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(April 6, 2015)
Shafts For Sign Structure Foundations

Shaft foundations for the sign structures at the following location(s) shall be constructed in accordance with the following requirements, except that temporary casing is not required by the Contracting Agency but is instead a Contractor option:

*** \$\$1\$\$ ***

Shaft foundations for the sign structures at the following location(s) shall be constructed in accordance with the following requirements, including required use of temporary casing:

*** \$\$2\$\$ ***

Submittals

Contractor Project Reference and Personnel Experience Submittal

Prior to the start of shaft construction, the Contractor shall submit a Type 2 Working Drawing consisting of a project reference list verifying the completion by the Contractor of at least three separate shaft foundation projects in the past five years with drilled shafts of diameters and depths similar to or larger than those shown in the Plans and ground conditions similar to those identified in the Contract. A brief description of each listed project shall be provided along with the name and current phone number of the project owner or the owner's Contractor.

Prior to the start of shaft construction, the Contractor shall submit a Type 2 Working Drawing consisting of a list identifying the on-site supervisors, and drill rig operators potentially assigned to the project. On-site supervisors shall have a minimum two years experience in supervising construction of shaft foundations, and drill rig operators shall have a minimum one year experience in construction of shaft foundations. The list shall contain a brief description of each individual's experience.

Shaft Installation Narrative Submittal

The Contractor shall submit a Type 3 Working Drawing consisting of a shaft installation narrative. The narrative shall reference available subsurface data provided in the contract test hole boring logs, and the geotechnical report(s) prepared for this project. This narrative shall provide the following information in a single complete submittal:

1. Proposed overall construction operation sequence.
2. Description, size, and capacities of specific equipment that will be available on site, including but not limited to cranes, drills, auger, bailing buckets, final cleaning equipment and drilling unit. The narrative shall describe why the equipment was selected, and describe equipment suitability to the anticipated site conditions and work methods. The narrative

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shall include a project history of the drilling equipment demonstrating the successful use of the equipment on shafts of equal or greater size in similar soil/rock conditions. The narrative shall also include details of shaft excavation and cleanout methods

3. Details of the method(s) to be used to ensure shaft stability (i.e., prevention of caving, bottom heave, etc. using temporary casing, slurry, and other means) during excavation (including pauses and stops during excavation) and concrete placement. Temporary casing dimensions and detailed procedures for temporary casing installation and removal, and methods of advancing temporary casing with the excavation in accordance with this Special Provision, shall be provided.
4. Detailed procedures for mixing, using, and maintaining the slurry shall be provided. A detailed mix design (including all additives and their specific purpose in the slurry mix), and a discussion of its suitability to the anticipated subsurface conditions, shall also be provided for the proposed slurry.

The submittal shall include a detailed plan for quality control of the selected slurry, including tests to be performed, test methods to be used, and minimum and/or maximum property requirements which shall be met to ensure that the slurry functions as intended, considering the anticipated subsurface conditions and shaft construction methods, in accordance with the slurry manufacturer's recommendations and this Special Provision. As a minimum, the slurry quality control plan shall include the following tests:

Property	Test Method
Density	Mud Weight (Density), API 13B-1, Section 1
Viscosity	Marsh Funnel and Cup, API 13B-1, Section 2.2
PH	Glass Electrode, pH Meter, or pH Paper
Sand Content	Sand, API 13B-1, Section 5

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5. Description of the method used to fill or eliminate all voids below the top of shaft between the plan shaft diameter and excavated shaft diameter.
6. Reinforcing steel shop drawings, details of reinforcement placement, including bracing, centering, steel reinforcing bar

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cage centralizers, and lifting methods, and the method to assure the reinforcing cage position is maintained during construction.

7. Details of concrete placement, including operational procedures for pumping methods, and a sample uniform yield form to be used by the Contractor for plotting the approximate volume of concrete placed versus the depth of shaft for all shaft concrete placement (except concrete placement in the dry).
8. Description of the material (either CDF or granular material) used to temporarily backfill a shaft excavation during a stoppage of the excavation operation, as well as the method used to place and remove the material.
9. Storage and disposal plan for excavated material and drilling slurry (if applicable).

Synthetic Slurry Technical Representative Submittal

If synthetic slurry is used to construct the shafts, the Contractor shall provide or arrange for technical assistance in the use of the synthetic slurry as specified in the **Slurry** subsection of this Special Provision. As part of the shaft installation narrative Working Drawing, the Contractor shall submit one of the following:

1. The name and current phone number of the synthetic slurry manufacturer's technical representative assigned to the project.
2. The name(s) of the Contractor's personnel assigned to the project and trained by the synthetic slurry manufacturer in the proper use of the synthetic slurry. The submittal shall include a signed training certification letter from the synthetic slurry manufacturer for each trained Contractor's employee listed, including the date of the training.

Quality Assurance

Shafts shall be constructed so that the center at the top of the shaft is within four inches of the Plan location. Shafts shall be within 1.5 percent of plumb. Shaft steel reinforcing bar placement tolerances shall conform to Section 6-02.3(24)C.

A shaft preconstruction conference shall be held at least five working days prior to the Contractor beginning any shaft construction work at the site to discuss construction procedures, personnel, and equipment to be used, and other elements of the approved shaft installation plan as specified elsewhere in this Special Provision. Those attending shall include the superintendent, on site supervisors, and all foremen in charge of excavating the shaft, placing the casing and slurry as applicable, placing the steel reinforcing bars, and placing the concrete, a representative of the concrete supplier, and the pump truck operator. If synthetic slurry is used to construct the shafts, the synthetic slurry manufacturer's representative

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and/or approved Contractor's employees trained in the use of the synthetic slurry shall also attend.

If the Contractor proposes a significant revision of the approved shaft installation plan, as determined by the Engineer, the Engineer may require an additional conference be held before any additional shaft construction operations are performed.

Shaft Excavation

Once the shaft excavation operation has started, the excavation shall be conducted in a continuous operation until the excavation of the shaft is completed, except for pauses and stops as noted, using approved equipment capable of excavating through the type of material expected.

Pauses, defined as momentary interruptions of the excavation operation, will be allowed only for casing splicing, tooling changes, slurry maintenance, and removal of obstructions. Shaft excavation operation interruptions not conforming to this definition shall be considered stops. Stops for uncased or partial depth cased excavations shall not exceed 16 hours in duration. Stops for fully cased excavations shall not exceed 65 hours duration.

For stops exceeding the time durations specified above, the Contractor shall stabilize the excavation using one or both of the following methods:

1. Before the end of the work day, install casing in the hole to the depth of the excavation. The outside diameter of the casing shall not be smaller than six inches less than either the Plan diameter of the shaft or the actual excavated diameter of the hole, whichever is greater. Prior to removing the casing and resumption of shaft excavation, the annular space between the casing and the excavation shall be sounded. If the sounding operation indicates that caving has occurred, the casing shall not be removed and shaft excavation shall not resume until the Contractor has stabilized the excavation in accordance with item 3 of the shaft installation narrative as approved by the Engineer.
2. Backfill the hole with CDF or granular material as specified by the Contractor and approved by the Engineer in accordance with item 8 of the shaft installation narrative. The Contractor shall backfill the hole to the ground surface if the excavation is not cased, or to a minimum of five feet above the bottom of casing if the excavation is cased. Backfilling of shafts with casing fully seated into rock, as determined by the Engineer, will not be required.

During stops, the Contractor shall stabilize the shaft excavation to prevent bottom heave, caving, head loss, and loss of ground. The Contractor bears full responsibility for selection and execution of the method(s) of stabilizing and maintaining the shaft excavation, in accordance with

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Section 1-07.13. Shaft stabilization shall conform to item 3 of the shaft installation narrative.

If slurry is present in the shaft excavation, the Contractor shall conform to the requirements in the **Slurry** subsection of this Special Provision regarding the maintenance of the slurry and the minimum level of drilling slurry throughout the stop, and shall recondition the slurry to the required slurry properties prior to recommencing shaft excavation operations.

Temporary casing shall be advanced during excavation operations within the limits of temporary casing shown in the Plans for all sign structure shaft foundation locations specified at the beginning of this Special Provision as requiring temporary casing. Excavation in advance of the casing tip shall not exceed three feet, except that in no case shall shaft excavation and casing placement extend below the bottom of shaft excavation as shown in the Plans. Unless partial depth temporary casing is shown in the Plans, temporary casing shall be full depth of the sign bridge shaft.

The Contractor shall conduct casing installation operations and shaft excavation operations such that the adjacent soil outside the casing and shaft excavation for the full height of the shaft is not disturbed. Disturbed soil is defined as soil whose geotechnical properties have been changed from those of the original in-situ soil.

The Contractor shall use appropriate means such as a cleanout bucket, smooth mouth grab, or air lift to clean the bottom of the excavation of all shafts. No more than two inches of loose or disturbed material shall be present at the bottom of the shaft just prior to placing concrete.

The excavated shaft shall be inspected and approved by the Engineer prior to proceeding with construction. The bottom of the excavated shaft shall be sounded with an airlift pipe, a tape with a heavy weight attached to the end of the tape, or other means acceptable to the Engineer to determine that the shaft bottom meets the requirements in the Contract.

When obstructions are encountered, the Contractor shall notify the Engineer promptly. An obstruction is defined as a specific object (including, but not limited to, boulders, logs, and man made objects) encountered during the shaft excavation operation which prevents or hinders the advance of the shaft excavation. When efforts to advance past the obstruction to the design shaft tip elevation result in the rate of advance of the shaft drilling equipment being significantly reduced relative to the rate of advance for the portion of the shaft excavation in the geological unit that contains the obstruction, then the Contractor shall remove, break-up, or push aside, the obstruction under the provisions of Section 8-21.5 as supplemented in these Special Provisions. The method of dealing with such obstructions, and the continuation of excavation shall be as proposed by the Contractor and approved by the Engineer.

The Contractor shall use slurry, as specified in the **Slurry** subsection of this Special Provision, to maintain a stable excavation during excavation

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and concrete placement operations once water begins to enter the shaft excavation and remain present.

Slurry

If synthetic slurry is used, either a manufacturer's representative or a Contractor's employee trained in the use of the synthetic slurry, as approved by the Engineer in accordance with the **Submittals** subsection of this Special Provision, shall provide technical assistance for the use of the synthetic slurry, shall be at the site prior to introduction of the synthetic slurry into the first drilled hole requiring slurry, and shall remain at the site during the construction of the first shaft excavated to adjust the slurry mix to the specific site conditions.

If the Contractor uses slurry in shafts installed below groundwater and in caving or sloughing soils, the slurry level in the excavation shall be maintained above the groundwater level the greater of the following dimensions, except as otherwise noted for the special requirements for all stops in shaft excavation operations:

1. Not less than ten feet,
2. Dimension as required to provide and maintain a stable hole.

The Contractor shall provide casing, or other means, as necessary to meet these requirements.

The slurry level shall be maintained above all unstable zones a sufficient distance to prevent bottom heave, caving or sloughing of those zones.

Throughout all stops in shaft excavation operations as defined in the **Shaft Excavation** subsection of this Special Provision, the Contractor shall monitor and maintain the slurry level in the excavation the greater of the following elevations:

1. No lower than the water level elevation outside the shaft.
2. Elevation as required to provide and maintain a stable hole.

Synthetic slurry shall be mixed and thoroughly hydrated in slurry tanks, ponds, or storage areas. The Contractor shall draw sample sets from the slurry storage facility and test the samples for the conformance with the specified viscosity and pH properties before beginning slurry placement in the drilled hole. Synthetic slurry shall conform to the quality control plan included in the shaft installation plan as approved by the Engineer. A sample set shall be composed of samples taken at mid-height and within two feet of the bottom of the storage area.

When synthetic slurry is used, the Contractor shall keep a written record of all additives and concentrations of the additives in the synthetic slurry. These records shall be provided to the Engineer once the slurry system has been established in the first drilled shaft on the project. The

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Contractor shall provide revised data to the Engineer if changes are made to the type or concentration of additives during construction.

The Contractor shall sample and test all slurry in the presence of the Engineer, unless otherwise directed. The date, time, names of the persons sampling and testing the slurry, and the results of the tests shall be recorded. A copy of the recorded slurry test results shall be submitted to the Engineer at the completion of each shaft, and during construction of each shaft when requested by the Engineer.

Sample sets of all slurry, composed of samples taken at mid-height and within two feet of the bottom of the shaft and the storage area, shall be taken and tested once every four hours minimum at the beginning and during drilling shafts and prior to cleaning the bottom of the hole to verify the control of the viscosity and pH properties of the slurry. As a minimum, sample sets of all slurry shall be taken and tested at least once every two hours if the previous sample set did not have consistent viscosity and pH properties. All slurry shall be recirculated, or agitated with the drilling equipment, when tests show that the sample sets do not have consistent specified properties. Cleaning of the bottom of the hole shall not begin until tests show the samples taken at mid-height and within two feet of the bottom of the hole have consistent viscosity and pH properties.

Sample sets of all slurry, as specified, shall be taken and tested to verify control of the viscosity, pH, density, and sand content properties after final cleaning of the bottom of the hole just prior to placing concrete. Placement of the concrete shall not start until tests show that the samples taken at mid-height and within two feet of the bottom of the hole have consistent specified properties.

The Contractor shall clean, recirculate, de-sand, or replace the slurry to maintain the required slurry properties.

If stable conditions are not being maintained, the Contractor shall immediately take action to stabilize the shaft. The Contractor shall submit a revised shaft installation narrative which addresses the problem and prevents future instability. The Contractor shall not continue with shaft construction until the damage which has already occurred is repaired in accordance with the specifications, and until receiving the Engineer's approval of the revised shaft installation narrative.

The Contractor shall dispose of the slurry and slurry-contacted spoils as specified in the shaft installation plan and in accordance with Section 6-19.3(4)F.

Assembly And Placement Of Steel Reinforcing Bars

The steel reinforcing bar cage shall be rigidly braced to retain its configuration during handling and construction.

The reinforcement shall be carefully positioned and securely fastened to provide the minimum clearances listed below, and to ensure that no displacement of the steel reinforcing bars occurs during placement of the

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concrete. The reinforcing steel centralizers shall be placed at least at the quarter points around the circumference of the steel reinforcing bar cage, and located vertically at least at the 1/4 and 3/4 points of the shaft length below the shaft cap.

The Contractor shall place bars as shown in the Plans with minimum concrete cover of three inches for shafts with diameters of three feet or less, and four inches for shafts with diameters greater than three feet.

Placing Concrete

Shaft concrete shall be Class 4000P. Concrete placement shall commence immediately after completion of excavation by the Contractor and inspection by the Engineer. Immediately prior to commencing concrete placement, the shaft excavation and the properties of the slurry (if used) shall conform to the excavation and slurry requirements specified elsewhere in this Special Provision. Concrete placement shall be continuous until the Work is complete.

During concrete placement, the Contractor shall monitor, and minimize, the difference in the level of concrete inside and outside of the steel reinforcing bar cage. The Contractor shall conduct concrete placement operations to maintain the differential concrete head as 1'-0" maximum.

When placing concrete in the dry, only the top five feet of concrete shall be vibrated. The amount and extent of vibration shall be sufficient to assure concrete flow to the outside of the shaft with full consolidation without causing segregation to occur. Temporary casing shall be removed before vibration. This requirement may be waived if the temporary casing is removed with a vibratory hammer during the concrete placement operation. Vibration of the top five feet of concrete does not affect the maximum slump allowed for the concrete class specified.

If water is not present, the concrete shall be deposited through the center of the reinforcement cage by a method which prevents segregation of aggregates and splashing of concrete on the reinforcement cage. The concrete shall be placed such that the free-fall is vertical down the center of the shaft without hitting the sides, the steel reinforcing bars, or the steel reinforcing bar cage bracing. The Section 6-02.3(6) restriction for 5'-0" maximum free-fall shall not apply to placement of Class 4000P concrete into a shaft.

When placing concrete underwater, including when water in a shaft excavation exceeds three inches in depth, the Contractor shall place the concrete by pressure feed using a concrete pump with a watertight tube having a minimum diameter of four inches. The discharge end of the tube on the concrete pump shall include a device to seal out water while the tube is first filled with concrete. Alternatively, the Contractor may use a plug that is inserted in the hopper of the concrete pump and travels through the tremie to keep the concrete separated from the water and slurry. Concrete placement by gravity feed is not allowed.

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Throughout the underwater concrete placement operation, the discharge end of the tube shall remain submerged in the concrete at least five feet and the tube shall always contain enough concrete to prevent water from entering.

Before placing any fresh concrete against concrete deposited in water or slurry, the Contractor shall remove all scum, laitance, loose gravel and sediment on the upper surface of the concrete deposited in water or slurry and chip off any high spots on the upper surface of the existing concrete that would prevent the steel reinforcing bar cage from being placed in the position required by the Plans.

The Contractor's construction operation in the vicinity of a drilled shaft excavation with freshly placed concrete and curing concrete shall conform to Section 6-02.3(6)D.

Except for shafts where the shaft concrete is placed in the dry, the Contractor shall complete a uniform yield form, consistent with the sample form submitted to the Engineer as part of the shaft installation plan, for each shaft and shall submit the completed form to the Engineer within 24 hours of completing the concrete placement in the shaft.

Casing Removal

As the temporary casing is withdrawn, the Contractor shall maintain the concrete and slurry inside the casing at a level sufficient to balance the hydrostatic pressure outside the casing. The Contractor shall completely remove all temporary casings.