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## Supplemental Technical Specification for

# Rapid Axial Load Testing of Drilled Shafts

SCDOT Designation: SC-M-712-3 (07/19)

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APPROVED:

Division Administrator

By: \_\_\_\_\_

FEDERAL HIGHWAY ADMINISTRATION

### 1.0 GENERAL

**1.1** This work shall consist of performing a rapid axial compression load test on a test drilled shaft for the purpose of determining and/or verifying the nominal bearing resistance that may be used in the design of production drilled shafts. In addition, the load-deflection and soil-load transfer relationships shall also be determined. Production drilled shaft lengths may be adjusted after results of the test drilled shaft have been analyzed. No materials shall be ordered until drilled shaft lengths are approved by the Department. The test drilled shaft depth, diameter, and location shall be as specified in the plans. The testing specified in the project documents shall be conducted in general accordance with ASTM D7383 – *Standard Test Method for Axial Compressive Force Pulse (Rapid) Testing of Deep Foundations* and this Supplemental Technical Specification.

**1.2** The Rapid Load Testing equipment shall have sufficient capacity to fully mobilize the test shafts' ultimate nominal bearing resistance shown in the plans.

**1.3** The approximate location of the test drilled shaft (non-production) will be as indicated in the plans. The test drilled shaft shall maintain a minimum distance of 25 feet from any foundation element of any future bent. The Contractor shall submit the proposed location to the Department for approval.

**1.4** Load testing of the test drilled shaft shall not begin until the concrete has attained a compressive strength ( $f'_c$ ) as indicated in the plans and had a curing time of no less than 7 days. High early strength concrete may be used to obtain the required strength at an earlier time to prevent testing delays, upon the approval of the Department.

**1.5** The Contractor will be required to furnish and include all costs in the bid item for all materials, personnel, and equipment as described in the plans, this Supplemental Technical Specification, the Special Provisions and as required by the contract to adequately perform the Rapid Load Test. The Contractor shall engage the services of an approved Rapid Load Test supplier for instrumenting, performing, and reporting of the load test. The Contractor may contact the Engineer for names of Rapid Load Test suppliers.

**1.6** Supply the name and qualifications of the selected Rapid Load Test supplier a minimum of 45 days prior to conducting the Rapid Load Test. Electronically submit all shop drawings, erection plans, details, calculations, and procedures to the Department at least 21 days prior to beginning the Rapid Load Testing. Include with the submittal details with respect to the movement measuring system the piston support system and the method for measuring the applied load. Approval of these submittals by the Department shall not relieve the Contractor from making subsequent changes that may become necessary to carry out the test.

**1.7** The Contractor, in cooperation with the Rapid Load Test supplier will supply and supervise the mobilization, assembly, and operation of the Rapid Load Test equipment. Rapid Load Test supplier shall provide and install the required instrumentation for the test drilled shaft, acquire the test data during testing, and reduce the data into a report. This report shall be presented to the Contractor and the Department for evaluation. Interpretation of the test data with regard to foundation recommendations will be performed by the Geotechnical Engineer-of-Record (GEOR) with acceptance by the Department.

Rapid testing is non-destructive and entails no greater danger of shaft damage than static load testing.

## **2.0 MATERIALS & EQUIPMENT**

**2.1** The Contractor will supply all materials, personnel and equipment as described below and as required by the Contractor and the Rapid Load Test supplier to adequately perform the Rapid Load Test. Such materials and equipment are:

1. Rapid Load Testing apparatus, including pressure chamber and cylinder, reaction masses, exhaust silencer, gravel structure, gravel structure base frame, and all items specifically incidental to the Rapid Load Test system.
2. Foundation top plate (and follower assembly, if needed), adequate to distribute the applied rapid test load to the test shaft.
3. Rapid Load Test device, acceleration transducers, and data acquisition system pertaining directly to the Rapid Load Test device. All required electronic equipment for the recording, processing, and storage of the Rapid Load Test will be operated by the Rapid Load Test supplier.
4. Resistance based strain gages and sufficient cabling (as required).
5. One Geotechnical Engineer, licensed Professional Engineer in South Carolina, and one technician experienced in the implementation of the Rapid Load Test methods who will direct the test setup, perform the testing, direct the disassembly of the test apparatus, provide load test submittals, provide assistance as needed with pertinent Rapid Load Test issues, and provide a written report. Both the engineer and the technician shall, individually, have at least 2 years' experience in Rapid Load Testing.

**2.2** Additional materials required for the Rapid Load Test shall be supplied by the Contractor as specified by the Rapid Load Test supplier and include, but are not limited to, the following:

1. Support piles for falsework platform. A falsework platform is not required for land based testing. However, materials such as crane mats and plywood may be necessary to provide a level and firm surface to assemble the Rapid Load Test device on land based testing.
2. If the nominal resistance provided on the plans is in excess of 2,000 tons then approximately 180 tons of  $\frac{3}{4}$ -inch of gravel with less than 5 percent fines shall be provided as required by the Rapid Load Test supplier. If more than 1 Rapid Load Test is to be conducted over land, it is anticipated that the Contractor shall provide the necessary equipment to move the gravel between Rapid Load Test sites. The gravel material must be approved by the Department. (Note that #67 Stone has been used successfully in the past.)

**2.3** The Contractor shall supply any additional equipment and personnel to assemble, perform, disassemble, and move to next test site (if applicable). This equipment includes, but is not limited to, the following:

1. Unloading and loading of the Rapid Load Test device trucks during mobilization and demobilization.
2. Any necessary on-site mobilization of test equipment.
3. A level and firm surface surrounding the test drilled shaft to support the Rapid Load Test

device.

4. A level and smooth drilled shaft top. The top of the test drilled shaft shall incorporate permanent casing length as indicated in the plans and have a minimum ½-inch wall thickness. There shall be at least 6 inches between the top of the test drilled shaft and the top of casing left in place.
5. A crane, rigging and operator capable of lifting, unloading, assembling, disassembling, and packing all Rapid Load Test device equipment. The crane and rigging should be of sufficient size and strength to handle the required Rapid Load Test device equipment.
6. Power source adequate for electronic equipment.
7. For over water tests only, welding equipment and welder for falsework platform.

### **3.0 PREPARATION FOR TESTING**

**3.1** The Contractor shall perform site and foundation preparation. Foundation preparation includes the cutting and cleaning of the surface of the test drilled shaft down to design or test elevation. The top of the test drilled shaft shall be smooth and level. The area around the test drilled shaft, on land, shall be leveled and compacted within a 15-foot radius. The top of the drilled shaft should be approximately 2 feet above grade for axial testing. For over water or elevated work areas, the area provided shall be level and at the test elevation. The support falsework platform shall be assembled and installed by the Contractor at the test location.

**3.2** Prior to performing the load test, the Testing Engineer shall be provided with soil boring logs, test shaft installation records, concrete properties (strength, etc.) and details regarding the anticipated dynamic loading equipment. The Testing Engineer is required to perform wave equation analyses (using GRLWEAP or equivalent) to determine the amount of propellant fuel charge required for Rapid Load Testing so as not to cause damage in the test shaft during dynamic testing.

**3.3** For the test drilled shaft, proposed instrumentation location shall be provided to the Department a minimum of 7 days prior to the fabrication of the drilled shaft reinforcement cage. The Department will provide comments for the final instrumentation locations within 3 business days after receiving this information.

**3.4** Strain and pressure gage instrumentation, displacement transducers, CSL access tubes, Rapid Load Testing devices and any other materials and equipment required by Rapid Load Test supplier shall be installed on the reinforcing cage.

**3.5** Immediately prior to placement of the reinforcement cage, the dimensions and verticality of the drilled shaft excavation shall be determined by Contractor using a sonic calibration method approved by the Engineer.

**3.6** CSL testing will be performed by the Department personnel or a Department designated representative in accordance with Section 727 of the Standard Specifications.

**3.7** The Contractor shall perform the test drilled shaft excavation in accordance with Section 712 of the Standard Specifications.

**3.8** 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 cage to 2 feet between pick points while lifting the cage from the horizontal position to vertical. 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.

#### **4.0 PROCEDURE FOR LOAD TESTING**

**4.1** The Contractor shall assist the Rapid Load Test supplier as necessary during all aspects of the Rapid Load Test. The following steps shall be taken in the performance of the Rapid Load Test.

1. Preparation for testing as described in Section 3.0.
2. Place the piston mounting plate on the center of the test shaft, level the plate and secure with anchor bolts or welding.
3. Survey and record the shaft top elevation to a bench mark.
4. Bolt the piston assembly to the piston mounting plate.
5. Set the base frame for the gravel containment structure.
6. Connect load cell cable, ignition cable, and accelerometers to piston.
7. Connect all instrumentation to the data acquisition system.
8. Install the predetermined propellant fuel charge. Check the ignition initiating circuit for the correct resistance.
9. Install vent pin with new seal. Grease piston and cylinder. Place cylinder over piston.
10. Place reaction masses. Secure the masses to the cylinder assembly.
11. Place the gravel containment structure and secure into position (if required).
12. Fill the annular space between the gravel containment structure and the Rapid Load Test apparatus using gravel (if required).
13. Check the assembled device to ensure there is no physical interference of the load or acceleration monitoring systems.
14. Clear the test work area, for a distance of at least 100 feet from the test shaft, of personnel.
15. Perform final check of instrumentation and recording equipment.
16. Perform the test.
17. Back up test data on hard drive or jump drive.

#### **5.0 INSTRUMENTATION**

**5.1** The intent of the load test instrumentation is to measure the test load and its distribution between side resistance and end resistance, load versus deflection, to provide information for design calculations and estimates, and to provide information for final design. The Contractor shall provide assistance when requested by the Rapid Load Test supplier during installation of any instrumentation supplied through this contract. The Contractor should be aware that lead times are required for ordering instrumentation.

The Contractor shall take the lead times into account when planning the work. The instrumentation shall be installed prior to the construction or installation of the test drilled shaft.

**5.2** The cost of all instrumentation, to be installed as directed by the Rapid Load Test supplier, shall be included in the cost for Rapid Load Testing. Instrumentation pertaining to the Rapid Load Testing, and listed below, shall be provided by the Rapid Load Test supplier.

1. Electronic Resistance Based Strain Gages – See plans for layout and location of electronic resistance based strain gages. Lead wire shall be unspliced.
2. Accelerometers – A total of 3 accelerometers shall be arranged across the top of the test shaft approximately 120 degrees apart during Rapid Load Testing.
3. Data Acquisition System – The resistance strain gages will require specialized equipment capable of digitizing at very fast rates. The Rapid Load Test supplier shall supply the necessary equipment and record the test data.

## **6.0 REPORTING OF RESULTS**

**6.1** Unless otherwise specified by the Department, provide a sealed, color electronic copy report for each load test, for each drilled shaft tested using the Rapid Load Test device. Field results of the Rapid Load Test shall be provided within 3 working days of test completion. Submit a final report of the Rapid Load Testing no later than 7 days after testing is completed and accepted by the Department.

## **7.0 METHOD OF MEASUREMENT**

**7.1** The quantity of the pay item "Rapid Load Test of Drilled Shafts" is measured by each (EA) completed and accepted by the Department. A completed Rapid Load Test shall be 1 test conducted on a test drilled shaft using the Rapid Load Test method.

**7.2** The Rapid Load Test shall be considered as any material, labor, equipment, instrumentation, etc. required above. This item should include everything necessary to assemble, install, perform, collect data, and remove the Rapid Load Test equipment; under the direction of the Rapid Load Test supplier and others.

**7.3** All costs associated with the normal production of the drilled shaft are measured and paid for elsewhere in the contract documents.

## **8.0 DISPOSITION OF TEST SHAFT**

**8.1** After all testing and data collection has been completed, the test drilled shaft shall be cut off to a minimum depth of 2 feet below the ground surface. The cut-off portion of the shaft shall be properly disposed of by the contractor and the resulting hole shall be backfilled with soil in accordance with Section 205 of the Standard Specifications. The test area shall be graded smooth. In addition, the location of this test drilled shaft shall be indicated on the As-Built plans for this project.

## **9.0 BASIS OF PAYMENT**

**9.1** Rapid Load Testing will be paid for at the contract bid price per each accepted test. The price and payment shall be considered full compensation for furnishing all materials, providing all tools, equipment, labor and incidentals, providing assistance to the production of the test shaft, performing the Rapid Load Test, and disposing of the test drilled shaft as described in Section 8.0 above.

## **10.0 PAYMENT**

**10.1** Payment shall be made under SCDOT Pay Item No. 712XXXX, "Rapid Load Testing of Drilled Shafts".