2018
- Project Cost: $275 million
- Maximum Load: 1,620 kips (411 ksf end bearing)

### SERVICES PROVIDED

- Single level O-Cell load test
- Load test program design

## BI-DIRECTIONAL LOAD TEST

Choosing a "Chicago-Method" O-Cell test to allow for maximization of end bearing measurement was of benefit to the project from load optimization and schedule. Using a traditional O-Cell test placed at the pile tip with a reduced diameter circular bottom plate, as compared to the shaft diameter, allows confirmation of much higher end bearing values. A 102-inch production test shaft was drilled through the overburden to the top of rock with a single 20-inch diameter O-Cell located at the shaft base to provide a theoretical maximum test capacity of 4500 kips.

## CONCLUSIONS

Fugro Loadtest performed the O-Cell test in September 2015 in accordance with the Quick Load Test Method for Individual Piles (ASTM D1143). The O-Cell, loaded in nine nominally equal increments, produced a maximum directly applied unit end bearing of 411 ksf.

The O-Cell test method proved to be an invaluable tool for foundation optimization for No.9 Walton, given the site constraints and large required test loads. No.9 Walton simply could not have been built without the O-Cell proving the foundation viability.

*120-inch Diameter Steel Temporary Casing*


*Secant pile wall under construction*



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*Image courtesy Ross Barney Architects*

# O'HARE MULTI-MODAL FACILITY

CHICAGO, ILLINOIS, USA

**O'Hare Airport's 2.5 million square feet multi-modal facility hosts all rental car agencies under one roof to add airport efficiencies and reduce surface traffic congestion. Linked by light rail, to eliminate cumbersome shuttle buses, this facility will accommodate 30,000 daily travellers and provide dramatic benefits to the airport expansion and modernization.**

The multi-modal facility is one of the Midwest's largest structures and includes a 6700 vehicle five-level main parking structure and a Quick Turnaround maintenance garage. It is designed for future expansion to nine stories. The multimodal center connects airlines, light rail transit, traditional rail, buses, shuttles, rental cars and private vehicles all at one location to facilitate travel within the Chicago region and to destinations throughout the world.

## O-CELL® LOAD TESTS

To provide foundation optimization Fugro Loadtest advised using "Chicago-Method" O-Cell® tests for the project to prove higher foundation end-bearing values. It is a variation of the traditional O-Cell test that uses the hydraulic jack at the pile tip with a reduced diameter circular bottom plate, as compared to pile diameter, to concentrate end bearing load. As in regular O-Cell tests the load is applied to the reduced diameter bottom plate using the available side shear capacity above as reaction.

Two tests were performed on production 72-inch diameter caissons. The O-Cell configuration for both piles utilized single 20-inch diameter O-Cells located at the

## PROJECT INFORMATION

- Owner: Chicago Department of Aviation
- Foundation Contractor: Case Foundation
- Architect: Ross Barney Architects
- Completion Date: 2018
- Project Cost: $800 Million
- Maximum Load: Shaft End Bearing 287 tsf; CFA End Bearing 180 tsf

## SERVICES PROVIDED

- 3 O-Cell load tests
- SONICaliper™

shaft base with a 24-inch reduced diameter bottom plate to provide a maximum unit end bearing confirmation up to 319 tsf. The stratigraphy was generally overburden, weathered bedrock and Dolostone. One caisson penetrated through the overburden with the pile tipped about a foot above the Dolostone. The second was extended with the pile tip socketed about a foot into the Dolostone. The excavations were inspected with the SONICaliper ™ for plumbness, alignment and shape to assure that anomalies were not introducing errors in the load test results. The included SONICaliper image indicates one of the shaft profiles.

The third test was performed on a 48-inch diameter Continuous Flight Auger Cast (CFA) pile. As this was the first ever "Chicago-Method" O-cell test for an augercast pile, this proved a welcome challenge. Unlike traditional caissons, augercast piles are grouted as they are constructed, with the reinforcing steel then placed into the grout filled hole. The production CFA test pile was drilled through the overburden with the tip bearing in weathered bedrock about a foot above the dolomitic limestone bedrock. The O-Cell configuration was a single 13-inch diameter O-Cell with an 18-inch reduced diameter bottom plate located at the shaft base to provide a maximum unit end bearing confirmation up to 220 tsf.

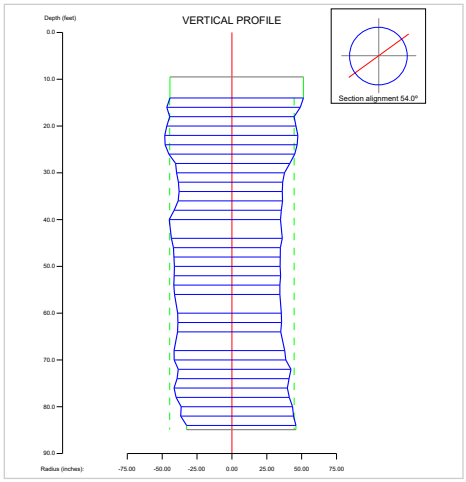
Fugro Loadtest performed the three O-Cell static load tests in November and December 2015 in accordance with the Quick Load Test Method for Individual Piles (ASTM D1143) using twenty nominally equal load increments. The 72-inch caisson test tipped

*Cage assembly*

1-foot above Dolostone had a maximum applied unit end bearing of 287 tsf while the second 72-inch caisson socketed into the Dolostone had a maximum applied unit end bearing of 279 tsf. These tests proved that foundations sitting on bedrock could obtain large end bearing values without having to penetrate the rock.

By the foundation not having to penetrate the rock, faster and more economical drilling techniques other than traditional caissons become viable. This was proven by the augercast pile test, founded just above the dolomitic limestone, which produced a unit end bearing of 180 tsf. This made the 48-inch augercast piles a viable foundation alternative for the Multi-Modal Facility.


*O-Cell assembly*




*SONICaliper profile*



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# THE RESIDENCES AT PARK GROVE

COCONUT GROVE, FLORIDA, USA

Park Grove is a luxury residential condominium development located on South Bayshore Drive in Miami's Coconut Grove. The project consists of three 20-story, nearly 300-foot towers with 298 residential units featuring panoramic Biscayne Bay views along with 6 smaller amenity buildings. The two towers located closest to the bay feature a unique figure-eight shape designed to maximize natural light in the center of the buildings.

Loadtest performed multi-level O-Cell® tests on two dedicated test shafts. Subsurface conditions consisted of very soft to soft limestone with some sand and very loose sand. Malcolm Drilling Company Inc. completed construction of the two test piles utilizing the continuous flight auger method. After each pile was excavated and grouted, the reinforcing cage with attached O-Cell assemblies was immediately inserted. The first test was performed on a 73.4-foot deep, 30-inch diameter test pile, using two 16-inch O-cells located at approximately 8

*Lowering assembly cage*

## PROJECT INFORMATION

- Owner: Park Grove
- Client: Malcolm Drilling Company Inc.
- Engineer: NV5
- Completion Date: 2017
- Project Cost: $680 million
- Maximum Load: 6,382 kips

## SERVICES PROVIDED

- Bi-directional O-Cell load testing and reporting
- Foundation risk management

feet and 26 feet above the pile tip. Test Pile 1 resulted in a maximum sustained combined load of 5,407 kips. Test Pile 2 was performed on an 84.8-foot deep, 36-inch diameter shaft, and consisted of two 20-inch O-Cells located at approximately 11 and 35 feet above the pile tip. The maximum sustained bi-directional load was 6,382 kips.
By validating the required loads for the buildings, Loadtest's testing program thereby reduces uncertainty and supports the most efficient foundation design.

*Preparing foundation construction*



LOADTEST™

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# SOUTH MOUNTAIN FREEWAY

PHOENIX, ARIZONA, USA

**The Arizona Department of Transportation's Loop 202, or South Mountain Freeway, is a 22-mile freeway, expected to open by late 2019. The South Mountain Freeway will complete the Loop 202 and Loop 101 freeway system.**

Subsequent to the load test program, the project was awarded to Connect 202 Partners as part of a Public-Private Partnership (P3) for a total of $1.8 billion. The team consists of Fluor Enterprises Inc., Granite Construction Co. and Ames Construction Inc. This project represents the largest highway project in the State's history.

Prior to finalizing the P3 selection, the ADOT embarked on an aggressive load testing program with HDR Inc. and Loadtest. The preliminary testing allowed ADOT to put economizing load test data in the hands of all three major bidders. This helped ensure the State would get the very best bids from all teams. Loadtest was utilized to provide its testing experience and equipment on two drilled shafts in order to optimize the design parameters for both the SR 202 / I-10 and the Salt River sites. Each site had unique subsurface features and as it turned out, differing drilled shaft capacities.

Test loads exceeded 8,400 kips at the SR-202/ I-10 site and 23,000 kips at the Salt River Site. Shaft profiles were taken of the drilled shafts by Southwest Exploration Services. Strain gages were installed at multiple elevations to allow analysis of load transfer to different soil strata (t-z analysis) and to obtain bearing data (q-z analysis).

## PROJECT INFORMATION

- Owner: ADOT
- Engineer: HDR, Inc.
- Client Case Foundation Company
- Completion Date: 2019
- Project Cost: $1.8 billion

## SERVICES PROVIDED

- Design, assembly and installation of O-Cells
- Testing, analysis and reporting of load test results

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# Transbay Tower

San Francisco, CA

*View of the San Francisco Skyline from the Transbay Tower Job Site*

## Changing the Skyline in San Francisco

Transbay Tower, designed by architect Cesar Pelli, will be a mixed use skyscraper and will stretch into the clouds at a future rail hub that developers describe a Western Grand Central Station. The tower will have 61 stories and reach 1,070 feet into the sky, making it the tallest building west of the Mississippi River. The small lot used to be a passenger waiting, loading and drop-off area for the old Transbay Terminal.

*Lower Rebar Cage with O-cells Lowered into Excavation*

The small (50,000 sqft.) lot was sold to Hines for $235 million.

Loadtest provided full scale load testing equipment and services for the deep foundation load bearing elements (LBE) on the Transbay Tower project. The owner, City and Engineer all considered load testing vital to the project due to the large loads, project significance and uncertainty with regard to soil and rock capacities. The foundation system as designed, consists of multiple rectangular LBEs as deep as 300 feet.

| Project Info | |
|---|---|
| Owner: | Boston Properties Inc. / Hines |
| Client: | Bencor of America |
| Prime: | Clark / Hathaway Dinwiddie<br>A Joint Venture |
| Engineer: | ARUP |
| Project Cost: | $1,000,000,000 (est.) |
| Completion Date: | 2018 |

### Services Provided

- O-cell Test Design
- Assembly and Installation of O-cells and Instrumentation and Integration into LBEs
- Testing, Analysis and Reporting of Load test Results

Loadtest was instrumental in the early test design phase. The production LBEs were designed to be incorporated into the foundation system and included very complex reinforcement. The reinforcing cage was assembled over the excavation in multiple spliced sections. The installation was difficult and time consuming. It took over twenty hours.

In late 2013 and early 2014, Loadtest tested a 250 and 290 feet deep LBE. The panels were 10.5 feet long and 5 feet wide. The first LBE was socketed 10 feet into rock (Franciscan Formation, Mélange) and the second, 50 feet.

Using eight 24-inch O-cells on a single plain in the first LBE and six 24 inch O-cells in the second, Loadtest applied loads of 17,400 kips and 27,800 kips respectively. Movements were small in the upward direction and over 6 inches down. The displacement, strain gage and load data was analyzed to obtain t-z curves in 16 zones and q-z curves. The load test reports and the contained data and analyses allowed ARUP to redesign the foundations for maximum economy, safety and functionality.

# A. James Clark Hall

College Park, Maryland

*Drilled shaft excavation.*

## O-cell® Testing at the University of Maryland

Set to open in 2017, the A. James Clark Hall at the University of Maryland is the new six-story, 187,000 square-foot building that will serve as home to the advancement of engineering and biomedical research. A combination of cutting edge laboratories, research facilities, classrooms and office space, the new building will bring together students, faculty and scientists from many disciplines with the common goal of health advancement through teaching, research and development.

A. James Clark and Dr. Robert E. Fishcell, both graduates of the University of Maryland, respectively donated $15 million and $6 million to make the $120 million project possible.

| Project Info | |
|---|---|
| Owner: | University of Maryland |
| Client: | Seaboard Foundations, Inc. |
| Prime: | Clark Construction Group |
| Designer: | Ballinger |
| Ground Breaking: | Nov. 2014 |
| Est. Opening: | 2017 |

**Services Provided**

- O-cell test design
- Assembly and Installation of O-cell and Instrumentation and Integration into Drilled Shaft
- Testing, Analysis and Reporting of Load Test Results


Loadtest was utilized to provide testing experience and equipment to Seaboard Foundations, Inc. to optimize the design parameters for the new A. James Clark Hall. Testing was performed prior to the ground breaking ceremony on a 94 foot deep drilled shaft. Construction of the shaft included multiple casings in the overburden soils and a 7 foot long socket into bedrock.

The goal of the load test was to prove the redefined design parameters in the rock socket. Strain gages were installed at five locations along the length of the shaft to determine the load transfer through the varying soil layers. The O-cell was placed near the tip of the shaft to ensure the end bearing would be fully mobilized. A combined end-bearing and side shear resistance of 2,798 kips was mobilized during the test. The test results proved a unit end-bearing resistance of 211 ksf at just over an inch of displacement. Strain gage data showed an average unit side shear of 16.7 ksf in the rock socket at just 0.05 inches of displacement.