

# **SAMPLE GUIDE SPECIFICATIONS FOR OSTERBERG CELL LOAD TESTING OF DEEP FOUNDATIONS**

## **1. GENERAL REQUIREMENTS**

### **1. Description of Work:**

This work consists of furnishing all materials, equipment and labor necessary for performing a load test using an Osterberg Cell, herein called the O-cell, and reporting the results of the test. The O-cell is a calibrated bi-directional loading device capable of applying loads upward and downward when embedded in a deep foundation. The Contractor shall employ the services of a Specialty Contractor to provide the necessary load testing equipment and instrumentation and to perform the load test. The O-cell load test is a non-destructive test and is suitable for both dedicated test shafts and production shafts. If a production shaft (intended to carry structural service loads) is tested, it shall be left in a condition suitable for use as a foundation element in the finished structure.

- A. Notify the Specialty Contractor at least 45 days in advance of load testing. The Contractor shall provide auxiliary equipment and services to support the Specialty Contractor as required.
- B. Unless otherwise directed or approved by the Engineer of Record and the Geotechnical Engineer, the O-Cell load test shall be performed on a drilled shaft installed at the location specified in the Plans.
- C. The O-Cell load test shall be performed on one (1) \_\_\_\_-inch diameter, non-production drilled shaft to a static bi-directional test load of at least \_\_\_\_\_ kips.
- D. The Contractor shall submit shop-drawings detailing the test shaft reinforcement, O-cell configuration, instrumentation and any other applicable details. The Contractor shall provide a load test plan including the testing procedures to the Engineer for approval no later than 30 days before beginning construction of the test shaft.

### **2. Definitions:**

- A. Contractor: The individual, firm, joint venture, or company contracting with the Department to perform the work.
- B. Specialty Contractor: The firm responsible for performing the static load test and reporting the results.

### 3. Submittals:

- A. The Contractor shall submit a load testing plan which outlines the test setup, including details of all system elements, instrumentation, materials, data collection systems and procedures. This testing submittal shall be developed with review and input from the Specialty Contractor, and submitted for review and approval by the Engineer at least 30 days prior to test shaft construction.
- B. Drawings showing the setup for the O-Cell test, including details of the Osterberg type embedded jack, load transfer mechanisms (bearing plates), instrumentation including telltales, strain gages, etc., and calibrations shall be provided.
- C. Load test reports as outlined in this Guide Specification.

## 2. INSTRUMENTATION AND MATERIAL REQUIREMENTS

The contractor shall supply all instrumentation and materials required to install the O-cell and related components, perform the load test and remove the load test instrumentation and apparatus as required. Instrumentation and materials include, but are not limited to the following:

### 1. O-cell

The Contractor shall furnish one (1) or more O-cells as required for each test shaft to be supplied by:

Loadtest  
2631 NW 41<sup>st</sup> Street  
Suite D-1  
Gainesville, FL 32606  
Telephone: (800)368-1138 or (352)378-3717  
<http://www.loadtest.com>

The O-cell to be provided shall have a capacity of at least \_\_\_\_\_ kips in each direction with signed certificate of calibration. The O-cell shall be equipped with all necessary hydraulic lines and fittings.

### 2. Assembly and Installation Materials

- A. Steel reinforcing cage or carrying frame used to support and convey O-cell assembly, instrumentation and piping to appropriate levels within the test shaft.

- B. Two (2) circular steel plates per O-cell assembly, which shall be 2 inches thick and approximately equivalent diameter as I.D. of steel reinforcing cage used on production shafts of same diameter. The plates are welded to the top and bottom of the O-cell for use as mechanism of load transfer.
- C. Centralizers shall be provided or means shall be implemented to ensure centralizing of the load test apparatus, instrumentation and reinforcing steel.
- D. Steel pipes which shall be ½-inch diameter used as conduit for telltales from above working level to the top of the O-cell assembly. Additional set of steel pipes serving dual purpose of venting the O-cell annulus during the test and as post-test grout placement tube, if production shaft is tested.
- E. Materials such as angle or channel steel or rebar needed to protect O-cell assembly, hydraulic fittings and instrumentation during installation and concreting procedures.
- F. Materials such as rebar used to construct an apparatus for funneling of the concrete slickline or tremie through the O-cell assembly for concrete placement.

### **3. Instrumentation and Testing Materials**

- A. Linear Vibrating Wire Displacement Transducers (LVWDT's) having a range of at least 6 inches, with signed certificates of calibration. Transducers shall be capable of reading to within 0.001-inch of displacement.
- B. Sister Bar Vibrating Wire Strain Gauges, with signed certificates of calibration.
- C. Telltale extensometer assemblies having a range of at least 1 inch with signed certificates of calibration. Transducers shall be capable of measuring movement within 0.001-inch.
- D. Embedded compression telltale assemblies shall be used when typical surface measuring methods are impractical.
- E. Clean water from an approved source to mix with water-soluble oil contained within the O-cell to form the hydraulic fluid used to pressurize the O-Cell.
- F. Materials sufficient to construct a protected work area, including provisions such as a tent or shed for protection from inclement weather for the load test equipment and personnel.

### **3. EQUIPMENT AND LABOR REQUIREMENTS**

1. Stable electric power source as required for lights, instruments, tools, etc.
2. Equipment and labor to construct the steel reinforcing cage or placement frame and position in a flat, suitable work area on job site.
3. Welding equipment, certified welding personnel and labor, as required, to prepare the work area, construct the O-cell assembly, attach it to the reinforcing cage or carrying frame and attach instrumentation to the O-Cell, all under the supervision of the Specialty Contractor.
4. Equipment and operators for handling the O-Cell, instrumentation and steel reinforcement during the installation of the O-Cell, including but not limited to a crane or other lifting devices, manual labor and hand tools.
5. Air compressor (minimum 185 cfm, 125 psi) with hose and Chicago-type fitting for pump operation during the load test.
6. Air-driven hydraulic pump to be used as O-cell pressure source and accompanying pressure gage.
7. Tripods, automated survey levels and related equipment to measure upward top of shaft displacement.
8. All necessary data acquisition equipment.

### **4. PROCEDURES**

#### **1. Test Shaft Assembly and Installation:**

- A. For the drilled shaft(s) selected for testing by the Engineer, the Contractor shall construct the shaft(s) using the approved drilling and installation techniques. Use the same means and methods for construction of the test shaft that will be implemented on all remaining production shafts. The drilling equipment and methods shall be suitable for drilling through the conditions encountered, with minimal disturbance to these conditions or any overlying or adjacent structure or services. This includes both wet and dry methods of drilled shaft construction.
- B. The O-Cell, hydraulic supply lines, and instrumentation shall be assembled and made ready for installation in a suitable area adjacent to the test element. The O-Cell assembly shall be welded to the reinforcing steel, with the plane of the bottom plate of the O-Cell set at right angles to the long axis of the

reinforcing steel assembly. Installation of the O-Cell and instrumentation assembly shall be performed under the direction and supervision of the Specialty Contractor.

- C. The intent of the load test internal instrumentation is to measure the test load and its distribution along the shaft and near the tip. The O-Cell and vibrating wire strain gages shall be incorporated into the reinforcing steel assembly as shown in the contract documents plans. Strain gages shall be uniformly spaced around the circumference of the shaft reinforcing cage. The geotechnical engineer may require revisions to location of the instrumentation.
- D. Once the shaft excavation has been completed, tested, inspected and accepted by the Engineer, the O-Cell and reinforcing steel assembly shall be lowered into the excavation. A seating layer of concrete shall be placed by an approved method in the base of the shaft to provide a level base and reaction for the O-cell. The preferred method is to install the O-cell assembly and deliver the seating layer using a slick line or tremie pipe extending through the O-cell assembly to the base of the shaft. Depending on the configuration of the test assembly, it may be necessary to deliver the seating layer of concrete prior to installing reinforcing cage with attached O-cell assembly. In this case, the O-cell assembly shall be installed while the concrete at the base is still fluid and should end up at least partially submerged and firmly seated in the wet concrete.
- E. The Contractor shall use the utmost care in handling the test assembly so as not to damage the instrumentation during installation. The contractor shall limit the deflection of the reinforcing cage to two (2) feet between pick points while lifting the cage from the horizontal to the vertical position. The maximum spacing between pick points shall be 25 feet. The contractor shall provide support bracing, strong backs, etc. to maintain the deflection within the specified tolerance. The O-cell assembly must remain perpendicular to the long axis of the reinforcing cage throughout the lifting and installation process.
- F. After the O-Cell and steel assembly have been set, confirm the proper elevation of the reinforcing cage has been attained. The shaft shall then be further concreted by an approved method as contained in the Standard Specifications and similar to that utilized for typical production shafts, ideally using the same concrete mix.
- G. In addition to those required by the contract documents, obtain at least four (4) concrete cylinders for compressive strength testing from the concrete used in the shaft. At least one cylinder shall be tested prior to the O-Cell load test to establish the minimum concrete strength, and two (2) cylinders tested on the day of the load test. Submit results to the Specialty Contractor and the Engineer.

## 2. Load Testing:

- A. The Contractor shall engage a specialty contractor with a minimum of 10 years experience specializing in bi-directional static load testing to provide the necessary load testing equipment and instrumentation and to perform the load tests. The Specialty Contractor shall be approved in advance by the Engineer.
- B. O-Cell load testing shall not begin until after a minimum of one week after completion of test shaft construction and/or shaft concrete attains a minimum compressive strength of not less than 85% design mix strength.
- C. The O-cell load test is performed in general compliance with *ASTM D1143-07 Standard Test Method for Deep Foundations Under Static Axial Compressive Load* using Procedure A: Quick Test loading schedule. The loads shall be applied in increments of between 5 to 10% of the anticipated failure load. The magnitude of the load increments should not be changed during the test.
- D. During the period required to perform the load test, no drilling or excavation operations on any shaft may be performed in the vicinity of the test. No casings shall be vibrated into place in the area near the test. If test apparatus show an indication of negative effects due to other construction activities, such activities shall be halted for the test duration.
- E. The specialty contractor shall collect all test data during O-Cell load testing and the Contractor shall assist as necessary during all aspects of the load test.
- F. The load shall be maintained constant at each increment for a period of at least 8 minutes. At the end of the final load increment, the load shall be removed in decrements of approximately 20% of the maximum test load. Each decrement shall be maintained for 4 minutes. Final rebound readings shall be taken after a minimum of 8 minutes after removal of the test load.
- G. As a minimum, direct movement indicator measurements shall be made of: O-Cell expansion, upward top of shaft displacement and top of O-Cell plate movement relative to upward top of shaft displacement (compression).
- H. If the shaft is a production shaft intended to carry load, the shaft shall be reloaded. At the completion of the first load cycle, the test shaft shall be reloaded to \_\_\_\_% of the maximum load sustained during the initial load test. Reload of the test shaft shall be performed in increments not to exceed \_\_\_\_% of the maximum load sustained during initial load test, with each increment held for a period of at least 4 minutes. Unload in one decrement with the final rebound reading taken 8 minutes after final removal of the test load.

### 3. Reporting:

- A. At each load increment (or decrement) telltale, survey level, LVWDT and strain gage data shall be reported at 1, 2, 4, and 8-minute (when applicable) intervals.
- B. Provide an electronic version to the Engineer for evaluation. An initial data report containing the load-movement curves and data tables will be provided to the Engineer within three (3) working days of the completion of load testing, to allow evaluation of the test results. A final report on the load testing report shall be submitted within seven (7) working days after completion of the O-Cell load test. As a minimum the report shall include:
  - a. Summary of the load test procedures
  - b. Tabulated data of all embedded and surface instrument readings.
  - c. Load vs. upward top of O-cell and downward base of O-cell displacement plots.
  - d. Equivalent top-loaded load settlement plot.
  - e. Load distribution plot based on strain gage data.
  - f. Provide net unit side shear curves, and unit end bearing vs. displacement curves (t-z and q-z curves), if applicable.
  - g. Creep limit analysis of all test shaft sections.
  - h. Caliper tool shaft excavation profiling.
  - i. Calibration documentation for all instrumentation and O-cell(s) used during the load test.
  - j. Boring logs and related site investigation results.
  - k. Summary of test shaft details and schematic as-built drawing of test shaft indicating locations of O-cell, instrumentation and soil stratigraphy.

### 5. DISPOSITION OF TESTED SHAFT

- 1. **Post-Test Grouting:** Post-test grouting of the shaft shall not be undertaken prior to formal acceptance of the load test results by the Owner or Owner's Engineer. During the O-cell test, the shaft breaks on a horizontal plane separating the upper section above the O-cell (upper side shear) from the lower section below (combined end bearing and lower side shear). This creates an annular space, the size of which depends on the shaft/O-cell geometry and the magnitude of O-cell expansion.

When a production shaft has been tested, the contractor will be required to grout the O-cell and the annular space around the O-cell in order to allow load transfer to the lower side shear and end bearing. The O-cell and annular space around the outside of the O-cell shall be grouted using techniques described herein and approved by the Engineer.

- A. Post Test Grouting of Osterberg Cells

- a. The grout shall consist of Portland cement and water only, **NO SAND**.

The grout shall be fluid and pumpable. An initial mix consisting of 6 to 7 gallons of water per 95-lb bag of cement is recommended. Adjust water to obtain desired consistency.

- b. The mixing shall be thorough to ensure that there are no lumps of dry cement. Pass the grout through a window screen mesh before pumping.
- c. Connect the grout pump outlet to one hydraulic line of the O-cell. Open the other line and establish a flow of **water** through the system.
- d. Pump the grout through the O-cell hydraulic line while collecting the effluent from the bleed line. Monitor characteristics of effluent material and when it becomes equivalent to the grout being pumped, stop pumping.
- e. Take three samples of the grout for compression testing @ 28 days, if required.

Recommended pre-mixed amount of grout for grouting of O-cell:						
O-cell Diameter (Inches)	9	13	16	21	26	34
Grout Volume (Cubic Feet)	3	4	5	7	9	13

B. Post Test Grouting of Annular Space Around Osterberg Cells

- a. Prepare a fluid grout mix consisting of Portland cement and water only, **NO SAND**. The mixing procedures should be as outlined for grouting the O-cells. The quantity of grout should be at least three (3) times the theoretical volume required to fill the annular space and grout pipes.
- b. Pump **water** and establish a flow through the grout pipes (minimum two per shaft).
- c. Pump the fluid grout through one of the grout pipes until grout is observed flowing from the second grout pipe or until 1.5 times the theoretical volume has been pumped.
- d. If no return of grout is observed from the second grout pipe, transfer the pump to the second pipe and pump grout through it until 1.5 times the theoretical volume has been pumped.
- e. If higher strength grout is deemed necessary, immediately proceed with pumping the higher strength grout (which may be a sand mix). The pumping procedures for this grout will be the same as described above for the initial cement-water grout. The entire grouting operation must be completed before the set time for the initial grout has elapsed.
- f. Take three (3) samples of each type of grout for compression testing @ 28 days.

<b>Recommended pre-mix amount of grout for grouting of annular space:</b>								
Shaft Diameter (Feet)	2	3	4	5	6	7	8	9
Grout Volume (Cubic Feet)	25	30	40	50	65	80	100	125

2. **Dismantling the Test Shaft:** Dismantling of the test shaft or cutting of any wires, hoses or piping shall not be undertaken prior to formal acceptance of the load test results by the Owner or Owner's Engineer. After the completion of the sacrificial or production load test and with prior approval by the Owner or Owner's Engineer, remove any equipment, material, waste, etc. which are not to be a part of the finished structure.
3. **Removal:** After each sacrificial load test is approved and accepted by the Engineer, remove the top of the shaft to at least two feet below finished grade. The Contractor shall take ownership and dispose of the cut off section and related material.

## 6. METHOD OF MEASUREMENT

The drilled shaft O-cell load test shall be considered as all material, labor, equipment, etc. required above the requirements of drilled shaft construction. This item should include everything necessary to assemble, install, conduct, report the results and remove the drilled shaft load test, under the direction of the Engineer and Specialty Contractor. All costs associated with the normal production of the drilled shafts are measured and paid for elsewhere in the contract documents.

## 7. BASIS OF PAYMENT

1. **Acceptance:** O-Cell load testing will be paid for at the contract bid price per each completed and accepted test. The price and payment shall be considered full compensation for furnishing all materials, providing all tools, equipment, labor and incidentals, conducting the load test, providing assistance to the Specialty Contractor and the Engineer and reporting the results.
2. **Pay Item:** Drilled Shaft Osterberg Cell Load Test.
3. **Pay unit:** Each