March 22, 2017

DEPARTMENT OF TRANSPORTATION
STATE OF GEORGIA

SPECIAL PROVISION

Courtland Street Bridge Replacement
Fulton County
P.I. No. 752015-

SECTION 999 – MICROPILE FOUNDATIONS

Add the following:

999.1 General Description

This work consists of furnishing all labor, materials, equipment, tools and other incidental items to design and construct micropile foundations and includes all incidentals and additional work in conjunction therewith.

Micropile permanent casing diameter, micropile permanent casing wall thickness, micropile minimum permanent casing tip elevation or embedment into rock, and micropile minimum bond length shall be in conformance with the Contract Drawings, and as specified herein. Micropile minimum bond length and the minimum tip elevation for the micropile permanent casing were designed on the basis of lateral load and subsurface conditions.

Estimated bond length is provided in the Contract Drawings based on presumptive values of the grout-to-ground bond. The Contractor shall ensure the permanent casing wall thickness is adequate to resist any installation stresses or loads and verification and proof test loads. The Contractor shall be responsible for designing and installing the micropiles to meet the requirements specified on the Contract Drawings and as presented herein.

The bond length refers to the embedded portion of the pile, below the tip of the permanent steel casing, in which the frictional resistance of the pile is developed in dense granular soils or rock. The Contractor shall be responsible for determining the bond length necessary to develop a site specific load capacity to satisfy the micropile verification and proof load tests. The design shall be performed in accordance with AASHTO LRFD Bridge Design Specifications, 7th Edition - 2014.

The Contractor's installation methods and procedures will influence how much bond length is required. The Contractor shall submit proposed bond lengths, after the completion of verification load testing for the approval of the Engineer.

999.1.1 Definitions

Admixture:	Substance added to the grout to either control bleed and/or shrinkage, improve flowability, reduce water content, retard setting time, or resist washout.
Alignment Load:	A minimum initial load (no greater than 10 percent of the Design Load) applied to micropile during testing to keep the testing equipment correctly positioned.
Bond-Breaker:	A device or special treatment incorporated into a length of a micropile

	that will allow no load to be transferred to the soil over that length. A bond breaker also provides full lateral support of the pile over the length of the bond breaker.
Bond Length:	The length of the micropile that is bonded to the ground and used to transfer the applied axial loads to the surrounding soil or rock.
Casing:	Steel tube introduced during the drilling process in overburden soil to temporarily stabilize the drill hole. This is usually withdrawn as the pile is grouted, although in certain types of micropiles, some casing is permanently left in place to provide added pile reinforcement.
Centralizer:	A device to support and position the reinforcing steel in the drill hole and/or casing to provide a minimum grout cover.
Coupler:	The means by which the load can be transmitted from one partial length of reinforcement to another.
Free (Unbonded) Length:	The designed length of the micropile that is not bonded to the surrounding ground or grout during testing.
Micropile:	A small diameter, bored, cast-in-place pile, in which most of the applied load is resisted by the steel reinforcement, cement grout and frictional grout/ground bond.
Mill Secondary:	Mill rejected American Petroleum Institute (API) casing, a.k.a. "Mill Rejects," "Structural Grade," "Limited Service," or "Minimum Test Pipe."
Non-production Pile:	Non-production piles are piles that are not incorporated into the substructure. For example, test piles which are abandoned after testing has been completed.
Nominal Grout-to-Ground Bond Values:	The estimated ultimate geotechnical unit grout-to-ground bond strength selected for use in design.
Nominal Resistance:	The limiting resistance of the grout-to-ground bond or structural resistance, which is shown on the Contract Drawings.
Overburden:	Material, natural or placed, that may require cased drilling methods to provide an open borehole to underlying strata.
Positive Circulation or Flush:	A method of progressing and cleaning out a hole for a micropile wherein water is injected into the hole and returns upward along the outside of the drill casing.
Post-grouting:	The injection of additional grout into the load transfer length of a micropile after the primary grout has set, also known as regrouting or secondary grouting. A method used to increase pile capacity after the grout column has reached initial set. Grout is pumped at high pressure through a sleeved port pipe (post-grout tube), fracturing and expanding the grout column. A positive displacement piston pump with a liquid filled pressure gauge located near the pile head is used to pump the grout, and packers are used to isolate the grout ports.
Pressure Grouting:	A method used to develop pile capacity wherein controlled pressure is applied continuously to the top of the fluid grout column using a grout pump to inject additional grout, and is applied continuously within the bond length.
Primary Grout:	Portland-cement-based grout injected into the micropile hole prior to or after the installation of the reinforcement to direct the load transfer to the surrounding ground along the micropile.

Production Pile:	A pile used for supporting a structure. Production piles shall be installed using the same equipment, methods, and materials as accepted test piles.
Proof Load Test:	Incremental loading of a production micropile, recording the total movement at each increment.
Recirculation:	A method of handling drill fluid where the fluid coming back out of the hole is captured in a pan and reused.
Reinforcement:	The steel component of the micropile which accepts and/or resists applied loadings.
Reverse circulation:	A method of cleaning the inside of casing. Water is circulated down through the drill rods and returns upward through the inside of the casing to flush the casing clean.
Spacer:	A device to separate elements of a multiple-element reinforcement.
Test Piles:	Sacrificial test piles that are not incorporated into the substructure, and which are abandoned after completion of testing. Non-production test piles shall be installed using the same equipment, methods, materials, and under the same headroom as production piles.
Tremie Grouting:	A method used to place grout in a wet hole. A 1/2-inch to 1-inch inside diameter grout tube is placed to the bottom of the drill hole. While keeping the tube opening submerged in the grout, grout is pumped into the hole and displaces the drill fluid. Verification Load Test. Pile load test performed to verify the design of the pile system and the construction methods proposed, prior to installation of production piles.

999.1.2 Related References

A. Standard Specifications

General Provisions 101 through 150

Section 500 – Concrete Structures

Section 511 – Reinforcement Steel

Section 830 – Portland Cement

Section 831 – Admixtures

Section 880 – Water

B. Referenced Documents

AASHTO M 31/M 31M – Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement

AASHTO M 85 – Standard Specification for Portland Cement

AASHTO M 275/M 275M – Standard Specification for Uncoated High-Strength Steel Bars for Prestressing Concrete

AASHTO LRFD Bridge Design Specifications, 7th Edition - 2014

API RP 13B1 – Recommended Practice – Standard Procedure for Field Testing Water Based Drilling Fluid.

API Specifications 5CT – Specification for Casing and Tubing

ASTM A 252 - Standard Specification for Welded and Seamless Steel Pipe Piles

ASTM A615/A615M – Deformed and Plain Billet Steel Bars (A615M Grade 520 or A615 Grade 75) for Concrete Reinforcement.

ASTM C109 - Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in or 50-mm Cube Specimens).

ASTM D1143 – Standard Test Methods for Deep Foundations Under Static Axial Compressive Load

ASTM D3689 – Standard Test Methods for Deep Foundations Under Static Axial Tensile Load

999.1.3 Submittals

A. Proof of Ability

Submit to the Engineer for review and approval the following proof of ability at least 21 days prior to beginning micropile construction:

- Documented qualifications of at least one Registered Professional Engineer licensed to perform work in the State of Georgia employed for the overall charge of the Work and a supervising Engineer for the Project with at least 5 years of experience in constructing micropiles.
- Documented qualifications of the Micropile Design Engineer as a Registered Professional Engineer licensed to perform work in the State of Georgia with working experience on a minimum of five projects designing and constructing micropiles.
- Evidence of successfully completing at least five projects similar in concept and scope to the proposed design. Include names, addresses and telephone numbers of the owner's representatives for verification.
- Resumes of foremen, superintendents, and drilling operators to be employed on this project. Show the type, length, and number of micropiles each has installed or tested within the past five years
- Evidence of experience in load testing. Persons performing load testing must list previous load testing projects within the past five years
- Documented qualifications of certified welder and a specialized welding plan for the micropile casing, if applicable.

The Department is the sole judge of the qualifications of the foreman, drilling operator, and testing personnel. Do not begin construction on foundations until the Engineer has approved the documented proof of ability.

B. Micropile Final Plan, Calculations, and Sequence of Construction

Work shall not begin until the appropriate submittals have been received and reviewed, with the exception of work associated with the verification load tests. The Contractor shall notify the Engineer of the date and time of verification load tests a minimum of seven days prior to verification load testing. Additional time required due to incomplete or unacceptable submittals shall not be cause for delay or impact claims. Contractor submittals which are incomplete or unacceptable shall be resubmitted at no additional cost to the Department. Work other than test pile installation shall not begin until the construction submittals have been received, reviewed, and accepted in writing by the Engineer. Review by Engineer does not relieve the Contractor of his responsibility for the design and installations of the micropiles that are capable of supporting the design loads shown on the Contract Drawings and meeting the criteria developed by the Engineer.

1. The qualification documentation required in Section 999.1.3.A shall be submitted.

2. Design calculations

The design calculations shall include grout-to-ground bond and axial resistance and any other pertinent calculations. These calculations shall be based upon the construction method proposed. The micropile casings shall not be shallower than the minimum tip of casing elevation included in the Contract

Drawings, and bond zone lengths shall not be less than the minimum bond zone length included on the Contract Drawings. The micropiles shall be designed for the resistance specified on the Contract Drawings. The calculations shall assess any temporary load the piles will be subjected to during construction. The design calculations shall be signed and dated by the Engineer registered in the State of Georgia.

3. Shop Drawings

The shop drawings shall include; micropile diameter, casing diameter, casing thickness, bond length, grout compressive strength, pile details including, but not limited to, nominal diameter, length, size and length of permanent casing, reinforcement, post-grout tube, grouting pressure and type, pile to footing connection details, working and staging areas, and layout drawings showing the proposed sequence of pile installation.

The shop drawings shall be signed and dated by the Engineer.

4. Site Specific Work Plan (SSWP)

The SSWP shall describe the installation equipment, including lifting capacities, vertical clearance compared to clearance available, manufacturer's information, model, size, and type of equipment.

The SSWP shall describe the methods to be used for installation of micropiles including; the consecutive steps and the approximate time required for each step and labor and equipment usage schedule, any interference to any existing structures, facilities, or utilities as a result of the micropile installation, methods to be used to control and verify pile position and alignment, procedures for proper removal and disposal of all wastes, including groundwater, and spoils including drilling fluid, cuttings, and grout, details of placement, splicing and centering devices for steel reinforcing, and the procedures for placing the grout.

The SSWP shall include details for pressure grouting when used, including the method, grouting pressure, procedure, and equipment to be used. It shall also include details for post-grouting, when used, including the method, grouting pressure, grout tube arrangements, procedure, and equipment to be used. The SSWP shall include methods to flush the drilled hole, methods and equipment for measuring volumes of grout placed in each hole, depths, and pressures, and estimated curing time for grout to achieve specified strength. If available, the grouting rate shall be calculation based on the initial pump pressures or static head on the grout and losses throughout the placing system, including anticipated head of drilling fluid (if applicable) to be displaced.

5. Materials Certifications

Provide certified mill test reports for the reinforcing steel and casing. The ultimate strength, yield strength, elongation, and material properties composition shall be included. If API N-80 pipe casing is specified on the Contract Drawings, coupon test results may be submitted in lieu of mill certification. Documentation that the Buy America requirements are satisfied shall be provided.

The Contractor shall submit the grout mix design and documentation from an independent testing laboratory. This submission shall include the proportions of the batch, the manufacturer of the components, the specific gravity, and compressive strength results.

6. Load Test Reports

A report shall be submitted for each load test performed. The verification load test report shall describe the nominal unit grout to ground bond resistance proposed to be used for the design of production micropiles. The proof load test reports shall state whether the proof load test exceed the failure criteria. All load test reports shall include load vs. displacement data in tabular and graphical formats. The load vs. displacement plot shall also include the elastic line and failure criteria line. Load test reports shall include calibration results for jacks and load cells.

7. Engineering Installation Records

The records shall be submitted within 24 hours after installation is completed for the pile. The records shall include the following minimum information: pile number designation, pile materials and dimensions, elevation of top of pile, elevation of the top of the bond length, bond length, pile drilling logs including start and finish time(s), final tip elevation, cut-off elevation, design factored resistance, type, length, and size of reinforcing steel, description of unusual installation behavior or conditions, grout pressures attained if pressure grouting or post-grouting is performed, post-grouting details when performed, grout quantities pumped, theoretical grout volume, and time required for each operation.

8. As-Built Plans

Upon the completion of the pile installation, as-built drawings showing the location of the piles, their depth and inclination from vertical, their designed factored resistance, and cross sectional properties shall be prepared and submitted.

Do not begin micropile foundation construction until the Plan, calculations, and sequence of construction have been approved in writing by the Engineer.

If alternate installation procedures are proposed or become necessary, provide a revised installation plan to the Engineer. If the work deviates from the accepted submittal the Engineer may suspend micropile construction until a revised plan is submitted and approved.

The time required for Plan, calculation, and sequence preparation and review will be charged to the allowable Contract time. The Department has 30 days for Plan, calculation, and sequence review per Item after receiving the structure calculations and drawings and sequence of construction.

New submittals from the Contractor showing corrections from the Department's review or changes to ease construction or to correct field errors have a 30-day review. The Department is the sole judge of information adequacy.

The Department's review and approval of the final Plan and construction methods does not relieve the Contractor from successfully completing the work. Time extensions are not granted for Contractor delays from untimely submissions and insufficient information.

C. Admixture Literature

Submit to the Engineer the manufacturer's literature, before using an admixture for review and approval. Indicate the admixture type and the manufacturer's recommendations for mixing the admixtures with grout.

D. Structural Steel

Submit to the Engineer the mill test reports for each heat or lot of prestressing material used to fabricate micropiles.

E. Calibration Data

Submit to the Engineer for review and approval calibration data for each test jack, pressure gauge and master pressure gauge. Provide calibration tests that have been performed by an independent testing laboratory within 180 days of the date of the submittal

The Engineer will approve or reject the calibration data within seven calendar days after receipt of the data. Do not begin testing until the Engineer has approved the jack, pressure gauge and master pressure gauge calibrations.

999.2 Materials

For all steel remaining as a permanent part of the work, all Buy America provisions shall apply. Furnish materials new and without defects. Remove defective materials from the jobsite at no additional cost. Materials for micropiles shall meet the following requirements:

A. Cement

Use Type I, II or III cement conforming to AASHTO M85-09 for the grout mixture. Do not add sand to the grout unless approved by the Engineer.

B. Admixtures

Admixtures to control bleed, improve flowability, reduce water content and retard set may be used in the grout subject to the approval of the Engineer. Use admixtures compatible with manufacturer's recommendation.

C. Water

Use potable water for mixing grout that meets the requirements of Specifications Section 880.

D. Micropile Steel Components

1. Reinforcing Casings

   Permanent steel casing shall have the diameter and wall thickness shown on the approved Shop Drawings. Provide steel casing with flush joint for micropiles conforming to the requirements of ASTM A252 Grade 3 (45 to 80 ksi yield strength) or API N80 (80 ksi yield strength), as shown on the Contract Drawings. The casing should be able to withstand the stresses associated with advancing it into the ground, in addition to the stresses due to hydrostatic and earth pressures.

   The casing shall not be “Structural Grade” (a.k.a. “Mill Secondary”) steel pipe, unless mill certification can be provided documenting the casing was fabricated in America such that the Buy America requirements are satisfied. Spiral welded pipe shall not be allowed. The casing shall be flush joint with shoulders and no stripped threads.

   All welded connections shall be performed by a Certified Welder. Welds shall be full penetration welds for full structural load capacity. For piles with bending or tension stress, welds shall be Ultrasonic (UT) or Radiograph Tested (RT). These requirements do not apply to minor welding that does not carry structural load, such as cutting teeth and tacking on bearing plates.

2. Reinforcing Bars

   Reinforcing steel shall be deformed bars in accordance with ASTM A 615/AASHTO M31. When a bearing plate and nut are required to be threaded onto the top end of reinforcing bars for the pile top to footing anchorage, the threading may be continuous spiral deformed ribbing provided by the bar deformations (e.g., Dywidag or Williams continuous threadbars) or may be cut into a reinforcing bar. If threads are cut into a reinforcing bar, the next larger bar number designation from that shown on the Contract Drawings shall be provided, at no additional cost. Bar tendon couplers, if required, shall develop the ultimate tensile strength of the bars without evidence of any failure, and be sized such that they allow the passage of grout between the casing and coupler. Couplers shall be placed no shallower than 15 feet below the cutoff elevation.

   The corrosion protection required is a function of the site conditions and is specified on the Contract Drawings. Requirements for particular corrosion protection methods are specified below.

   Encapsulation: Encapsulation (double corrosion protection) shall be shop fabricated using high-density, corrugated polyethylene tubing conforming to the requirements of ASTM D3350/AASHTO M252 with a nominal wall thickness of 0.8 mm. The inside annulus between the reinforcing bars and the encapsulating tube shall be a minimum of 5mm and be fully grouted with non-shrink grout conforming to Materials Section 2.0.

   Epoxy Coating: The minimum thickness of coating applied electrostatically to the reinforcing steel shall be 0.3 mm. Epoxy coating shall be in accordance with ASTM A775 or ASTM A934. Bend test requirements are waived. Bearing plates and nuts encased in the pile concrete footing need not be epoxy coated unless the footing reinforcement is epoxy coated.

   Galvanization: If used, galvanization shall meet the requirements of ASTM A 153.

   Sheathing: Smooth plastic sheathing, including joints, shall be watertight. Polyvinyl chloride (PVC) sheathing shall conform to ASTM D 1784, Class 13464-B.

E. Centralizers

Centralizers shall be fabricated from schedule 40 PVC pipe or tube, steel, or a material that is non-detrimental to the reinforcing steel. Centralizers shall be able to withstand installation without causing misalignment of the reinforcement and shall allow free flow of grout through them. Wood shall not be used. Fabricate bar centralizers from schedule 40 polyvinyl chloride (PVC) plastic pipe or tube, steel, or other material not detrimental to steel reinforcement.

F. Grout

Produce cement grout using Portland cement conforming to AASHTO M85, Type I, II or III and potable water, with a minimum 3-day compressive strength of 2,000 psi and a 28-day compressive strength of 5,000 psi per, unless otherwise specified on the Contract Drawings. Use fresh cement free of lumps and hydration. Do not use admixtures with chemicals that will be harmful to the reinforcing steel or cement. If approved by the Engineer, use admixtures that will impart low water content, flowability, and minimum bleeding in the cement grout.

999.2.01 Delivery, Storage, and Handling

A. Micropile steel components

Store steel reinforcement on blocking a minimum of 12 inches (300 mm) above the ground and protect the reinforcement at all times from damage.

999.3 Construction Requirements

999.3.1 Personnel

A. Contractor

Ensure personnel meet qualification requirements and have been approved by the Engineer in compliance with Subsection 999.1.03.A.

B. Micropile Design Engineer

Ensure Design Engineer meets qualifications requirements and has been approved by the Engineer in compliance with Subsection 999.1.03.A and is available at any time during the Contract to discuss the design of the micropiles with the Department.

999.3.2 Equipment

A. Drilling Rig

Use micropile drilling rigs capable of drilling through whatever materials are encountered to the dimensions and elevations required.

B. Grout Pump

Use a pump equipped with a pressure gauge to monitor grout pressures capable of measuring pressure of at least 150 psi (1035 kPa) or twice the actual grout pressures, whichever is greater. This equipment is only required on Micropile Types that require pressure grouting for construction in AASHTO LRFD.

999.3.3 Construction

Perform the micropile construction and related excavation in accordance with the Contract Drawings and approved submittals. The Contractor shall use appropriate pile installation procedures as approved by Engineer to achieve the required pile capacity. The overhead clearance varies along the site, and it is the responsibility of the Contractor to assess this and properly select equipment and construction methods.

Piles shall not be installed within 10-feet of piles that are less than 24 hours old.

A. Installing Casing. Permanent casing shall be fully supported along its length and in contact with the soil or encapsulated in grout which shall be in contact with the soil.

Vibratory pile driving hammers shall not be used to advance casing. Driven or rotary spinning techniques may be used to advance casing.

B. Drilling. The Contractor shall use approved construction methods to maintain a stable hole and prevent collapse and disturbance to the drilled hole during the installation of the micropile. The drilling equipment and methods shall be suitable for drilling through the conditions to be encountered, without causing damage to any overlying or adjacent structures or services. The Contractor shall maintain a stable open drill hole greater than or equal to the minimum diameter shown in the Contract Drawings, prior to placing any grout or reinforcement.

The Contractor's proposed method(s) to provide drill hole support and to prevent detrimental ground movements shall be reviewed by the Engineer. Detrimental ground movement is defined as movement which requires remedial repair measures.

Use of drilling fluid containing bentonite is not allowed. Temporary casing or other approved methods of pile drill hole support will be required in caving or unstable ground to permit the pile shaft to be formed to the minimum design drill hole diameter. Advance the hole using duplex drilling methods and reverse circulation within the drill casing. Positive circulation or flushing, a method of progressing and cleaning out a hole for a micropile wherein water is injected into the hole and returns upward along the outside of the drill casing will not be allowed. The use of air to clean the casing will not be allowed, unless otherwise approved by the Engineer.

The drill tool shall be kept no further than 6 inches ahead of the end of the drill casing at all times. The cutting shoe used for advancing the casing, the cutting shoe diameter shall not exceed the outer diameter of the casing plus 0.25-inches. Drill fluid and cuttings shall be controlled by diverters, or other methods approved by the Engineer, that produce a closed system allowing all drill spoil to be placed in settling tanks for separation of fluid and solids for eventual disposal.

Drilling casing shall be in intimate contact with the bored holes sides at all times. Casing spinning, sudden or rapid withdrawn and plunge or similar operating procedures that may result in disturbance, collapse or an unsupported drill hole shall not be permitted during pile installation.

If obstructions, natural or manmade, are encountered during excavation for a pile the Contractor is responsible for advancing the drilling to the required depth at no additional cost. Use of drop type impact hammers and blasting will not be permitted.

The use of a down-the-hole hammer (DTHH) must be approved by the Engineer. The use of the DTHH will not be allowed within 20-feet of micropiles that were grouted within the previous 24 hours. If, when using the DTHH disturbance to freshly grouted piles greater than 20-feet away is observed, then Contractor shall stop using the DTHH until such time that any disturbance to completed piles is avoided. If, during the installation of the micropiles, adverse effects on adjacent structures or utilities are observed, then further use of the DTHH will not be allowed until remedial actions are provided to eliminate these adverse effects. The costs associated with the remedial measures will be Contractor's responsibility.

Control the procedures and operations to preclude undermining, disturbance, or settlement to adjacent structures or utilities. If any disturbance occurs, halt operations and modify the equipment and/or procedures so that no further disturbance occurs. Repair any disturbance to the satisfaction of the Engineer and at the Contractor's own cost.

Control the procedures and operations so as to prevent the soil at the bottom of the hole from flowing into the hole. Maintain the fluid level inside the hole above the ground water level at all times during installation and cleaning out. Monitor and record the rate of fluid flow used to progress the hole.

Wastes and spoils must be disposed of in an appropriate manner. Deposition of waste and spoil on local streets and in sewers will not be permitted.

Pre-drilling more than one hole or incomplete drilling of holes shall not be permitted unless otherwise approved by the Engineer. All incomplete piles that are in progress shall be capped or covered during overnight or weekend breaks for safety and to prevent any objects from falling in.

Complete drilling and install steel casing to the required depths. Clean the hole with water before installing reinforcing steel or grout and until all contaminated water, drilling fluid, and cuttings are removed and a clean return is observed.

C. **Placing Reinforcement**. Reinforcement may be placed either prior to grouting or placed into the grout filled drill hole before temporary casing (if used) is withdrawn. Reinforcement surface shall be free of deleterious substances such as soil, mud, grease or oil that might contaminate the grout or coat the reinforcement and impair bond. Pile cages and reinforcement groups, if used, shall be sufficiently robust to withstand the installation and grouting process and the withdrawal of the drill casings without damage or disturbance. Reinforcing steel bars shall be placed in each pile as shown on the Contract Drawings.

The Contractor shall check pile top elevations and adjust all installed micropiles to the planned elevations. Centralizers and spacers (if used) shall be provided at 8 foot centers maximum spacing. The upper and lower most centralizer shall be located a maximum of 5 feet from the top and bottom of the micropile. Centralizers and spacers shall permit the free flow of grout without misalignment of the reinforcing bar(s) and permanent casing. The central reinforcement bar(s) with centralizers shall be lowered into the stabilized drill hole and set. The reinforcing steel shall be inserted into the drill hole to the desired depth without difficulty. Partially inserted reinforcing bars shall not be driven or forced into the hole. Contractor shall redrill and reinsert reinforcing steel when necessary to facilitate insertion.

Lengths of casing and reinforcing bars to be spliced shall be secured in proper alignment and in a manner to avoid eccentricity or angle between the axis of the two lengths to be spliced.

D. **Grouting**. If post grouting is proposed, load tests have to be performed on post grouted piles which shall be approved by the Engineer with no additional costs. The Contractor shall also determine the micropile casing size, final drill hole diameter and bond length, and central reinforcement steel sizing necessary to develop the specified load capacities and load testing requirements. The Contractor is also responsible for estimating the grout volume.

Place grout by means of a tremie pipe extending to the bottom of the pile and pump upward to displace the fluid in the hole until grout returns at the top of the pile. The above operation shall be continued until the grout coming out has the same consistency as the grout being pumped into the pile through the tremie pipe.

Pile shall be tremie grouted the same day the load transfer bond length zone is drilled. Construction cold joints will not be permitted in the grouted concrete column.

Pressure is usually applied by attaching a pressure cap to the top of the drill casing or drilling head and injecting additional grout into the casing under controlled pressure. The minimum pump pressure at the top of the steel casing shall be calculated by the Contractor and provided in his submittal. The pressure gauge for grout pressure monitoring shall be capable of measuring pressure of at least 200 psi or twice the actual grout pressure to be used by Contractor, whichever is greater.

Closely control the rate of drill casing removal so that the grout level remains at the top of the casing. Perform pressure grouting and simultaneous casing withdrawal until the required bond length is achieved. Maintain a positive flow of grout into the pile after withdrawal of each length of casing.

Maintain the grout level at the top of the pile until the grout has set.

Calculate and record the initial volume of grout required to fill the hole. Record the grout pressures and volume pumped during pressure grouting.

Post-grout load test piles if selected by Contractor to achieve the design capacity. Provide the equipment and materials to perform post-grouting in test piles. The same procedure, equipment, and materials used to perform post-grouting for the test piles shall be used for production piles.

Record the pressure at which the grout was pumped and the volume pumped through each port.

For test piles, multiple post grout tubes to perform staged post- grouting procedures may be considered.

E. **Construction Tolerances**. Install the piles so that the center of each micropile does not vary from the plan location by more than 3 inches. Do not allow the micropile to vary from the vertical (plumb) or established batter by more than ¼" per foot.

Cut off the top of the pile within one-half inch of the elevation shown on the Contract Drawings or as directed by the Engineer.

If the pile is post-grouted, monitor the elevation of the pile top during post-grouting. Do not permit pile uplift to exceed ¼ inch.

Centerline of reinforcing steel bar shall not be more than 0.5 inch from indicated location on the drawings.

F. Pile Acceptance Criteria. All piles shall be installed in accordance with the dimensions and procedures shown in the approved submittals, installation criteria established during load tests, and as specified herein.

All piles shall meet construction tolerance criteria specified herein.

Unacceptable piles are piles that are rejected by the Engineer because of damage, failure to advance through obstructions, mis-location, misalignment, failure to meet load test acceptance criteria, failure to install the pile using the approved equipment and procedures, or failure to install the pile to the proper depth. Submit a written plan of action to the Engineer for approval, showing how to correct the problem and prevent its reoccurrence. Repair or augment the pile to the satisfaction of the Engineer to make it acceptable. To mitigate and/or to remedy unaccepted piles, the Contractor may be required to provide additional piles or supplement piles to meet specified requirements at no additional cost. Any associated work required due to unacceptable piles shall be at no additional. Payment will not be made for a rejected pile until such time that the pile is repaired or augmented to the satisfaction of the Engineer.

G. Inspection. The On Site Forman described in Section 1.04 should observe the inspection and record the information required in Section 1.05 G.

H. Verification Load Tests. Verification load tests shall be performed to a minimum of the Nominal Axial Compressive Resistance Required (Synonymous with Ultimate Capacity) as shown on the Contract Drawings or until failure, and in accordance with AASHTO LRFD Bridge Design Specifications, 7th Edition - 2014 Article 10.9.3.5.4 (ASTM D1143 and ASTM D3689) using the "Quick Load Test Method". The Contractor shall engage a Professional Engineer, registered in the State of Georgia who shall perform the final design and prepare design submittals as required in this specification.

Minimum of two (2) Verification Load Tests shall be performed. Locations for verification load testing will be approved by the Engineer. Verification Load Testing shall be performed in tension in accordance with ASTM D3689, unless otherwise approved by the Engineer to be performed in compression in accordance with ASTM D1143. Details of how the Contractor will debond the overburden soil above the soil in the bond zone shall be included. Verification Load Tests shall be performed on non-production piles. Oversized reinforcing bars in non-production test pile may be required. The Contractor may propose performing Verification Load Testing on micropiles with shorter bond zone lengths than production micropiles, for the review and approval of the Engineer.

I. Proof Load Tests. Proof load tests shall be performed in accordance with AASHTO LRFD Bridge Design Specifications, 7th Edition – 2014 Article 10.9.3.5.4. The proof load test will be conducted to the factored resistances shown on the Contract Drawings. A proof load tests shall be performed at each substructure, and a minimum of five percent of micropiles shall be proof tested. The Engineer shall select the pile to be tested. Proof load tests shall be performed in tension in accordance with ASTM D3689, to 70% of the Nominal Axial Compressive Resistance Required (Synonymous with Ultimate Capacity) as shown in the Contract Drawings.

J. Grout Consistency. Grout consistency as measured by grout density shall be determined by the Contractor per ASTM C188 or API RP-13B-1 at a frequency of at least one test per pile conducted just prior to start of pile grouting.

During construction, samples selected at random of grout mix shall be taken daily (one set of samples per pile). Each set consists of at least three grout cubes. The Engineer will control sample selection. The Contractor shall be responsible for such testing by retaining an independent testing company to perform the grout testing, the cost of same deemed to be included in the cost of micropiles.

The samples shall be molded, cured in a properly constructed curing box supplied by the Contractor, tested in accordance with ASTM C 109, and shall reach a compressive strength after seven days equal to at least 60 percent of the design strength. If this requirement is not met, the Contractor shall modify the proportions of the mix subject to the approval of the Engineer. If the required design strength is not attained after 28 days then the Contractor shall install replacement pile(s) as required at no additional

cost.

Compressive strength and grout density test results shall be submitted to the Engineer within seven calendar days of grout sampling date.

Contractor shall modify the mix design if; a) an excessive amount of grout is lost from a pile hole into voids in the in-place materials and b) if the rebar and centralizers get excessive resistance during installation.

Each batch of grout shall have the same volume and contain the same whole number of sacks of cement, unless a modification is approved by the Engineer. Time of mixing shall be not less than three minutes.

If agitated continuously, the grout may be held in the mixer or agitator for a period not exceeding three hours at temperatures below 70 degrees Fahrenheit and for a period not exceeding two hours at higher temperatures.

If there is a lapse in pumping of the grout, the grout shall be re-circulated through the pump or through the mixer drum (or agitator) and pump.

Re-tempering of grout will not be permitted.

K. Meetings

A preconstruction meeting will be scheduled by the Construction Project Engineer a minimum 1 week prior to the load test. Discussion at the meeting will cover the construction sequence, delineation of responsibilities between the Prime Contractor and subcontractors on site, any necessary design considerations, and any additional information that the Department or the Contractor brings to the meeting about the construction and testing of the micropile foundations.