ITEM #702026A - MICROPILES

ITEM #702027A - VERIFICATION TEST FOR MICROPILES

ITEM #702028A - PROOF TEST FOR MICROPILES

ITEM #702029A – MICROPILE LENGTH ADJUSTMENT

Description: This work shall consist of constructing micropiles as shown on the contract plans and approved working drawings and as specified herein. The Contractor is responsible for furnishing all design, materials, products, accessories, tools, equipment, services, transportation, labor and supervision, and manufacturing techniques required for design, installation and testing of micropiles and micropile top attachments for this project.

The Contractor shall select the micropile type, size, pile top attachment, installation means and methods, estimate the ground-grout bond value and determine the required grout bond length and final micropile diameter. The Contractor shall design and install micropile that will develop the load capacities indicated on the plans. The micropile load capacities shall be confirmed by verification and proof load testing as required and must meet the test acceptance criteria specified herein.

Materials: Furnish materials new and without defects. Materials for micropiles shall consist of the following:

Admixtures for Grout: Admixtures shall conform to Article M.03.01 of the Form 816. Accelerators are not permitted. Expansive admixtures and admixtures containing chlorides are not permitted.

Cement: All cement shall be Portland cement conforming to ASTM C 150/AASHTO M85, Types II, III or V.

Centralizers and Spacers: Centralizers and spacers shall be fabricated from schedule 40 PVC pipe or tube, steel, or material non-detrimental to the reinforcing steel. Wood shall not be used. Centralizers and spacers shall be securely attached to the reinforcement; sized to position the reinforcement within ½ inch of plan location from center of pile; sized to allow grout tremie pipe insertion to the bottom of the drillhole; and sized to allow grout to freely flow up the drillhole and casing and between adjacent reinforcing bars.

Grout: Neat cement or fine aggregate/cement mixture. The designer is responsible for indicating the 3 day and 28 day compressive strengths. The grout shall conform to the specification AASHTO T106/ASTM C109 and to any minimum and/or maximum properties shown on the plans. The grout shall conform to Article M.03.01 of the Form 816.

Permanent Casing Pipe: Permanent steel casing/pipe shall conform to required minimum and/or maximum properties shown on the plans. The permanent steel casing/pipe shall be designed to withstand the design service loadings shown on the plans and the proof/verification

tests loading described in this specification. The steel casing/pipe shall conform to one or more of the following specifications ASTM 252, ASTM 106, or API (N-80). The designer will be responsible for indicating the applicable material specification(s) and any welding or fabrication conditions that apply.

Reinforcing Bars: Reinforcing steel shall be deformed bars in accordance with ASTM A615/AASHTO M31. The grade, thickness and number of bars shall be indicated by the designer and shall conform to any minimum and/or maximum properties shown on the plans. Continuous spiral deformations (i.e. continuous threadbars) shall be used. Bar tendon couplers, if required, shall develop the ultimate tensile strength of the bars without evidence of any failure.

Construction Methods:

1 - Contractor's Experience Requirements:

The micropile Contractor shall be experienced in the construction and load testing of micropiles and have successfully constructed at least 5 projects in the last 5 years involving construction totaling at least 100 micropiles of similar capacity to those required in these plans and specifications.

The Contractor shall have previous micropile drilling and grouting experience in soil/rock similar to project conditions. The Contractor shall submit construction details, structural details and load test results for at least three previous successful micropile load tests from different projects of similar scope to this project.

The Contractor shall assign a professional engineer, licensed in the State of Connecticut, to supervise the work. This engineer shall have experience on at least 10 projects of similar scope to this project completed over the past 5 years. The Contractor shall not use manufacturers' representatives to satisfy the supervising engineer requirements of this section. The contractor may use a single independent consultant for this purpose, provided the consultant has specific experience as listed above, and operates their business specifically for the purpose of transferring technology and skills in micropiling to contractors. The on-site foremen and drill rig operators shall also have experience on at least 10 projects over the past 5 years installing micropiles of equal or greater capacity than required in these plans and specifications.

The Contractor shall assign a professional engineer, licensed in the State of Connecticut, to design the micropiles. This engineer shall have experience in the design of at least 3 successfully completed micropile projects over the past 5 years, with micropiles of similar capacity to those required in these plans and specifications. This engineer shall also be responsible for design, supervision and reporting of the verification and proof test(s).

At least 45 calendar days before the planned start of micropile construction, the Contractor shall submit 5 copies of the completed project reference list and a personnel list. The project reference list shall include a brief project description with the owner's name and current phone number and load test reports. The personnel list shall identify the supervising project engineer, drill rig operators, and on-site foremen to be assigned to the project. The personnel list shall contain a summary of each individual's experience and be complete enough for the Engineer to determine

whether each individual satisfies the required qualifications.

Work shall not start, nor materials ordered, until the Engineer's written approval of the Contractor's experience qualification is given. The Engineer may suspend work if the Contractor uses non-approved personnel. If work is suspended, the Contractor shall be fully liable for all resulting cost and no adjustment in contract time will result from the suspension.

2-Micropile Design Requirements and Submittals

The micropiles shall be designed to meet the specific loading conditions, as shown on the plans and approved working drawings. Design the micropiles and pile top to footing connections using the Service Load Design (SLD) procedures contained in the FHWA "Micropile Design and Construction Guidelines Manual", Report No. FHWA-SA-97-070 and the "Connecticut Department of Transportation Bridge Design Manual".

The required geotechnical safety factors/strengths factors (for SLD Design) shall be 2.0, unless specified otherwise. Estimated applied foundation loading, easements, rights-of-way and other applicable design criteria will be as shown on the plans or specified herein. Structural design of any individual micropile structure elements not covered in the FHWA manual shall be by the SLD method in conformance with appropriate articles of the most current Edition of the AASHTO Standard Specification for Highway Bridges, including current interim specifications.

Steel pipe used for micropile permanent casing shall incorporate an additional 1/16" thickness for sacrificial steel corrosion protection.

Where required as shown on the plans, corrosion protection of the internal steel reinforcing bars, consisting of either encapsulation, epoxy coating, or grout, shall be provided in accordance with the Material portion of this specification. Where the permanent casing is used for a portion of the micropile, encapsulation shall extend at least 5ft into the casing.

The Contractor shall prepare and submit to the Engineer working drawings. Working drawings shall be submitted in accordance with Article 1.05 of the Form 816. The working drawings shall include all information required for the design, plans, construction and quality control of the piling. This information should include the following, but not necessarily be limited to;

1. Design Computations

    a. A written summary report which describes the overall micropile design.

    b. Applicable code requirements and design references.

    c. Micropile structure critical design cross-section(s) geometry including soil/rock strata and piezometric levels and location, magnitude and direction of applied loadings, including slope or external surcharge loads.

    d. Design criteria including, soil/rock shear strengths (friction angle and cohesion), unit weights, and grout-to-ground bond values and micropile drillhole diameter assumptions for each soil/rock strata.

e. Safety factors/strength factors used in the design of the ground-grout bond values, surcharges, soil/rock and material unit weights, steel, grout and concrete materials.

f. Design calculation sheets with the project number, micropile structure location, designation, date of preparation, initials of designer and checker, and page number at the top of each page. Provide an index page with the design calculations.

g. Design notes including an explanation of any symbols and computer program used in the design.

h. Pile to footing connection calculations.

2. Plans

a. A plan view of the micropile structures identifying;

i. A reference baseline and elevation datum.

ii. The offset from the construction centerline or baseline to the face of the micropile structure at all changes in horizontal alignment.

iii. Beginning and end of micropile structure stations.

iv. Right-of-way and permanent or temporary construction easement limits, location of all known active and abandoned utilities, adjacent structures or other potential interference. The centerline of any drainage structure or drainage pipe behind, passing through or passing under the micropile structure.

v. Subsurface exploration locations shown on the plan view of the proposed micropile structure alignment with appropriate reference baselines to fix the locations of the exploration relative to the micropile structure.

b. An elevation view of the micropile structure(s) identifying;

i. Elevation view showing micropile locations and elevations; vertical and horizontal spacing; batter and alignment and the location of drainage elements (if applicable).

ii. Existing and finish grade profiles both behind and in front of the micropile structure.

c. Design parameters and applicable codes.

d. General notes for constructing the micropile structure including construction sequencing or other special construction requirements.

e. Horizontal and vertical curve data affecting the micropile structure and micropile structure control points. Match lines or other details to relate micropile structure stationing to centerline stationing.

f. A listing of the summary of quantities on the elevation drawing of each micropile structure showing pay item estimated quantities.

g. Micropile typical sections including micropile spacing and inclination; minimum

drillhole diameter; pipe casing and reinforcing bar size and details; splice type and locations; centralizers and spacers; grout bond zone and casing plunge length (if used); corrosion protection details; and connection details to the substructure footing, anchorage, plates, etc.

h. A typical detail of verification and production proof test micropiles defining the micropile length, minimum drillhole diameter, inclination, and load test bonded and unbonded test lengths.

i. Details, dimensions and schedules for all micropiles, casing and reinforcing steel, including reinforcing bar bending details.

j. Details for constructing micropile structures around drainage facilities (if applicable).

3. Construction Procedures

a. Detailed step-by-step description of the proposed micropile construction procedure, including personnel, testing and equipment to assure quality control. This step-by-step procedure shall be shown in sufficient detail to allow the Engineer to monitor the construction and quality of the micropiles.

b. Proposed start date and time schedule and micropile installation schedule providing the following:

i. Micropile number.

ii. Micropile design load.

iii. Type and size of rebar.

iv. Minimum total bond length.

v. Total micropile length.

vi. Micropile top footing attachment.

c. If welding of casing is proposed, submit the welding procedure. All welding shall be done in accordance with the current AWS Structural Welding Code.

d. Information on space requirements for installation equipment that verify the proposed equipment can perform at the site.

e. Plan describing how surface water, drill flush, and excess waste grout will be controlled and disposed.

f. Certified mill test reports for the reinforcing steel and for permanent casing. The ultimate strength, yield strength, elongation, and material properties composition shall be included. For API N-80 pipe casing, coupon test results may be submitted in lieu of mill certification.

g. Proposed Grouting Plan. The grouting plan shall include complete descriptions, and details for the following:

i. Grout mix design and type of materials to be used in the grout including certified test data and trial batch reports. The Contractor shall also provide specific gravity of the wet mix design.

ii. Methods and equipment for accurately monitoring and recording the grout depth and grout volume as the grout is being placed.

iii. Estimated curing time for grout to achieve specified strength. Previous test results for the proposed grout mix completed within one year of the start of grouting may be submitted for initial verification and acceptance and start of production work. During production, grout shall be tested in accordance with Article M.03.01 of the Form 816.

iv. Procedure and equipment for Contractor monitoring of grout quality. At a minimum, the Contractor shall be required to use a Baroid Mud Balance (per API RP-13B-1) to check the specific gravity of the mixed grout prior to placement of the grout into each drilled micropile.

4. Detailed plans for the proposed micropile load testing method. This shall include all drawings, details, and structural design calculations necessary to clearly describe the proposed test method, reaction load system capacity and equipment setup, types and accuracy of apparatus to be used for applying and measuring the test loads and pile top movements in accordance with this specification.

5. Calibration reports and data for each test jack, pressure gauge and master pressure gauge and electronic load cell to be used. The calibration tests shall have been performed by an independent testing laboratory, and tests shall have been performed within 90 calendar days of the date submitted. Testing shall not commence until the Engineer has reviewed and accepted the jack, pressure gauge, master pressure gauge and electronic load cell calibration data.

Work shall not begin until the construction submittals have been received, reviewed, and accepted in writing by the Engineer. Any submittals that are found to be unacceptable by the engineer shall be revised, resubmitted and accepted prior to commencing work.

3 - Pre-construction Meeting.

A pre-construction meeting will be scheduled by the Engineer and held prior to the start of micropile construction. The design Engineer, supervising Engineer, prime Contractor, and micropile specialty Contractor, shall attend the meeting. Attendance is mandatory. The pre-construction meeting will be conducted to clarify the construction requirements for the work, to coordinate the construction schedule and activities, and to identify contractual relationships and delineation of responsibilities amongst the prime Contractor and the various Subcontractors – specifically those pertaining to excavation for micropile structures, installation of temporary sheeting, anticipated subsurface conditions, micropile installation and testing, micropile structure survey control and site drainage control.

4 - Site Drainage Control.

The Contractor shall control and properly dispose of drill flush and construction related waste, including excess grout, in accordance with Section 1.10 of the Form 816, any related specifications within the contract documents and all applicable codes and regulations. Drill flush shall be conveyed by pipe, hose or conduit a minimum 20ft away from the location where the micropile is being drilled and away from any adjacent structure or facility. Provide positive control and discharge of all surface water that will affect construction of the micropile installation. Maintain all pipes or conduits used to control surface water during construction. Repair damage caused by surface water at no additional cost. Upon substantial completion of the work, remove surface water control pipes or conduits from the site. Alternatively, with the approval of the Engineer, pipes or conduits that are left in place may be fully grouted and abandoned or left in a way that protects the structure and all adjacent facilities from migration of fines through the pipe or conduit and potential ground loss.

Immediately contact the Engineer if unanticipated existing subsurface drainage structures or other utilities are discovered during excavation or drilling. Suspend work in these areas until remedial measures meeting the Engineer's approval are implemented.

5 - Excavation

Coordinate the work and the excavation so the micropile structures are safely constructed. Perform the micropile construction and related excavation in accordance with the Plans and approved submittals.

6 - Micropile Allowable Construction Tolerances

1. Centerline of piling shall not be more than 3 inches from indicated plan location.
2. Pile shall be plumb or battered within 2 percent of total-length plan alignment.
3. Top elevation of pile shall be plus 1 inch or minus 1 inch maximum from vertical elevation indicated.
4. Centerline of reinforcing steel shall not be more than 0.5 inches from indicated location.

7 - Micropile Installation

The micropile Contractor shall select the drilling method, the grouting procedure and the grouting pressure used for installation of the micropiles. The micropile Contractor shall also determine the micropile casing size, final drillhole diameter and bond length, and central tendon reinforcement steel sizing necessary to develop the specified load capacities and load testing requirements. The micropile Contractor is also responsible for estimating the grout take. There will be no extra payment for grout overruns.

Should the plans require uncased drilling of the micropile into bedrock, the permanent and/or temporary casing shall be drilled a minimum 6 inches into ledge or to a depth within the ledge so as to prevent subsidence of over burden into the uncased and/or bond zone portion of the drill hole (i.e. the rock socket). The plans show estimated permanent casing lengths for each

substructure unit. Any difference in the required length of permanent casing installed and accepted by the Engineer from the estimated lengths shown on the plans shall be measured for payment and/or credit. There will be no payment for differences in required length of temporary casing.

The drilling equipment and methods shall be suitable for drilling through the conditions to be encountered, without causing damage to the overburden above rock head, any overlying or adjacent structures, buried structures or utilities, or services. If called for in the drilling method description, or by the nature of the stratum to be drilled through, the micropile Contractor shall furnish an overburden casing of the type and thickness, which can be installed without distortion. Casings that fail, fracture, or otherwise distort during drilling or after drilling shall, unless otherwise directed, be withdrawn or replaced at the micropile Contractor's expense. The drillhole must be open along its full length to at least the design minimum drillhole diameter prior to placing grout and reinforcement.

Temporary casing or other approved method of pile drillhole support will be required in caving or unstable ground to permit the pile shaft to be formed the minimum design drillhole diameter. The Contractor's proposed method(s) to provide drillhole 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, in order to maintain site conditions as determined by the Engineer. Use of drilling fluid containing bentonite or any other non-reverting drilling fluid is not allowed.

During construction, the Contractor shall observe the ground conditions in the vicinity of the micropile construction site on a daily basis for signs of ground heave or subsidence. Immediately notify the Engineer if signs of movements are observed. The micropile Contractor shall immediately suspend or modify drilling or grouting operations if ground heave or subsidence is observed, if the micropile structure is adversely affected, or if adjacent structures are damaged from the drilling or grouting. If the Engineer determines that the movements require corrective action, the micropile Contractor shall take corrective actions necessary to stop the movement or perform repairs.

Reinforcement may be placed prior to grouting the drillhole. 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 reinforcement groups, if used, shall be sufficiently strong to withstand the installation and grouting process without damage or disturbance.

The micropile Contractor shall check pile top elevations and adjust all installed micropiles to the planned elevations.

Centralizers and spacers shall be provided at 10ft centers maximum spacing. The upper and lower most centralizer shall be located a maximum of 3ft 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 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. The micropile Contractor shall re-drill 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 axes of the two lengths to be spliced. Splices and threaded joints shall meet the requirements of the rebar material. Threaded pipe casing joints shall be located at least two casing diameters (OD) from a splice in any reinforcing bar. When multiple bars are used, bar splices shall be staggered at least 1 foot.

Micropiles shall be grouted the same day the load transfer bond length is drilled. The grouting equipment used shall be a colloidal grout plant, and shall produce a grout free of lumps and undispersed cement. Paddle type mixers are not acceptable. The micropile Contractor shall have means and methods of measuring the grout quantity and pumping pressures during the grouting operations. The grout pump shall be equipped with a pressure gauge to monitor grout pressure. A second pressure gauge shall be placed at the point of injection into the pile top. The pressure gauge shall be capable of measuring pressures of at least 145 psi or twice the actual grout pressure used, whichever is greater. The grout shall be kept in agitation prior to mixing. Grout shall be placed within one hour of mixing. The grouting equipment shall be sized to enable each pile to be grouted in one continuous operation. The grout shall be injected from the lowest point of the drill hole and injection shall continue until uncontaminated grout flows from the top of the pile. The grout may be pumped through pumped through grout tubes, casing, hollow stem augers or drill rods. Temporary casing, if used, shall be extracted in stages ensuring that, after each length of casing is removed the grout level is brought back up to the ground level before the next length is removed. The tremie pipe or casing shall always extend below the level of the existing grout in the drillhole. The grout takes shall be controlled to prevent excessive heave or fracturing of rock or soil formations. Upon completion of grouting, the grout tube may remain in the hole, but must be filled with grout.

If the Contractor elects to use a post-grouting system, Working Drawings and details shall be submitted to the Engineer for review in accordance with Article 1.05 of the Form 816.

Grout within the micropile verification and proof test piles shall attain the minimum required 3-day compressive strength prior to load testing. During production, micropile grout shall be tested by the Contractor for compressive strength in accordance with AASHTO T106/ASTM C109 at a frequency of no less than one set of three 2 inch grout cubes, or 3” cylinders, from each grout plant each day of operation or per every 10 piles, whichever occurs more frequently. The compressive strength shall be the average of the 3 cubes tested.

Grout consistency as measured by grout density shall be determined by the micropile Contractor per API RP-13B-1 at a frequency of at least one test per pile, conducted just prior to start of pile grouting. The Baroid Mud Balance used in accordance with API RP-13B-1 is an approved device for determining the grout density of neat cement grout.

Provide grout cube/cylinder compressive strength and grout density test results to the Engineer within 24 hours of testing.

8 - Micropile Installation Records.

The micropile Contractor shall prepare and submit to the Engineer full-length installation records for each micropile installed. The records shall be submitted within one work shift after that pile installation is completed. The data shall be recorded on a micropile installation log. A separate log shall be provided for each micropile.

9 – Verification and Proof Tests

Perform verification and proof testing of piles at the locations specified on the plans. Perform compression load testing in accord with ASTM D1143 and tension load testing in accord with ASTM D3689, except as modified herein.

Perform pre-production verification pile load test(s) to verify the design of the pile system and the construction methods proposed prior to installing any production piles. Sacrificial verification test pile(s) shall be constructed in conformance with the approved Working Drawings. Verification test pile(s) shall be installed at the location(s) shown on the plans or at a location(s) approved by the Engineer.

Verification load test(s) shall be performed to verify that the Contractor installed micropiles will meet the compression and/or tensile load capacities and load test acceptance criteria and to verify the length of the micropile load transfer bond zone is adequate. The micropile verification load test results must verify the Contractor's design and installation methods.

The drilling method, grouting method, casing length, micropile diameter (cased and uncased), reinforcing bar length and length of embedment for the verification test pile shall be identical to those specified for the production piles at the given locations. The verification test micropile structural steel sections shall be sized to safely resist the maximum test load.

The maximum verification and proof test loads applied to the micropile shall not exceed 80 percent of the structural capacity of the micropile structural elements; include steel yield in tension, steel yield or buckling in compression, or grout crushing in compression. Any required increase in strength of the verification and proof test pile elements above the strength required for the production piles shall be provided for in the Contractor's bid price.

Testing equipment shall include dial gauges, dial gauge independent reference frame, jack and pressure gauge, electronic load cell (with readout device), and a reaction frame. The load cell is required only for the creep test portion of the verification test. The contractor shall provide a description of test setup and jack, pressure gauge and load cell calibration curves in accordance with the Submittals Section.

Design the testing reaction frame to be sufficiently rigid and of adequate dimensions such that excessive deformation of the testing equipment does not occur. Align the jack, bearing plates, and stressing anchorage such that unloading and repositioning of the equipment will not be required during the test.

Apply and measure the test load with a hydraulic jack and pressure gauge. The pressure gauge

shall be graduated in 100psi increments or less. The jack and pressure gauge shall have a pressure range not exceeding twice the anticipated maximum test pressure. Jack ram travel shall be sufficient to allow the test to be done without resetting the equipment. Monitor the creep test load hold during verification tests with both the pressure gauge and the electronic load cell. Use the load cell to accurately maintain a constant load hold during the creep test load hold increment of the verification test.

Measure the pile top movement with a dial gauge capable of measuring to 0.001 inches. The dial gauge shall have a travel sufficient to allow the test to be done without having to reset the gauge. Visually align the gauge to be parallel with the axis of the micropile and support the gauge independently from the jack, pile or reaction frame. Use a minimum of two dial gauges when the test setup requires reaction against the ground or single reaction piles on each side of the test pile.

Test verification piles to a maximum test load of 2.0 times the maximum allowable compressive load, hereafter termed, "Design Load" shown on the Plans. The verification pile load tests shall be made by incrementally loading the micropile in accordance with the following cyclic load schedule for both compression and tension loading (test the compression prior to tension):

Verification Test Loading Schedule		
AL = Alignment Load DL = Design Load		
	LOAD	HOLD TIME
1	AL (.05 DL)	1 minute
2	0.25 DL	1 minute
3	0.50 DL	1 minute
4	AL	1 minute
5	0.25 DL	1 minute
6	0.50 DL	1 minute
7	0.75 DL	1 minute
8	AL	1 minute
9	0.25 DL	1 minute
10	0.50 DL	1 minute
11	0.75 DL	1 minute
12	1.00 DL	1 minute
13	AL	1 minute
14	0.25 DL	1 minute
15	0.50 DL	1 minute
16	0.75 DL	1 minute
17	1.00 DL	1 minute
18	1.33 DL	60 minutes
19	1.75 DL	1 minute
20	2.00 DL (Maximum Test Load)	10 minutes
23	AL	1 minute

The test load shall be applied in increments of 25 percent of the DL load. Each load increment shall be held for a minimum of 1 minute. Pile top movement shall be measured at each load increment. The load-hold period shall start as soon as each test load increment is applied. The verification test pile shall be monitored for creep at the 1.33 Design Load (DL). Pile movement during the creep test shall be measured and recorded at 1, 2, 3, 4, 5, 6, 10, 20, 30, 50, and 60 minutes. The alignment load shall not exceed 5 percent of the DL load. Dial gauges shall be reset to zero after the initial AL is applied.

The acceptance criteria for micropile verification load test are:

1. The Engineer shall determine the criteria for tolerable movement during the load test at the top of the micropile.

2. At the end of the 1.33 DL creep test load increment, test piles shall have a creep rate not exceeding 0.05 inch/log cycle time (1 to 10 minutes) or 0.1 inch/log cycle time (6 to 60 minutes or the last log cycle if held longer). The creep rate shall be linear or decreasing throughout the creep load hold period.
3. Failure does not occur at any load increment up to and including the 2.0 D.L. max test load. Failure is defined as load at which attempts to further increase the test load simply result in continued pile movement.

Upon completion of the test, the Contractor shall submit a report stamped by a qualified Professional Engineer licensed in the State of Connecticut of the test results for review and acceptance by the Engineer prior to beginning installation of production micropiles. This report shall include written confirmation of the verification micropile's capacity.

If a verification tested micropile fails to meet the acceptance criteria, the Contractor shall modify the design, the construction procedure, or both. These modifications may include modifying the installation methods, increasing the bond length, or changing the micropile type. Any modification that necessitates changes to the structure shall be submitted as a revision to the working drawings and require the Engineer's review and acceptance. Any modifications of design or construction procedures or cost of additional verification test piles and load testing shall be at the Contractor's expense. At the completion of verification testing, test piles shall be removed down to the elevation specified by the Engineer.

Perform proof load tests at the micropile locations as shown on the plans. Perform proof load tests on the first set of production piles installed at each designated substructure unit prior to the installation of the remaining production piles in that unit. The initial proof test piles shall be installed at the locations shown on the plans. Upon completion of each test, the Contractor shall submit a report stamped by a qualified Professional Engineer licensed in the State of Connecticut of the test results for review and acceptance by the Engineer

Proof test piles to a maximum test load of 1.67 times the micropile Design Load shown on the Plans or Working Drawings. Proof tests shall be made by incrementally loading the micropile in accordance with the following schedule, to be used for both compression and tension loading:

Proof Test Loading Schedule		
AL = Alignment Load DL = Design Load		
	LOAD	HOLD TIME
1	AL	1 minute
2	0.25 DL	1 minute
3	0.50 DL	1 minute
4	0.75 DL	1 minute
5	1.00 DL	1 minute
6	1.33 DL	60 minutes Creep Test
7	1.67 DL (Maximum Test Load)	1 minute
8	AL	1 minute

Depending on performance, either a 10 minute or 60 minute creep test shall be performed at the 1.33 DL Test Load. Where the pile top movement between 1 and 10 minutes exceeds 1 mm, the Maximum Test Load shall be maintained an additional 50 minutes. Movements shall be recorded at 1, 2, 3, 5, 6, 10, 20, 30, 50 and 60 minutes. The alignment load shall not exceed 5 percent of DL. Dial gauges shall be reset to zero after the initial AL is applied.

The acceptance criteria for micropile proof load tests are:

1. The Engineer shall determine the criteria for tolerable movement during the load test at the top of the micropile.

2. At the end of the 1.33 DL creep test load increment, test piles shall have a creep rate not exceeding 0.05 inch/log cycle time (1 to 10 minutes) or 0.1 inch/log cycle time (6 to 60 minutes).The creep rate shall be linear or decreasing throughout the creep load hold period.

3. Failure does not occur at the 1.67 DL maximum test load. Failure is defined as the load at which attempts to further increase the test load simply result in continued pile movement.

If a proof-tested micropile fails to meet the acceptance criteria, the Contractor shall immediately proof test another micropile within that footing. For failed piles and further construction of other piles, the Contractor shall modify the design, the construction procedure, or both. These modifications may include installing replacement micropiles, incorporating piles at not more than 50% of the maximum load attained, post-grouting the tested pile and re-proof testing the pile, modifying installation methods, increasing the bond length, or changing the micropile type. Any modification that necessitates changes to the structure design shall require the Engineer's prior review and acceptance. Any modifications of design or construction procedures, or cost of additional verification test piles and verification and/or proof load testing, or replacement production micropiles, shall be at the Contractor's expense.

Method of Measurement: Measurement will be made as follows for the quantity, as specified or directed by the Engineer. Micropiles will be measured as each installed, and accepted. There will be no separate measurement for mobilization and demobilization associated with this item. Verification Tests (performed on sacrificial micropiles) and Proof Tests (performed on production piles) for Micropiles will be measured as each. Micropile Length Adjustment will be measured in feet as the difference between the estimated length of permanent casing, as shown on the plans, and the actual length of permanent casing installed and accepted by the Engineer. Note that the permanent casing length is measured from the bottom of the pile cap to the permanent casing tip, including the required embedment into rock. Embedment into the pile cap will not be measured for payment because it is considered incidental to micropile construction. Any increase in casing length will be measured for payment to the Contractor, and any decrease in casing length will be measured for credit to the State.

Basis of Payment: The quantities accepted for payment will be paid for at the contract unit prices for the for the items listed below, complete in place and accepted, which price shall include all materials, equipment, tools, proper disposal of drilling spoil, and labor incidental thereto.

Pay Item	Pay Unit
Micropiles	EA.
Verification Test for Micropiles	EA.
Proof Test for Micropiles	EA.
Micropile Length Adjustment	L.F.