SP-150237a
(Replaces SP-150237)

SPECIAL PROVISIONS
FOR
DRILLED-IN PILES

Black Hawk County
NHSX-063-6(90)--3H-07

Effective Date
March 21, 2017

THE STANDARD SPECIFICATIONS, SERIES 2015, ARE AMENDED BY THE FOLLOWING MODIFICATIONS AND ADDITIONS. THESE ARE SPECIAL PROVISIONS AND THEY SHALL PREVAIL OVER THOSE PUBLISHED IN THE STANDARD SPECIFICATIONS.

150237a.01 DESCRIPTION.

A. A concrete drilled-in pile foundation consists of a drilled shaft with a steel H-pile core installed in bedrock then filled with concrete.

B. As shown in the contract documents, the drilled-in piles are encased in concrete up to the bottom of the MSE wall, then encased with sand or bentonite fill between the bottom of the MSE wall and the bottom of the abutment footing. The sand shall be per Section 4133 of the Standard Specifications and the bentonite shall be per Article 2501.03, Q of the Standard Specifications.

C. Elevations, dimensions, and depth of the soil shafts and rock sockets shall be as specified in the contract documents. If bearing strata are encountered at different elevations or are judged to be of a different quality, the Engineer will adjust the permanent casing length and the socket elevation.

D. Site Conditions.

1. Artesian conditions have been encountered during drilling of borings BR-01 through BR-09. For example, boring BR-01, drilled from existing grade at elevation 828.4 feet, encountered an artesian water condition with water head at approximate elevation 835 feet. It is anticipated that similar artesian conditions will be encountered during probe testing and installation of the drilled-in piles. To minimize the impacts of artesian conditions, the planned sequence of construction requires the Contractor to fill between the existing grade and the bottom of the proposed MSE wall near the bridge (approximate elevation 847 feet) prior to installation of the drilled-in piles. The Contractor shall be prepared to handle the artesian condition during probe testing and pile installation.

2. Karst features, voids and cavities have been encountered during coring of borings BR-01 through BR-09. It is anticipated that similar conditions will be encountered during installation

of the drilled-in piles. If the Contractor is planning to use drilling fluid, he shall be prepared for drilling fluid loss. The Contractor shall be prepared to handle potential concrete quantity overruns during installation of the drilled-in piles.

150237a.02 MATERIALS.

A. Drilling Fluid.
Drilling fluid shall comply with Article 2433.02, A of the Standard Specifications except that only bentonite slurry or clean water shall be used.

B. Concrete.

1. All materials, proportioning, air entraining, mixing, slump, and transporting of Portland Cement Concrete (PCC) shall be according to Section 2403 of the Standard Specifications, except as modified herein.

2. Water/cement ratio: not to exceed 0.45.

3. Drilled-in pile construction: use Class D PCC mixture with a slump of 8 inches +/- 1.5 inches.

4. Portland cement: meet the requirements of ASTM C 150 Type I / II.

5. Air entrainment: apply Section 2403 of the Standard Specifications.

6. Retarder is required according to Materials I.M. 403 to maintain workable concrete.

7. ~~SIKA Intraplast-N, Intrusion-Aid MAX, or Eucon AWA is required. Use in accordance with the manufacturer's recommendations.~~ The use of fluidifier and anti-shrinkage admixture are required for the drilled-in pile concrete. The contractor shall determine the proper fluidifier and anti-shrinkage admixture product and dosage to be used in the concrete mix design.

8. Do not use Ground Granulated Blast Furnace Slag (GGBFS).

C. Grout.
Apply Materials I.M. 388.

D. Steel H-Pile Core.

1. Conform to Section 4167 of the Standard Specifications.

2. Storing, transporting, and handling shall be performed in a manner to prevent bending stresses or other damage.

3. Pile Order Lengths.
- **a.** The Contractor shall develop his schedule such that all the probes or test borings can be performed as early as possible. The record of the air-track probes or test borings shall be provided to the Engineer for evaluations and issuance of the final drilled-in piles. The Contractor shall allow the Engineer 15 working days to evaluate and issue the final tip elevations.
- **b.** The Contractor assumes all risk involved with ordering production piles in advance of the Engineer issuing the final drilled-in pile tip elevations.

E. Corrugated Metal Pipe (CMP).
Conform to Article 4141.01 of the Standard Specifications.

F. Permanent Steel Casing.

1. Conform to ASTM A252, Grade 3.

2. The minimum casing thickness shall be 1/2 inch.

3. Conform to the diameter specified in the plans.

150237a.03 CONSTRUCTION.

A. Construction Sequence.

1. Drill one 2 inch minimum air-track test probe or one test boring with NQ-size rock coring at each drilled-in pile location to the elevation specified in the plans.

2. Advance the drilled-in pile excavation to the tip elevation of the concrete socket per the approved installation plan.

3. Clean the drilled-in pile excavation to ensure that no fines or sediments are present per the approved installation plan.

4. Steel H-pile shall be placed with centralizers in the permanent casing.

5. Place the concrete using tremie pipe immediately after excavation bottom is approved by the Engineer.

6. The Contractor shall install CMP to support the ground above the top of the concrete to facilitate the placement of sand or bentonite.

B. Air-Track Probes and Test Boring.

1. Drill one test probe or one test boring at the center of each drilled-in pile location. Drill 2 inch minimum diameter probe or test boring to a depth as shown in the plans.

2. Test Borings: Equipment, methods, field records, sampling, final records, and storage of samples shall conform to Design Manual Chapter 200I-1. Fill in boreholes with neat cement grout.

3. Drill air-track probe or test borings at all drilled-in pile locations prior to the start of drilled-in pile excavation. Provide the logs to the Engineer. The probe log shall record rate of advance per foot, down pressure applied if any, rod drops, and any observation regarding the cuttings.

4. If voids, soil seams, or solution channels are detected, the Engineer shall be contacted for potential deeper probing or boring depth.

5. If the test probe hole has a diameter of 8 inches or greater, the test probe hole can be filled with drilled-in pile concrete in lieu of grout. Otherwise, fill drilled probe holes with neat cement grout.

6. Drilled-in pile installation shall not proceed until the Engineer issues the final tip elevation based on the results of the probing or boring.

C. Drilled-In Pile Installation Plan.

1. 2 weeks prior to the pre-construction conference, submit a list containing at least three drilled shafts or drilled-in pile projects with rock socket, of similar diameter and length to those shown on the plans, completed in the last three years. In the list of projects include names and phone numbers of owner's representatives who can verify the Contractor's participation

on those projects. In addition, submit a signed statement that the Contractor has inspected the project site and all the subsurface information made available in the contract documents.

2. Upon issuance of the final drilled-in pile tip elevation by the Engineer, and no later than 1 month prior to constructing drilled-in pile, submit a drilled-in pile installation plan for the Engineer to review. In this plan provide the following information:

- **a.** Name and experience record of firm(s) and associated personnel for the following:
  - **1)** Driller
  - **2)** Drilled-in pile superintendent.
  - **3)** Site exploration.
  - **4)** Confirmation boring
- **b.** List of proposed equipment to be used, including cranes, drills, augers, bailing buckets, grooving equipment, scouring equipment, final cleaning equipment, core sampling equipment, confirmation boring equipment, test probe equipment, tremies, casing, airlift pumps, etc.
- **c.** Details of overall construction operation sequence and the sequence of drilled-in pile construction in bents or groups.
- **d.** Details of excavation methods.
- **e.** Details of casing and forms, including installation and removal.
- **f.** Details of methods to clean the excavation, including air lift methods and spin bucket methods as applicable.
- **g.** Details of H-pile core placement, including support and centering methods.
- **h.** Details of H-pile splice and location of splice.
- **i.** Detail of centralizer and the way it is attached to the H-pile core.
- **j.** Details of concrete placement including procedures for tremie and method to prevent water or sediment intrusion at the discharge end.
- **k.** Concrete mix proposal.
- **l.** Details of methods to control cuttings, water, etc. with adjacent traffic conditions (vehicular or railroad if applicable).
- **m.** Details of final discharge of concrete at top of drilled-in pile, of removing contaminated concrete, and verifying concrete uniformity for site specific conditions.
- **n.** When casing is required, include details on casing to be used, including:
  - Specific length/depth of all casing proposed.
  - Specific evaluation and determination of casing (size, depth, etc.) required to prevent all drilled-in pile installation procedures from having an effect or impact on adjacent structures, railroads, etc.
- **o.** Contingency Plan: At the minimum, the contingency plan shall be developed to address the following situations:
  - Loss of drilling fluid during pile installation
  - Grout/concrete loss during pile installation
  - Artesian condition encountered during pile installation
  - Artesian condition encountered during probing or drilling of test boring
  - Loss of air track rods during probing

3. The Engineer will evaluate the drilled-in pile installation plan for conformance with the contract documents. Within 14 calendar days after receipt of the plan, the Engineer will notify the Contractor of additional information required or changes necessary to meet the contract requirements, or both. Field test the Engineer's procedural approvals. These approvals do not relieve the Contractor of the responsibility to satisfactorily complete the work as detailed in the contract documents.

4. A pre-construction conference, in which the Engineer, Contractor, and drilling staff discuss the anticipated drilled-in pile process, will be required for this work prior to the start of excavation.

D. Control and Disposal of Materials.

Dispose of excavated material including water removed from the excavation. Collect and properly dispose off site all water displaced during final cleaning and concrete placement. Open pits for collection of materials will not be allowed. Control all excavated material, water, and other matter so that at no time it enters or encroaches upon the adjacent travel lanes, railroad, waterways, etc.

E. Drilled-in Pile Excavation.

1. General.

- **a.** Construct drilled-in pile excavation by the casing method described below to produce sound, durable concrete foundation free of defects.
- **b.** If the Engineer determines that the material encountered during excavation and/or present at tip elevation is unsuitable and/or differs from that anticipated in the design of the drilled-in pile, extend the drilled-in pile tip elevations as directed by the Engineer.
- **c.** Maintain a drilling log during soil and rock socket excavation. In the log, place information such as elevation, depth of penetration, drilling time in each of the strata, material description, and remarks. Furnish the log to the Engineer within 1 week after completion of the excavation.
- **d.** Construction of the drilled-in pile shall begin within 8 hours of completion of the excavation.
- **e.** Due to the potential presence of karst features, the Contractor shall be prepared for drilling fluid loss.

2. Casing Method.

- **a.** The casing method with the use of drilling fluid shall be used to advance the excavation through unstable material. Over-reaming to the outside diameter of the casing is required. The permanent casing shall be terminated at the top of bearing strata, as specified by the Engineer. The permanent casing shall be left in place.
- **b.** The purposes of using drilling fluid are to prevent drilled hole caving during excavation and to properly handle the artesian water condition prior to placing the permanent steel casing.
- **c.** The purposes of the permanent casing are to stabilize the excavation walls during drilling to prevent cave-ins as the result of potential vibrations, to minimize downdrag load after the drilled-in pile is constructed, and to prevent drilled-in pile installation procedures from having an impact on adjacent structures, railroads, etc.
- **d.** Place concrete via tremie method to displace the drilling fluid.

F. Final Cleaning.

1. Clean the bottom of excavation via method of scouring or air lift pump usage.

2. Clean the base of each excavation so that the base will have less than 1/2 inch of sediment or debris at the time of concrete placement.

3. The Engineer will visually inspect excavations.

G. Excavation Inspection.

Provide equipment for checking the dimensions and alignment of each excavation. Under the direction of the Engineer, verify the dimensions and alignment of the drilled-in pile under construction. After final cleaning, use a suitable weighted tape or other approved methods to measure final excavation depths.

H. Placement of Steel H-Pile Cores.

1. First construct a pile template that is capable of maintaining alignment and position of the H-pile core during installing within tolerances specified herein.

2. The steel H-pile cores shall be placed within 8 hours of the completion of the excavation.

3. The steel H-piles core shall be placed in the excavation to the length shown on the plans.

4. The steel H-piles core shall be placed and maintained in the center of the excavation.

5. The steel H-piles core shall be furnished and installed full length. A maximum of one splice shall be used; the splice shall be performed in accordance with Article 2501.03, P of the Standard Specifications.

6. Steel sections damaged during transportation, handling or installation shall be removed.

7. Steel sections spacing shall be +/- 3 inches from plan location and shall not be more than 1% off from vertical.

8. All cuts of steel H-pile sections shall be perpendicular to the axis of the pile.

I. Concrete Placement.

1. General.

a. Place drilled-in pile concrete within 24 hours of the start of excavation of the rock socket. Place concrete within 8 hours of placing the steel H-pile.
b. Coordinate concrete batching and delivery with the batch plant so the time limits, as stated in the contract documents, between batching and delivery are not exceeded.
c. Place concrete in a continuous manner. Continue concrete placement after the excavation is full until good quality concrete is evident at the plan top elevation.
d. Calculate the volume of concrete needed to fill rock socket in competent rock and submit to Engineer for approval.
e. Record the top elevation of concrete and the volume of placed concrete at the top of competent rock. If the volume of concrete required to fill the rock socket exceeds the allowable differential, determine the cause of differential and notify the Engineer immediately.
f. Remove a sufficient volume of concrete from the top of freshly placed wet concrete to ensure elimination of all contaminated concrete at the top of drilled-in pile—a pump or air lift will be needed.
g. Place concrete through a tremie.
h. Complete placement of the concrete in the drilled-in pile within 3 hours. Adjust admixtures, when approved for use, for the conditions encountered on the job so the concrete remains in a workable plastic state throughout the 3 hour placement limit.
i. Leave all permanent casing in place.

2. Concrete Placement by Tremie.

a. For the tremie, comply with the following:
- The tremie shall be constructed so that it is watertight and will readily discharge concrete.
- The concrete shall be placed via a concrete pump or gravity tremie. A tremie shall have a hopper at the top that empties into a watertight tube at least eight inches in diameter. If a pump is used, a watertight tube shall be used with a minimum diameter of four inches.
- No aluminum parts shall come into contact with concrete.
- The discharge end of the tremie shall be constructed to prevent water intrusion and permit the free flow of concrete during placement operations.
- The tremie shall have sufficient mass so that it will rest on the excavation bottom before the start of concrete placement.
- Sufficient length to extend to the bottom of the excavation.

b. Maintain the discharge orifice between 5 feet and 10 feet below the surface of the fluid concrete.
c. Support the tremie so that it can be raised to increase the discharge of concrete and lowered to reduce the discharge of concrete.
d. Maintain a continuous flow of concrete. Ensure the concrete in the tremie maintains a positive pressure differential at all times to prevent introduction of air pockets or contaminants into the concrete.

3. Concrete Placement by Pump line.
Concrete placement by pump is not permitted without the use of a tremie pipe.

J. Demonstration Drilled-in Pile.

1. Demonstrate equipment and methods prior to construction of the first production drilled-in pile by installing a non-production drilled-in pile. Install on site at a location determined by the Engineer.

2. Construct the demonstration drilled-in pile in soil/rock as shown in the contract documents.

3. Construct the demonstration drilled-in pile according to the requirements of this specification with special emphasis on method of scouring, air lift pump usage, concrete delivery and coordination with the batch plant, concrete slump at the point of delivery, and concrete placement.

4. If the demonstration drilled-in pile installation demonstrates the equipment and methods used to construct drilled-in piles to the requirements of this specification are inadequate, the Engineer will require appropriate alterations in equipment or methods, or both, to eliminate the unsatisfactory results. The Contractor may be required to perform additional demonstration drilled-in piles until an adequate procedure is demonstrated and approved by the Engineer.

5. Do not begin constructing production drilled-in plies until the Engineer approves the methodology.

K. Construction Tolerances.
Drilled-in pile excavations and completed drilled-in piles not constructed within the required tolerances will be considered unacceptable. Correct all unacceptable excavations and completed drilled-in piles to the Engineer's satisfaction. Furnish materials and work necessary, including engineering analysis and redesign, to complete corrections for out of tolerance excavations (without either cost to the Contracting Authority or an extension of the completion dates of the project).

1. Ensure the drilled-in pile is within 3 inches of plan position at the top of drilled-in pile.

2. Ensure the vertical alignment of the excavation does not vary from the plan alignment by more than 1%.

3. Set full depth steel H-pile core section at the bottom of the excavation prior to concrete placement.

4. Casing dimensions are subject to American Pipe Institute tolerances applicable to regular steel pipe.

5. The top elevation of the concrete may have a tolerance of +/- 3 inches from the plan top of concrete elevation. Ensure sufficient steel H-pile core section length for embedment into abutment.

6. Use excavation equipment and methods that ensure the completed excavation will have a planar bottom. Ensure the excavation equipment cutting edges are normal to the equipment's vertical axis within a tolerance of 3/8 inch per foot of diameter.

L. Testing Program.

1. General.

a. Testing for all non-production and production drilled-in piles are required to ensure the quality and integrity of the piles.

b. Testing shall be done via Thermal Integrity Profile (TIP).

c. The testing method shall be selected by the Contractor and shall be capable of testing the installed length of the drilled-in piles.

d. The Contractor shall submit a summary report to the Engineer for approval within 5 working days after testing is conducted. The summary report shall include, at a minimum, the methodology of testing, list of equipment, details of test set-up, test data, and interpreted results.

2. Thermal Integrity Profile.

a. The Contractor shall perform the TIP testing by obtaining records of the heat generated by curing cement (hydration energy) to assess the quality of drilled-in piles. TIP measurements that are colder than normal indicate necks, inclusions, or poor quality concrete, while warmer than normal measurements are indicative of bulges. Variation in temperatures across the pile section can reveal reinforcement eccentricity. The TIP testing shall meet the requirements of ASTM D7949 and be performed along the full length of each drilled in pile.

b. The top of the concrete shall be covered with plastic to maintain the temperature for a minimum of 72 hours after the completion of the concrete placement.

c. Equipment: The Contractor shall supply all materials and equipment required to perform TIP tests. Equipment to perform the test shall have the following minimum requirements:

- Four thermal wire cables equally spaced at 90 degrees around the perimeter, attached to elements welded to the steel H-pile. The method of installation of thermal wire cables shall be included in the installation plan.
- Ability to collect data at user defined time intervals (typically 15 to 60 minutes).
- A computer based TIP data acquisition system to monitor temperature versus time after casting.

150237a.04 METHOD OF MEASUREMENT.

Measurement will be as follows:

A. Air-track Probe or Test Boring.
Feet, to the nearest 0.5 foot, measured down from the top of the abutment berm. Any drilling above this elevation is considered incidental.

B. Drilled-In Pile in Soil.
Feet, to the nearest 0.5 foot, constructed in soil.

C. Drilled-In Pile in Rock.
Feet, to the nearest 0.5 foot, constructed in rock.

D. Steel H-Pile.
Feet, to the nearest 0.5 foot, constructed.

E. Demonstration Drilled-in Pile.
Feet, to the nearest 0.5 foot, constructed and approved.

F. Testing Program.
Each, for each performed test for non-production and production piles.

150237a.05 BASIS OF PAYMENT.
Payment will be the contract unit prices as follows:

A. Air-track Probe or Test Boring.

1. Per foot.

2. Payment is full compensation for all equipment, labor, and materials necessary to satisfactorily complete the air-track probe or test boring including:
- Drilling and excavation air-track probe or test boring
- Furnishing and placing of grout backfill
- Disposal of excavated materials, water, and all other materials

B. Drilled-In Pile in Soil.

1. Per foot.

2. Payment is full compensation for all equipment, labor, and materials (except steel H- Pile Core) necessary to satisfactorily construct the drilled-in pile including:
- Drilling and excavation in soil
- Use of drilling fluid and all fluid loss during drilling (no additional compensation for fluid loss)
- Supplying and installing permanent steel casing
- Furnishing and placing concrete (up to 150% of the total theoretical volume of concrete), sand, bentonite, and any CMP required to support the ground to facilitate the installation of the sand and bentonite. The cost and installation effort of the CMP is considered incidental to the cost of the drilled-in piles.
- Drilled-in pile inspection
- Disposal of excavated materials, water, and all other materials

C. Drilled-In Pile in Rock.

1. Per foot.

2. Payment is full compensation for all equipment, labor, and materials (except steel H- Pile Core) necessary to satisfactorily construct the drilled-in pile including:
- Drilling and excavation of rock socket
- Use of drilling fluid and all fluid loss during drilling (no additional compensation for fluid loss)
- Furnishing and placing concrete (up to 150% of the total theoretical volume of concrete),
- Drilled-in pile inspection
- Disposal of excavated materials, water, and all other materials

D. Steel H-Pile.
Per foot, including centralizers and placement within the permanent casing/CMP.

E. Demonstration Drilled-in Pile.

1. Per foot.

2. Payment is full compensation for all equipment, labor, and materials necessary to satisfactorily construct the approved drilled-in pile including:
- Drilling and excavation of drilled-in pile in soil and rock socket

- Use of drilling fluid and all fluid loss during drilling (no additional compensation for fluid loss)
- Supplying and installing permanent casing
- Furnishing and placing H-pile core and centralizers
- Furnishing and placing concrete (up to 150% of the total theoretical volume of concrete),
- Drilled-in pile inspection
- Disposal of excavated materials, water, and all other materials

F. Testing Program.

Testing for all non-production and production piles, including all equipment, labor, and materials necessary to satisfactorily perform the test in accordance with the specified requirements.