



Iowa Department of Transportation

SPECIAL PROVISION FOR POST PRESSURE GROUTING

Pottawattamie County
BRF-006-1(113)--38-78

Effective Date
February 16, 2010

THE STANDARD SPECIFICATIONS, SERIES 2009, ARE AMENDED BY THE FOLLOWING MODIFICATIONS AND ADDITIONS. THESE ARE SPECIAL PROVISIONS AND THEY SHALL PREVAIL OVER THOSE PUBLISHED IN THE STANDARD SPECIFICATIONS.

090043.01 DESCRIPTION

This work shall consist of furnishing all materials and labor necessary to perform post pressure grouting of the drilled shaft bottom as shown in the Plans or as directed by the Engineer.

The post grouting Specialty Contractor shall be:

Applied Foundation Testing, Inc.
1060 Roland Avenue
Green Cove Springs, Florida 32043
Phone: 904.284.1337
FAX: 904.284.1339

The Contractor shall provide a minimum of 30 calendar days notice to the Engineer before the construction of drilled shafts to be post pressure grouted begins.

090043.02 MATERIALS

- A.** The post grouting Specialty Contractor shall supply all materials, personnel and equipment as described below and as required by the Contractor to adequately perform post grouting and grout feasibility test. Such materials and equipment are:
1. A grouting pump capable of supplying 1500 psi of grout pressure to the tip of the post-grout shafts. The grout pump shall be a single or double stage hydraulic piston type. The grout pump shall be equipped with a pressure gage capable of being monitored by the Engineer.
 2. Grout plant with a minimum capacity of 10 cubic feet. The plant shall be equipped with a colloidal mixer and an agitated holding tank.

3. Grout cell (grout plate assembly) in sleeve ports type with a steel plate and necessary accessories for installation.
 4. Two linear voltage differential transforms (LVDTs).
 5. Manual grout volume measurement equipment.
 6. Survey Level capable of reading to 0.001 feet.
 7. Geokon model 4850 NATM Style Stress Cell
- B.** The Contractor shall supply any additional materials, equipment, and labor required to effectively post grout the bottoms of the drilled shafts. This shall include, but is not limited to:
1. **Grout**

Grout shall consist of Type I-II Portland cement and water with a water cement ratio of 0.5. No sand mixes will be allowed. The grout shall be mixed thoroughly with a high efficiency mixer capable of producing a semi-colloidal suspension. A mixer assembly capable of mixing, holding, and pumping is recommended. The grout cube strength shall be at least 2500 psi after 28 days using ASTM C 109/C 109M-98.

Note that the grouting subcontractor should develop a mix with the addition of retarders or other additives as needed to ensure that the grout will have adequate working life at the anticipated grout pressures and temperatures and consistent with the grouting equipment to be used on the project.
 2. **Grout Tubes**

The grout tubes shall have an inner diameter of 1 inch and be made of SCH 80 PVC pipe. Sections of pipe shall be joined with SCH 80 PVC couplings. For all tube joints within the top 10 feet of the shaft shall be prepared by sanding and priming prior to gluing. The top 10 feet of each grout tube shall be made of Schedule 40 black steel pipe: 5 feet of this upper tube shall be encased by shaft concrete and 5 feet shall extend above the top of the shaft or ground surface elevation, whichever is higher. The grout tubes shall be terminated with a 1 inch NPT Male threaded fitting with cap. A minimum of four tubes shall be installed in each shaft equally spaced within the reinforcing cage. Final tube location shall be determined by the Contractor and approved by the Engineer.

Grout tubes installed in the test shaft are required to be of a flexible type (hydraulic hose) to accommodate up to 6-inches of movement of the Osterberg Cell. The grout tubes (hydraulic hose) shall be looped at the location of the Osterberg Cell to allow the required movement. The grout tubes shall be of sufficient strength to withstand the grout pressure anticipated during post grouting of the test shaft, as determined by the specialty Contractor and in accordance with this Special Provision.
 3. **Grout Cell**

The grout cell shall consist of a circular steel plate having a diameter three (3) inches smaller than the diameter of the drilled shaft. The plate shall be made of at least A36 steel and have a thickness of at least ½ inch. The grout cell shall consist of the steel plate, a rubber membrane or diaphragm that is attached to the bottom of the steel plate, and a single layer of drainage mat material between the steel plate and the rubber diaphragm. The steel plate shall be furnished with at least four steel tubes to allow grout to be pumped from the grout tubes into the space between the steel plate and the rubber diaphragm.

The grout cell for the demonstration/test shaft shall be furnished with four (4) Geokon model 4850 NATM style stress cells. The stress cells shall be attached to the steel plate in accordance with the manufacturer's recommendations. The post grouting Specialty Contractor shall furnish all necessary hardware and connections for the stress cells so that the distribution of applied grout pressure can be measured during the post grouting process. The stress cells shall be spaced equally across the area of the grout cell steel plate and shall not interfere with the grout tubes or the rubber diaphragm.

4. Potable fresh water, 1 inch supply line and pump.
5. Reference beams and necessary support.

090043.03 CONSTRUCTION

A. Preparation for Grouting.

The Contractor shall notify the Engineer of the shaft installation and post-grouting schedule 30 days prior to commencing. Construction of post-grouted drilled shafts is identical to conventional drilled shaft construction with the following exceptions: the installation of grout tubes and grout cells shall be under the supervision of the post grouting specialty contractor; reinforcing cages shall be placed in soft contact with the bottom of the excavation; and the grouting procedure shall follow these Special Provisions.

1. Grout tubes shall be installed in the reinforcing cage at the time of cage construction. They shall be installed from the tip of shaft extending approximately 5 feet above the shaft top. This shall include providing and installing 1 inch threaded male adapters on the top of each tube. They shall be securely fastened at a maximum of 5 foot intervals along the cage, with the exception of the bottom 10 feet to allow for grout cell installation. The reinforcing cage shall be lowered onto the grout cell after cage erection in order to minimize cell damage from cage racking. The lower 10 feet of the grout tubes (previously left unrestrained) shall be aligned with the grout cell slip tube connections and secured to the reinforcing cage. Supplemental grout cell restraints shall be furnished by the post grouting Specialty Contractor and firmly affixed to the reinforcing cage.
2. When installing the reinforcing cage in the excavation, it shall be lowered until coming into soft contact with the bottom of the excavation. To minimize potential cell damage and prevent inadvertent cage buckling/poor alignment, the full weight of the reinforcing cage shall not be applied to grout cell.
3. Post grouting procedures (detailed below) may commence upon achieving the specified 28-day concrete strength of 3500 psi.

B. Procedure of Post-grouting Shaft Bottom.

The Contractor shall perform the post-grouting process in accordance with the following procedure:

1. Access to the top of the shaft must be made available for surveying, grouting tubes and other required instrumentation.
2. Preparation for grouting shall be as specified.
3. The shaft top elevation shall be surveyed and recorded to a benchmark.

4. Using the intended grout pump, the pump reservoir shall be filled with water, and the pump lines and shaft access lines shall be flushed simultaneously until residual drilling fluid is expelled from all shaft access lines and clear water is returned. Each access line shall be fitted with a sacrificial in-line valve capable of sustaining the design grout pressure.
5. Grout tubes shall be connected to the grout pump and cementitious grout shall be pumped continuously until a grout pressure or shaft uplift limit is exceeded, as described in the production grouting criteria set by the Engineer (typically derived from the grout feasibility test). The grouting process shall be continuous from the time of commencing. A minimum net volume of 3 cubic feet shall be pumped to the toe by the time the design pressure is achieved. This assures that an artificial pressure is not induced by access line blockage.
6. Grout pressure, strain readings, and shaft top displacement shall be monitored continuously throughout the grout process. Grout volume may be measured manually every minute. The contractor shall stop the grout process immediately when the grouting reaches the production grouting criteria as specified by the Engineer. Upon achieving said pressure, the line pressure shall be safely vented and the valves removed or left open so as to not retain pressure within the grout cell during curing.
7. Upon completion and throughout the grouting process, the shaft top elevation shall be surveyed by the post grouting Specialty Contractor.

C. Survey Level.

As a check on the shaft movement, the elevations of a point near the top of the test shaft shall be determined by survey level before and after the pressure grouting. This shall be performed by the post grouting Specialty Contractor. Unless approved otherwise by the Engineer, level survey precision shall be 0.001 feet. Alternatively, the surveyor may read an Engineer's 50 scale attached near the shaft head. The initial elevation shall be determined before the application of the grout. A final reading shall be made at the time the grout pressure reaches the design pressure or as directed by the Engineer.

D. Grout Feasibility Test.

Grout feasibility tests were previously conducted as detailed in the report "Final Report of Drilled Shaft Post Grouting", dated October 9, 2008, by Applied Foundation Testing. The report is available from the Iowa Department of Transportation upon request.

So as to confirm the data detailed in the report referenced above, provide all necessary construction/production criteria for proper post-grouting, grout feasibility tests shall be conducted on the demonstration shaft as shown in the drawings or as directed by the Engineer. The test parameters, such as anticipated grout pressure and overall capacity should be established prior to construction.

Sufficient instrumentation shall be furnished to simultaneously record grout tube pressure and grout volume measurements at a minimum top of shaft displacement. A minimum of two linear voltage differential transforms (LVDTs) installed at the top of the test drilled shaft along the diameter shall be used to monitor the displacement of the shaft top. Reference beams with fixed supports at least 5 diameters from the test shaft shall be installed for LVDTs measurement. The strain gages shall be utilized to provide side shear distribution/performance and shaft tip upward movement in conjunction with shaft top displacement readings. The Engineer will review all data recorded during the grout feasibility test and will establish production grouting parameters.

E. Required Reports.

The post grouting Specialty Contractor shall provide a report of results of grout feasibility test for the demonstration/test shaft, including the top and tip of shaft upward movement versus grouting load, side shear versus grouting load curves for each subsoil stratum bounded by strain gages, and grout volume versus time during grouting. The report shall also provide recommendations for production grouting parameters, including upward movement limit, grout pressure, grout volume, and grouting stop criteria. Provide six hard copies and one electronic copy of the report to the Engineer.

The post grouting Specialty Contractor shall provide a report of the results of post grouting for each production shaft. This quality assurance report shall include monitoring of applied grout pressure, measurement of grout volume versus time, and the corresponding top displacement of the drilled shaft. Data for each production shaft shall be furnished in the final report and the final report shall include a graphical representation of top displacement versus production shaft location.

090043.04 METHOD OF MEASUREMENT

The Engineer will measure Post Pressure Grouting separately by count.

Post pressure grouting work shall include all necessary labor, materials and supplies, equipment, etc. to perform post pressure grouting, measurements, and reporting.

090043.05 BASIS OF PAYMENT

Post Pressure Grouting will be paid separately by each. Payment is full compensation for furnishing all materials, supplies, tools, equipment, and labor necessary to perform post pressure grouting, measurements, and reporting at production shafts and demonstration/test shaft. The Grout Feasibility Test shall be subsidiary.