ADMINISTRATIVE INFORMATION:
- This Engineering Instruction (EI) is effective beginning with projects submitted for the letting of May 3, 2007.
- This EI does not supersede any previous issuances.
- The information transmitted by this issuance will reside in the Special Specifications directory of the Toolbox Server.

PURPOSE: The purpose of this EI is to issue the revised special specification for micropiles.

TECHNICAL INFORMATION:
- The special specification was revised as follows:
  1. FHWA and the international community have adopted the term “micropile.” Therefore, the title of the special specification is revised from bored-in pile to micropile.
  3. Under Description, General: Changed the submittal process to go through the DCES to coincide with the submittal process for other foundation elements.
  4. Under Description, Definition of Terms: The definitions section was expanded to include a description of Drill Casing, Extended Lengths, Mill Secondary, revisions to the Static Pile Load Test, and a Telltale.
  5. Under Materials, A. Drill Casing: Titles were revised for clarification “A. Drill Casing,” “B. Drill Casing/Pipe Used As Reinforcement,” and “C. Bar Reinforcement.”
  6. Under Materials, B. Drill Casing/Pipe Used As Reinforcement: The steel drill casing was expanded to include new or unused “Structural Grade” American Petroleum Institute (API) or “Mill Secondary’s.” A Quality Control and Quality Assurance Procedure was added to the acceptance of the Mill Secondary’s.
  8. Under Materials, the materials section was expanded to include requirements for centralizers and spacers.
  9. A new Materials Procedure for approval of the structural steel casing has been developed by the Office of Structures and is included in the Materials section of the specification.
  10. A new Materials Procedure for field sampling and testing of grout has been developed by the Materials Bureau of the Office of Technical Services and is referenced in the specification.
11. Under Construction Details, A. Submittal 6 & 7: The limited headroom condition is expanded to identify location of joints and how they will be considered in the structural design.

12. Under Construction Details, A. Submittal 8: Grouting information is expanded to include data on compressive strengths in early breaks, monitoring grout quality by obtaining and maintaining the specific gravity and a specific requirement for the pressure gage to facilitate the Inspector’s job.

13. Under Construction Details, D. Reinforcement and Post Grout Tube Placement: The information was expanded to include details on sizing and securing centralizers.

14. Under Construction Details, E. Grout Placement and Casing Removal: The quality control test to measure the specific gravity of grout, API Recommended Practice (RP) 13B-1 by the Baroid Mud Balance Test, has been added along with mention of the quality assurance test by the Engineer.

15. Under Construction Details, H. Pile Acceptance: The pile acceptance criteria are revised.

16. Under Basis of Payment: The Basis of Payment was expanded to clarify the payment of a micropile that fails to meet the acceptance criteria. The micropile will be rejected and no payment will be made for these piles.

- The special specification for a micropile (design provided) has been created and issued under EI 06-034.
- The special specification for permanent casing for micropiles has been revised under EI 06-032.
- The special specification for a static pile load test has been revised under EI 06-031.
- The Static Pile Load Test Manual (GCP-18) has been revised and issued under EB 06-045.

- As with all foundation elements, it is the State’s responsibility for obtaining adequate subsurface information. After meeting with the designer of the structure, the Regional Geotechnical Engineer will develop their subsurface exploration program, progress the borings and prepare logs. If the foundation is to be supported by Contractor Designed Micropiles, the allowable load per pile and/or the need for extended lengths is provided in the Foundation Design Report, developed by the Geotechnical Engineering Bureau, and stated in the contract documents. Since the Contractor's Engineer shall design the micropiles, supporting geotechnical information, e.g. the official subsurface exploration logs, are available for purchase at the bidders table.

- PIN Approval: The micropile special specifications are to be approved on a project-by-project basis. Designers must send their request for approval to the Design Quality Assurance Bureau (DQAB) and the Geotechnical Engineering Bureau (GEB) through the Regional Special Specification Coordinator as per Highway Design Manual (HDM) Chapter 21.

**IMPLEMENTATION:**
- The following special specifications are disapproved:
  - Item 551.9922--17: Bored-In Piles – Design Load Less Than 900 kN.
  - Item 551.9922--16: Bored-In Piles – Design Load Less Than 900 kN.
  - Item 551.9923--17: Bored-In Piles – Design Load of 900 kN or More.
  - Item 551.9923--16: Bored-In Piles – Design Load of 900 kN or More.
  - Item 551.9924--17: Bored-In Piles – With Extended Lengths – Design Load Less Than 900 kN.
  - Item 551.9924--16: Bored-In Piles – With Extended Lengths – Design Load Less Than 900 kN.
BACKGROUND: The Department has recently concluded a few projects requiring the installation of micropiles as the foundation support which revealed a need to address a common industry practice to assure the State that the installation process is meeting the design requirements.

It is the intent of the special specification that the micropile designer demonstrate that all the requirements of the FHWA guidelines are met prior to, during, and after the installation has occurred. On some recent projects it was noted that the designer was not clearly stating specifications required to meet the design requirements and the Contractor was supplying materials that did not have specifications to follow.

The following is an outline of the recent problems encountered on some Departmental projects:

1. **Material Certification:** The specification calls for ASTM A252 pipe steel. A common industry practice is to substitute new “Structural Grade” American Petroleum Institute (API) N-80, a.k.a. “Mill Secondary.” However, this is not identified in the specification. In addition, the micropile Professional Engineer designer’s drawings may identify “Grade 345 MPa or better steel pipe.” With the use of Mill Secondary casing, the Contractor’s pile steel certificates to field personnel will state “Mill Rejects.” No heat numbers, elongation, or chemical tests are provided. Therefore, the field engineer does not know what the certification requirements are for the materials we are accepting, and how to correlate documentation received to the delivered material.

2. **Weld Procedures:** Since there are questions concerning the material on the projects, questions have arisen concerning weld procedures.

   Due to the high strength and typical chemical composition of Mill Secondary casing, weldability of the casing requires special welding procedures. The micropile P.E. designer has to inform field personnel that the pipe casing being delivered to the field may need special attention. Typically, the Contractor will submit weld procedures for approval.

3. **Location of Joints:** Field personnel have questioned the placement of joints in the micropile casings (The specification lacks restrictions on joints). Typically, pile casings delivered to a project come in 1.5 m to 3.0 m lengths, with threaded connections. Micropiles are sometimes used where overhead clearance is limited. Therefore, because of a height restriction, some piles may be constructed using all 1.5 m sections, or have a top section of 1.5 m or less. This means that the joints were placed in the field throughout the pile, unlike the Design Rationale requirements in the FHWA Manual which state that threaded joints are expected to be about in the middle of the pile that corresponds to low values of bending from the fixity condition at both ends.
However, the Manual does continue to mention that the length of the pipe sections used is dictated by the length of the drill mast and by the available overhead clearance. The reduced area of the threaded joint should be considered in the structural design of the pile, particularly for the capacity in tension and bending. Therefore, to provide improved communication with field personnel, the micropile P.E. designer must provide information on the location of joints.

**CONTACT:** Questions or comments regarding this issuance should be directed to Randy Romer of the Geotechnical Engineering Bureau at (518) 457-4714, rromer@dot.state.ny.us. Questions or comments regarding the technical aspects of the special specification should be directed to Steve Borg of the Geotechnical Engineering Bureau at (518) 457-4770, sborg@dot.state.ny.us.
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ITEM 551.9942  17:  MICROPILES (CONTRACTOR DESIGNED) - WITH EXTENDED LENGTHS – DESIGN LOAD LESS THAN 900 kN
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DESCRIPTION
This work shall consist of designing micropiles, furnishing all labor and materials, and performing all operations necessary to install micropiles at the locations and to the required capacities indicated in the contract documents.

Micropiles with extended lengths include an additional pile length as described in the Definition of Terms below. The Contractor's Engineer shall incorporate this requirement into the design of the micropile with extended lengths.

Definition of Terms
This section defines terms for use with this specification.

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.

Grout placed in contact with the soil using gravity pressure only will not be considered to constitute a bond breaker.

Bond Zone: The gravity grouted, pressure grouted, and/or post grouted length of a micropile that provides the pile's capacity.

Design Load: The load permitted on a pile. The design load is indicated in the contract documents.

Drill Casing: Steel pipe of flush joint type used in the drilling process to stabilize the drill hole.

Duplex drilling: A method of progressing and cleaning out a hole for installing a micropile in which the outer drill casing is progressed simultaneously with an inner drill rod string. The drill casing is cleaned using reverse circulation. Intimate contact between the soil and an outer drill casing is maintained during drilling.

Extended Length: An additional pile length resulting from a requirement that the pile capacity be achieved below a given elevation. Typically, extended lengths are prompted by a conflict with subsurface elements (e.g., underground structure, utilities, etc.) or unreliable soil strata. Bond breakers may be required.

Micropile: A small-diameter (typically less than 300 mm), friction pile formed by removing material using non vibratory and non displacement methods to create a cased open, cylindrical hole in the ground, which is subsequently filled with grout and steel reinforcement.

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“Structural Grade,” “Limited Service,” or “Minimum Test Pipe.” Casing not meeting stringent API specification is suitable for use in micropile construction.

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.

Permanent Casing: A steel casing installed in the upper portion of a micropile to increase the pile's moment capacity and lateral capacity against horizontal loads.

Positive circulation or flush: A method of progressing and cleaning out a hole for a micropile wherein drilling fluid is injected into the hole and returns upward along the outside of the drill casing.

Post grouting: A method used to increase pile capacity after the grout column has reached initial set by pumping grout at very high pressure (up to 7000 kPa) through a sleeved port pipe (post grout tube).

Pressure grouting: A method used to develop pile capacity wherein pressure is applied continuously to the top of the fluid grout column through the drill head as the casing is removed from the bond zone.

Production pile: A pile which will be incorporated into the structure's foundation.

Recirculation: A method of handling drilling fluid where the fluid coming back out of the hole is captured in a pan and reused.

Reverse circulation: A method of cleaning the inside of the drill casing. Drilling fluid is circulated down through the drill rods and returns upwards through the inside of the drill casing to flush the drill casing clean.

Static Pile Load Test: A test to verify design assumptions and the adequacy of the contractor’s installation methods.

Telltale: A simple mechanical device, a.k.a. “strain rod” that is used to measure deflection in concrete or steel. The device consists of a small-diameter steel rod that is fixed at a selected point along or within the pile. This rod is encased, and free to move, in a slightly larger pipe or tube which extends up to the pile top. Dial gages are used to measure the deflections at the top of the rod.

Tremie grouting: A method used to place grout in a wet hole. A 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, causing the drilling fluid to be displaced.

**MATERIALS**

**A. Drill Casing**
Provide drill casing consisting of flush joint type steel pipe of appropriate thickness to withstand the stresses associated with advancing it into the ground, in addition to the stresses due to hydrostatic and earth pressures.

**B. Drill Casing/Pipe Used As Reinforcement**
Provide steel drill casing/pipe used as reinforcement:

1. Conforming to ASTM A252 with the exception that spiral welded pipe shall not be allowed or;
2. May be new or unused “Structural Grade” American Petroleum Institute (API) or “Mill Secondary” casing free from defects (dents, cracks, tears).

Approval of the steel drill casing/pipe used as reinforcement shall be done in accordance with the following procedure:

1. **Requirements for Micropile Structural Casing**
   Structural casing that is installed in coupled (spliced) sections shall meet the following requirements:
   
   The casing shall be flush joint and the pipe joint shall be completely shouldered and with no stripped threads.
   
   All welded connections shall be performed by a NYSDOT Certified Welder in conformance with NYSDOT Steel Construction Manual (SCM), the approved Welding Procedure Specification (WPS) and the Approved Welding Procedure Qualification Record (WPQR). 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.
   
   If significant tension loads are being considered, the Department will require the Contractor to provide data demonstrating the adequacy of the proposed detail.
   
   The design shall limit the maximum yield stress of steel (Fy) to 600 MPa.

2. **Additional Requirements for New and Unused Mill Secondary Casing Without Mill Certification**
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The Manufacturer/Supplier shall incorporate the following Quality Control (QC) system and assume responsibilities for all QC activities. The Engineer has the right to monitor any QC sampling and testing and to test any material or retained samples for specification conformance.

**Quality Control**
A “Plant Lot” of pipe in a raw material state shall be a maximum of 300 linear meters. A random coupon sample shall be taken from every 75 meters of casing from each plant lot. These coupons shall be tested in accordance with ASTM A370 at a laboratory approved by the State. The coupons shall be tested for tensile strength, yield strength, elongation and wall thickness. The minimum elongation shall be 15%. For casing that will be welded, the testing shall also include sulfur content and carbon equivalency (CE) as defined in American Welding Society (AWS) D1.1, Section XI5.1. The sulfur content shall not exceed 0.05% and the carbon equivalency (CE) shall not exceed 0.45. Results of the testing shall be submitted to the Engineer for approval.

Coupons shall be marked with an identification number which will be traceable to the test certifications and includes the NYSDOT contract number. All casing in a plant lot shall be marked along the tubular body of the casing with the same identification number prior to testing. The identification number shall appear on every piece of casing at no more than 3 meter intervals.

If the Engineer determines the test results to be satisfactory, the approved plant lot may then be manufactured into the final product. Four random coupon samples taken from the “drops” during the manufacturing process shall be identified with the plant lot number and shipped to the job site with the finished casing.

The Contractor shall incorporate the following Quality Assurance (QA) system at the direction of the Engineer:

**Quality Assurance**
The “drops” shipped with the finished casing shall be tested by the Contractor at a laboratory approved by the State to identify the material properties outlined in the Quality Control section of this specification. The Engineer will review the test results prior to installation of the casing. If test results do not satisfy the criteria, coupons shall be taken from the lot at the job site. The requirement for testing of the “drops” may be waived at the discretion of the Engineer.

For each test result of the coupons taken from the lot at the job site found to be unsatisfactory by the Engineer, the rejected piece or pieces shall be removed from the lot. An additional two test coupons shall be taken from the lot at the job site. If test results from either of these additional coupons are unsatisfactory, the entire plant lot is rejected. If
C. **Bar Reinforcement**

Provide Bar reinforcement meeting the requirements of §709-01, Bar Reinforcement Grade 420, or continuously threaded "Uncoated High-Strength Steel Bar for Prestressing Concrete" - ASTM A722.

D. **Grout**

Provide a pumpable grout consisting of, as a minimum, Portland Cement - Type 2 and Water meeting the following Specification requirements:

<table>
<thead>
<tr>
<th>Material</th>
<th>Subsection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Portland Cement, Type 2</td>
<td>§701-01</td>
</tr>
<tr>
<td>Grout Sand</td>
<td>§703-04</td>
</tr>
<tr>
<td>Fly Ash</td>
<td>§711-10</td>
</tr>
<tr>
<td>Water</td>
<td>§712-01</td>
</tr>
</tbody>
</table>

The use of Grout Sand and Fly Ash in the mix is optional. Field sampling and testing shall be done in accordance with the current procedural directives of the Materials Bureau of the Office of Technical Services.

E. **Centralizers and Spacers**

Provide centralizers and spacers fabricated from schedule 40 PVC pipe, tube, steel, or material non-detrimental to the reinforcing steel. Wood shall not be used.

**CONSTRUCTION DETAILS**

Engage a professional engineer, licensed and registered to practice in New York State, to design the piles in accordance with FHWA’s “Micropile Design and Construction, Reference Manual,” Publication No. FHWA-NHI-05-039. The Contractor's Engineer shall design the piles to perform satisfactorily for both structural and geotechnical requirements. The Contractor's Engineer shall design the diameter, length, reinforcement, pile connections, grout strengths, and grouting pressures, and select the equipment, procedures and methods so that each pile meets the pile acceptance criteria, can support the ultimate tension and compression loads, and meet other requirements, indicated in the contract documents.

Progress all micropiles using steel drill casing.

The Contractor performing the work shall submit proof of: (1) two projects in the past two years on which the Contractor has successfully installed micropiles or soil tiebacks, using non-displacement methods under similar site conditions to those indicated in the contract documents,
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and, (2) the proposed On-Site Supervisor for this work having supervised the successful installation of micropiles or soil tiebacks on at least two projects in the past two years.

A. **Submittals**

Submit the design and method-of-installation information outlined below to the Engineer for approval by the Deputy Chief Engineer Structures (D.C.E.S.). The D.C.E.S. will require twenty (20) work days to review the submission. Do not begin work prior to receiving approval by the D.C.E.S. Approval of the installation method by the D.C.E.S. does not constitute a guarantee of acceptable pile installations. Acceptable installations are the responsibility of the Contractor.

Include in the submittal:

1. Pile computations and details for each design capacity including, but not limited to, nominal diameter, length, reinforcement, pile connections, post grout tube and grouting pressures.
2. Details of equipment for pile installation.
3. Details of procedures for pile installation including, but not limited to, installation sequence and the approximate time required for each sequence step.
4. Procedures for advancing through boulders and other obstructions.
5. Procedures for containment of drilling fluid and spoil, and disposal of spoil.
6. Where applicable, drawings that show the specific work can be performed under limited headroom conditions and as close to obstructions, as site conditions warrant, to install the piles at the locations indicated in the contract documents. Provide information on the length of the casing sections to be used, as dictated by the length of the drill mast and by the available overhead clearance, and the resulting location of joints.
7. When steel drill casing/pipe is used as reinforcement, account for the reduced area of the threaded joint in the structural design of the pile, particularly for the capacity in tension and bending. Identify any joint location restrictions that must be followed in construction.
8. Procedures and equipment for placing grout.
   a. Prepare the mix design for the grout and obtain documentation from an independent laboratory (approved by the Deputy Chief Engineer Technical Services) showing the following:
      i. The mix design conforms to the submitted mix and meets the strength requirements set by the Contractor.
      ii. The compressive strength of the mix, tested at 3, 7, 14, and 28 days.
      iii. The specific gravity of the mix.
   b. Identify a method for monitoring quality control of the mix. At a minimum, the Contractor shall use a Baroid Mud Balance per American Petroleum Institute (API) Recommended Practice (RP) 13B-1: Standard Procedure for Testing Water-Based Drilling Fluids, to check the specific gravity of the mixed grout prior to placement of the grout into each micropile.
   c. Provide pressure gages capable of measuring the actual grout pressures used and such that actual pressure readings are within the middle third of the gage.
9. If proposed, details of post-grouting equipment and procedures, including the method, sequence of operations and equipment required.
10. Layout drawings showing the proposed sequence of pile installation. Coordinate this sequence with the proposed phasing and scheduling.

B. Drilling and Excavation

Advance the hole using a duplex drilling method. Do not drill or flush ahead of the drill casing by more than 0.3 m. Perform drilling and excavation in such a manner as to prevent the collapse of the hole. Use of bentonite slurry is not permitted. Use of polymer slurry to remove cuttings from the cased hole must be approved by the Engineer.

If obstructions are encountered during excavation for a pile, progress through them by means of coring or a tricone roller bit. Use of drop type impact hammers and blasting are not permitted. Use of a down-the-hole hammer shall be approved by the D.C.E.S.

Control the procedures and operations so as to prevent mining, damage or settlement to adjacent structures, tunnels, utilities or adjacent ground. If any mining, damage or settlement occurs, halt operations. Provide a written plan to the Engineer for review with procedures to avoid reoccurrence. Resume work only after the Engineer has approved the plan in writing. Repair all damage and settlement at no additional cost to the State.

Control the procedures and operations so as to prevent the soil at the bottom of the hole from flowing into the hole at all times during installation and cleaning out. Monitor the rate of fluid flow used to progress the holes.

Control drilling fluid and dispose of spoil in accordance with the approved procedure.

Do not progress a hole, pressure grout, or post-grout, within a radius of five (5) pile diameters or 1.5 m, whichever is greater, of a micropile until the grout for that micropile has set for 24 hours or longer if a retarder is used.

C. Piles with Extended Lengths

Design and install piles with extended lengths at the locations shown on the plans. The specified ultimate tension and compression resistance derived from the soil and/or bedrock will be achieved below the elevations indicated in the contract documents.

D. Reinforcement and Post Grout Tube Placement

Provide centralizers sized to position the reinforcement within 10 mm 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 drill hole and casing and between adjacent reinforcing bars. Centralizers, spaced not to exceed 3 m, must be used to center the reinforcement for its entire length. Securely attach the centralizers to withstand installation stresses. Do not drop, but lower the steel reinforcement to its specified location in the hole. If a post grout tube is used, attach it
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to the steel reinforcement prior to lowering it.

E. Grout Placement and Casing Removal
Provide quality control of the mix by monitoring grout quality. Measure grout consistency by determining grout density per API Recommended Practice (RP) 13B-1 by the Baroid Mud Balance Test at a frequency, of at least one test per micropile, and provide the information to the inspector.
The Engineer will perform quality assurance of the mix in accordance with the current procedural directives of the Materials Bureau.

Place grout by means of a tremie pipe from the bottom of the pile upward. Record the initial volume of grout required to fill the hole. Record grouting pressure and volume of grout being pumped into the pile during pressure grouting. Upon completion, maintain the grout level at or above the pile cut off elevation until the grout has set.

Locate the grout pressure and volume measuring gages at the pile installation site so that they are accessible and legible to the inspector.

F. Post Grouting
Provide the equipment and materials to perform post grouting. Perform post grouting after the grout has reached initial set. Record the pressure at which the grout was pumped, the total volume pumped, and the volume pumped through each port (if applicable).

G. Construction Tolerance
Install the piles so that the center of each micropile does not vary from the plan location by more than 75 mm. Do not allow the micropile to vary from the vertical or established batter by more than 20 mm per meter, as measured above ground.

Cut off the top of the pile at the elevation indicated in the contract documents.

If the soil at the pile tip is post grouted, monitor the elevation of the pile top during post grouting. If movement occurs, the Engineer will immediately notify the D.C.E.S.

H. Pile Acceptance Criteria
1. Pile meets Construction Tolerance criteria.
2. Pile was installed in accordance with the approved submittal.
3. Pile is not damaged.
4. Pile was installed using the same method, grout volumes, and pressures as the accepted test pile, if applicable.

I. Unacceptable Piles
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Unacceptable piles are piles which do not meet the acceptance criteria identified in Paragraph H above.

Submit to the Engineer a written plan of remedial action, for approval by the D.C.E.S., showing how to correct the problem and prevent its reoccurrence. Repair, augment, or replace the unacceptable pile in accordance with the approved remedial plan at no additional cost to the State.

METHOD OF MEASUREMENT
The micropile work will be measured by the number of acceptable micropiles installed.

BASIS OF PAYMENT
The unit price bid for micropiles shall include the cost of the design of the micropiles and furnishing all labor and materials necessary to satisfactorily complete the work. Micropiles that fail to meet the acceptance criteria will be rejected and no payment will be made for these piles.