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**(April 6, 2015)**

**Shafts For Signal Standard Foundations**

Shaft foundations for the traffic signal standards at the following location(s) shall be constructed in accordance with the following requirements:

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**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 completion by the Contractor of at least three separate shaft foundation projects within 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 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 casing, slurry, or other means) during excavation (including pauses and stops during excavation) and concrete placement. Casing dimensions and detailed procedures for permanent casing installation, and

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methods of advancing permanent casing with the excavation in accordance with this Special Provision, shall be provided.

4. Description and details of the storage and disposal plan for excavated material and slurry (if applicable).
5. Description of the method used to fill or eliminate all voids below the top of shaft between the permanent shaft casing and surrounding soil.
6. Reinforcing steel shop drawings, details of reinforcement placement, including bracing, centering, steel reinforcing bar 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.
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.

**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 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

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removal of obstructions. Shaft excavation operation interruptions not conforming to this definition shall be considered stops.

During stops, the Contractor shall stabilize the shaft excavation to prevent bottom heave, caving, head loss, and loss of ground, in accordance with item 3 of the shaft installation narrative. For stops exceeding 65 hours, the Contractor shall stabilize the excavation by backfilling in accordance with item 8 of the shaft installation narrative. The Contractor shall backfill the hole to a minimum of five feet above the bottom of casing. Backfilling of shafts with casing fully seated into rock, as determined by the Engineer, will not be required.

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.

Permanent casing advanced during excavation operations is required full depth for all traffic signal standard shaft foundation locations specified at the beginning of this Special Provision. Excavation in advance of the casing tip shall not exceed three feet. In no case shall shaft excavation and casing placement extend below the bottom of shaft excavation as shown in the Plans.

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 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 8-20.5 as supplemented in these Special Provisions. The method of dealing with such obstructions, and the continuation of

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excavation shall be as proposed by the Contractor and approved by the Engineer.

After the casing has been filled with concrete, all void space occurring between the casing and shaft excavation shall be filled with a material which approximates the geotechnical properties of the in-situ soils, in accordance with item 5 of the shaft installation narrative as approved by the Engineer.

**Slurry**

If the Contractor uses slurry in shafts installed below groundwater 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.

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 narrative 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.

**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. If slurry is used, testing immediately prior to commencing concrete placement shall show a maximum sand content of 1.0 percent, in accordance with API 13B-1 Section 5. 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. 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.

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.

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

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5 **Casing Removal**

6 Tops of permanent casings for the shafts shall be removed to at least six  
7 inches beneath finish groundline, unless otherwise specified by the Engineer.