VIRGINIA DEPARTMENT OF TRANSPORTATION
SPECIAL PROVISION FOR
Quality Assurance/Quality Control (QA/QC)
for the Construction of
Deep Foundation Systems
for Design-Build and PPTA Contracts

November 10, 2009

I. DESCRIPTION

This work shall consist of all material, equipment, labor, and services necessary to perform all operations of the QA/QC for the construction of deep foundation systems in accordance with these Special Provisions, the details and dimensions shown on the Plans, and the Contract Documents. Deep foundation systems referenced herein are defined exclusively as either drilled shafts or driven piles. Other methods of deep foundation construction (including, but not limited to, auger-cast piles and micropiles) may be used subject to Department approval; however, the QA/QC requirements for methods other than drilled shafts or driven piles are beyond the scope of this document.

II. SUPPORTING DOCUMENTS

Implementation of this Special Provision requires a complete understanding of the following documents:

1. "Special Provision for Drilled Shafts"
2. "Special Provision for Wave Equation Analysis"
3. "Special Provision for Dynamic Pile Testing for Friction Piles"
4. "Special Provision for Dynamic Pile Testing for End Bearing Piles"
5. Section 403 of the VDOT Road and Bridge Specifications

III. CONSTRUCTION QUALITY CONTROL

The Contractor shall integrate the design and construction team to ensure coordination and implementation of its geotechnical engineer's foundation design requirements in the constructed product. The Contractor shall employ a full-time, Construction Quality Assurance Manager (QAM) in accordance with the project requirements. The Contractor's geotechnical engineer shall be a Professional Engineer registered in the Commonwealth of Virginia and qualified by education and experience with geotechnical engineering aspects of projects of similar scope and complexity. Qualified representatives of the Contractor's geotechnical engineer shall observe and document all work described in this Special Provision, and shall submit such documentation to the QAM. All work not performed in the presence of the representative of the Contractor's geotechnical engineer shall be considered unacceptable, and reparations shall be performed by the Contractor to the satisfaction of the Department. All remedial work required due to the Contractor performing work not supervised by a representative of the Contractor's geotechnical engineer shall be completed at no additional cost to the Department.

The Contractor's geotechnical engineer shall review all reports, tests and documentation required herein for conformance to contract requirements and its foundation design recommendations, and shall sign and seal all such reports, tests and documentation prior to issuance to the Department. All representatives of the QAM and the Contractor's geotechnical engineer shall keep a diary of the activities that he/she observes. The Contractor's geotechnical engineer shall provide weekly reports summarizing the contractor's work.

The Contractor's geotechnical engineer shall certify whether the work was subjected to the required QA/QC, whether its representatives were qualified by education, experience and training to conduct the referenced activities, shall note any non-compliance issues, and shall certify whether the work is deemed acceptable or unacceptable. The Contractor's geotechnical engineer shall promptly notify the Department and the QAM of the results of its review, and the QAM shall report the contractors plan and progress for correcting non-compliant work.

The QAM shall submit summary reports of all work corresponding to requests for payment. The QAM's summary reports shall include the Contractor's geotechnical engineer's certifications of completed work.

IV. **DRILLED SHAFTS**

A. **Demonstration Shafts** (also known as "Test Shafts" or "Technique Shafts")

Demonstration shafts shall be constructed to determine if the methods, equipment, and procedures proposed by the Contractor are adequate to produce drilled shafts that meet the requirements of the project. All demonstration shafts (and load tests performed on demonstration shafts, if required) shall be completed to the satisfaction of the Department prior to commencement of the construction of production shafts.

The location of the demonstration shaft(s) shall be shown on the plans and is subject to the approval of the Department. Demonstration shafts shall be considered non-production shafts and shall be located at least 25 ft. (horizontally) from all proposed foundation systems. The diameter of the demonstration shaft shall be the same as that of the production shafts used on the project. The depth of the demonstration shaft shall be extended a minimum of 10 feet below the lowest plan tip elevation of the production shafts estimated on the plans, except for shafts on which load testing will be performed. If a load test will be performed on a demonstration shaft, the tip elevation shall be the same as the estimated tip elevation of the closest production shaft. Steel reinforcement and concrete shall be placed within the test shaft in the same manner as that proposed for the production shafts.

Frequency:

For bridges having five (5) spans or less and if the entire bridge footprint will be constructed within the same geologic formation, at least one (1) demonstration shaft shall be installed per bridge for each drilled shaft size proposed for the structure. For bridges having greater than five (5) spans but less than fifteen (15) spans, at least two (2) demonstration shafts shall be installed per bridge for each drilled shaft size proposed for the structure. For bridges having fifteen (15) spans or more, at least three (3) demonstration shafts shall be installed per bridge for each drilled shaft size proposed for the structure. If multiple demonstration shafts will be constructed, they shall be well spaced across the site of the structure.

Regardless of the size of the bridge, if the footprint of the structure is known to span multiple geologic formations, at least one (1) demonstration shaft for each geologic formation shall be installed. If the Contractor intends to use more than one method of construction (i.e., slurry construction for some shafts and temporary casing for others), at least one (1) demonstration shaft shall be utilized for each method of construction.

Note that for dual structures (parallel bridges situated in close proximity to each other), while these bridges are considered to be two individual structures, for the purposes of the paragraphs above, they can be considered to be a "single" bridge. [For example, if two parallel, three-span structures will be supported on drilled shafts having a 60-inch diameter, and these bridges are founded within the same geologic formation, one (1) demonstration shaft, having a diameter of 60 inches, is required.]

Acceptance:

A demonstration shaft will be deemed acceptable if the results all of the test procedures performed on the shaft during, and subsequent to, construction are determined to be acceptable. The required testing procedures are described below.

If, based on the test results, a demonstration shaft is deemed unacceptable, the Contractor shall revise his methods and/or equipment, and a subsequent demonstration shaft shall be constructed in the same general area to determine if the corrective measures were adequate. The subsequent demonstration shaft shall be tested for acceptance in the same manner as the previous shaft.

B. Concreting Curves

Frequency:

During concrete placement of all demonstration shafts and production shafts, the Contractor shall plot the theoretical and actual concrete volume curves. This information shall be submitted to the Department no later than 48 hours after the concrete placement of each shaft has been completed. If unexpected occurrences are observed during concrete placement (such as the actual volume deviating from the theoretical volume by more than 10%, for example), the Department shall be contacted immediately.

Acceptance:

No acceptance/rejection of the concreting curves will be made. This information will be used as an indicator as to the quality of the concrete in the shaft.

C. Crosshole Sonic Logging (CSL)

CSL is a nondestructive testing method performed on completed drilled shafts. It provides a method for evaluating the integrity of the drilled shaft concrete. All shafts (demonstration shafts and production shafts) shall be equipped with CSL tubes as described the Special Provision for Drilled Shafts.

Frequency:

All demonstration shafts shall be CSL tested. All non-redundant shafts shall be CSL tested. (A typical example of a non-redundant shaft is the case in which a single drilled shaft supports a single pier column. The failure of a non-redundant shaft, by definition, will likely result in the failure of the entire substructure unit and the structure itself.)

On projects that utilize redundant shafts (several shafts arranged in a group), the first two (2) production shafts (of each size) constructed for each bridge shall be CSL tested. Furthermore, a minimum of 20% of the total number of production shafts shall be CSL tested for each structure. The CSL testing shall be equally spaced (in time and location) across the structure. Copies of the CSL test results shall be submitted to the Department within five (5) working days of the completion of the fieldwork. The Contractor shall be prepared to perform additional CSL testing as deemed necessary by the Department. Additional CSL testing will be requested if field observations seem to indicate that concrete contamination has occurred.

Acceptance:

Acceptable CSL tests will be defined as those for which there is essentially no signal distortion throughout the entire length of the shaft, and the signal velocity is reduced by no more than 10% of that of sound concrete. If the CSL test results indicate that the aforementioned criteria have not been met, the Contractor shall propose remedial procedures to the Department. If the Contractor feels that, in spite of marginal or poor CSL results, the drilled shaft is adequate, the Contractor shall propose alternative integrity testing to the Department in an attempt to demonstrate that the shaft is acceptable. Some of these alternatives may include the use of other appropriate methods of non-destructive testing, coring the entire length of the shaft, or some other method acceptable to the Department.

C. Load Testing

Load testing in this case shall be assumed to refer to the axial, compressive static load test as defined in Section 403 of the Road and Bridge Specifications. If a project requires either lateral or tensile load testing, the Contractor shall follow the procedures outlined in the latest versions of ASTM D3966 and ASTM D3689, respectively.

In lieu of traditional static load testing, the Contractor may perform Osterberg load tests or Statnamic load tests, provided the required test load can be applied to the shaft using the alternative test method. If the Contractor is considering either the Osterberg or Statnamic methods, a detailed submittal of the proposed procedure shall be provided to the Department for review and approval.

Frequency:

A minimum of one (1) load test shall be performed for each shaft size for each bridge on the project. For bridges having more than 30 shafts, two (2) load tests shall be performed for each shaft size. If multiple load tests will be performed, they should be located, generally, at opposite ends of the structure. The load tests shall be performed on non-production demonstration shafts, unless, based on the criteria above, the number of required load tests exceeds the number of demonstration shafts. If this occurs, additional load tests can be performed on production shafts, provided approval has been given by the Department.

Acceptance:

A load test will be considered acceptable if it satisfies the required deflection and load carrying requirements cited in the Special Provisions, the Plans and the Specifications. If, for a specific project, modifications to these deflection criteria are deemed necessary, the Contractor shall submit these modifications to the Department for approval.

V. DRIVEN PILES

A. Wave Equation Submittals

Frequency:

The Contractor shall submit Wave Equation models in accordance with the requirements set forth in the “Special Provision for Wave Equation Analysis.” One (1) model for each pile size and loading condition for each structure shall be submitted. Additionally, all proposed hammers and all distinctly differing subsurface conditions shall be modeled with individual wave equation models. It is preferable to submit drivability models, which evaluate the pile capacity, driving resistance and driving stresses throughout the entire depth of penetration.

Acceptance:

No driving tests shall be performed until the Department has reviewed and approved the Wave Equation models. Acceptance will be based on the requirements stated in the “Special Provision for Wave Equation Analysis.”

B. Driving Tests

The payment item for “Driving Test” is typically established per unit length of pile; however, the term “driving test” within these Special Provisions will refer to an individual driving test pile.

Frequency:

When prestressed concrete piles are used for foundation support, the Contractor shall perform all driving tests prior to ordering production piles. A minimum of one (1) driving test per substructure unit shall be performed. If a substructure unit is greater than 100 ft. in width, two (2) driving tests per substructure unit shall be performed. When two driving tests are used within the same substructure unit, they shall be spaced as far apart as practical. Note that, when parallel structures are proposed, as was noted in *Section III. A.* (See above), they can effectively be defined as a single structure for purposes of this Special Provision.

Driving test piles shall be cast at least 10 ft. longer than the production piles they are supposed to represent, in order to provide some contingency length.

It is permissible for the Contractor to drive test piles in production pile locations and, provided they are successfully installed, these piles can be used as production piles. However, if the test pile is not successfully installed (or if the pile is broken or damaged during installation), the Contractor shall remove the test pile from the production pile location.

When steel piles are used and it is anticipated that the pile tips will be driven to competent rock, driving tests generally need not be performed. However, if the pile tips are expected to bear on/within weathered rock or if steel piles will be used predominantly as friction piles, driving tests are required. In all cases in which dynamic pile tests are utilized, driving test piles (one for each dynamic pile test) shall be used.

The following table summarizes the minimum driving test quantities when steel piles are used for structural support:

Condition	Required Quantity of Driving Tests
1. Pile tips driven to competent rock (overburden contains no boulders or buried obstructions, and typical pile loads are used)	No driving tests required, unless Dynamic Testing is performed.
2. Pile tips driven to competent rock (overburden likely contains boulders or buried obstructions)	One (1) driving test per substructure unit.
3. Pile tips driven to/into weathered rock (particularly where the soil overburden gradually transitions to weathered rock)	One (1) driving test placed at alternating substructure units (e.g., Abutment A, Bent 2, Bent 4, etc.)
4. Steel piles used as friction piles	One (1) driving test per substructure unit.

Acceptance:

The results of the driving test work will be used to help determine production pile lengths, anticipated driving resistances, and potential driving problems. No acceptance/rejection of the driving tests will be made.

C. **Dynamic Pile Tests**

Frequency:

When prestressed concrete piles are used, dynamic pile tests shall be performed on at least 50% of the driving test piles, with a minimum of one (1) dynamic test per each pile size used for each structure. When multiple dynamic tests are performed, they shall be spaced equally across the site of the structure. Copies of the dynamic test reports shall be submitted to the Department within five (5) days of completion of the fieldwork.

With respect to steel piles, referring to the table above, if conditions #2, #3 or #4 are applicable, at least 50% of the driving test piles shall be dynamically tested.

If Condition #1 is applicable, no dynamic pile testing is required. However, if the piles are required to carry a higher load than is typically used, dynamic testing shall be utilized to estimate pile capacity and driving stresses. For Condition #1 where a higher than typical load will be used, a minimum of 5% of the production piles shall be designated as "driving test" piles and shall be dynamically tested.

Acceptance:

A dynamic pile test will be deemed acceptable if the required pile capacity is achieved per the requirements of the "Special Provision for Dynamic Pile Testing for Friction Piles" or the "Special Provision for Dynamic Pile Testing for End Bearing Piles." Also, an acceptable dynamic pile test is one in which the allowable stresses are not exceeded during the initial driving and restrike operations.

D. Load Testing

Load testing in this case shall be assumed to refer to the axial, compressive static load test as defined in Section 403 of the Road and Bridge Specifications. Load tests need not be performed for driven piles, provided an appropriate level of dynamic pile testing is performed. Exceptions to this rule, if required, will be clearly indicated in the contract.

In lieu of the traditional static load testing, the Contractor may perform Osterberg load tests or Statnamic load tests, provided the required test load can be applied to the shaft using the alternative test method. If the Contractor is considering either the Osterberg or Statnamic methods, a detailed submittal of the proposed procedure shall be provided to the Department for review and approval.

If a project requires either lateral or tensile load testing, the Contractor shall follow the procedures outlined in the latest versions of ASTM D3966 and ASTM D3689, respectively.

VI. MEASUREMENT AND PAYMENT

All QA/QC is integral to the relevant work package that is part of the lump sum contract price. There is no separate payment for QA/QC. If an item does not satisfy the criteria stated herein, and in the event the Department accepts this item, the QAM will document the basis of acceptance. The Contractor and the Department will negotiate an appropriate adjustment in the contract price, warranty, or other specific requirements or adjustments that are appropriate.

VIRGINIA DEPARTMENT OF TRANSPORTATION
SPECIAL PROVISION FOR
CONTROLLED BLASTING
DESIGN-BUILD PROJECTS

November 24, 2009

I. DESCRIPTION

The Design-BuilderDesign-Builder is hereby advised of the close proximity of this project to private property, dwellings, water wells, springs, utilities, railroads and/or other structures. Therefore, to avoid property damages, the Design-Builder shall explore other means of loosening and/or reducing the size of the excavation without blasting, or if blasting becomes necessary, then controlled blasting techniques shall be employed during construction. Prior to prosecuting the work, the Design-Builder shall conduct an on-site review of the work involved and develop a plan of operations for performing the excavation work. Blasting plan shall be approved by the Design-Builder's Geotechnical Engineer and submitted to VDOT at least two (2) weeks prior to scheduled blasting.

II. BLASTING PROCEDURES

No blasting shall be performed within fifty (50) feet of existing or new bridge foundations, railroad right-of-way, residential or commercial buildings, wells or other structures without the written approval of VDOT. In the vicinity of proposed concrete construction, blasting shall be scheduled so that blasting operations are fully complete prior to the placement of concrete.

All blasting shall be performed in accordance with the current edition of the Virginia Statewide Fire Prevention Code. The Design-Builder shall utilize the services of an experienced powder man at all times. The drill hole diameter, hole spacing, and size of charge per hole shall be such as to afford satisfactory breakage with a minimum of vibration. A Construction Blasting Quantity and Distance Table shall be utilized to control the maximum quantity of explosives per shot for instantaneous firing or per delay for delay firing in pounds. At no time shall the total size of any charge cause the particle velocity of the ground motion to exceed 0.50 inches per second when measured at the nearest structure to a blast.

The Design-Builder shall maintain a daily log of the type, grade and quantity of explosives, type of detonating cap, hole locations, depths and minimum distances from the blasts to private property, dwellings, water wells, springs, utilities, and other structures. A copy of this log shall be submitted to VDOT at the end of each workday on which blasting activity has occurred.

III. SEISMIC MONITORING

The Design-Builder shall also submit to VDOT a comprehensive blasting plan detailing the blasting techniques to be used near private property, dwellings, water wells, springs, utilities, and other structures. Seismic monitoring shall be performed by a qualified firm in advance of performing construction operations near private property, dwellings, water wells, springs, utilities, and other structures. Some of the initial blasts shall be monitored close to the blasting while others shall be monitored at private properties, dwellings, water wells, springs, utilities, and other structures, and the blasting plan shall be revised if it is anticipated that the maximum particle velocity at those locations will exceed 0.50 inches per second.

The seismograph used shall have the ability to store data such that it can be played back into a computer for digital processing, or onto a chart recorder for visual inspection interpretation. Further, the seismograph used shall be capable of accurately measuring frequency and amplitude in three planes: vertically, longitudinally, and transversely. These instruments must be dynamically calibrated and of such sensitivity that displacements as little as 0.0005 inches

and frequencies of from 1 to 100 cycles per second may be read. The instruments must also be capable of adjustment so that the peak of maximum amplitude of vibration can be recorded.

The Design-Builder shall cooperate and coordinate blasting activities with the owners of private property, dwellings, water wells, springs, utilities, and structures.

The cost for explosives and blasting operations, alternative methods, monitoring, and the recording and submission of daily blasting logs will not be measured for separate payment. Design-Builder's failure to maintain and submit daily blasting logs as stipulated herein will result in withholding payment for regular excavation until such time that daily logs are provided.