**S T A T E** **O F** **T E N N E S S EE**

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# SPECIAL PROVISION

# REGARDING

# DRILLED SHAFT SPECIFICATIONS

## 625.01 Description

This work consists of constructing cast-in-place reinforced concrete drilled shafts and rock sockets, as required, to serve as a structural foundation. This work shall provide reinforced concrete shafts cast in cylindrically excavated holes extending sufficiently into soil or sound rock to adequately support the structure and all externally applied loads for which the shaft was designed. The drilled shaft foundation, including the rock socket, where required, shall be constructed in accordance with these Specifications, as shown on the Plans and in accordance with other Specifications included in the contract documents.

## 625.02 Qualifications of Drilled Shaft Contractor

The driller and/or foreman or superintendent on the project site shall be experienced in the drilled shaft specialty and have installed drilled shafts of both diameter and length similar to those shown on the Plans. The driller and/or foreman or superintendent on site shall have a minimum of three years of experience in the geologic conditions associated with the project site prior to the bid date for this project. This work shall be performed under the direct supervision of driller, foreman or superintendent knowledgeable and experienced in the method of constructing drilled shafts as required by the project. Supply all equipment required to complete the work within the specified contract time. Furnish evidence of experience and expertise that meets the following requirements:

A list containing a description of at least five projects either on-going or completed in the last three years on which the driller, foreman or superintendent responsible for the drilled shaft construction, have installed drilled shafts of similar size as shown in the Plans and with similar excavation techniques anticipated for this project. This list of projects shall contain a brief description of the project as well as names and phone numbers of the project owner's representatives who can verify the participation on the project.

## 625.03 Drilled Shaft Work Plan

Develop a work plan for all the drilled shafts and submit the plan for review and acceptance by the Engineer 30 days prior to beginning construction of the drilled shafts. The Drilled Shaft Work Plan shall provide detailed project specific information, including the following:

1. Work experience in accordance with required qualifications in **625.02.**
2. List and size of proposed equipment; including cranes, kelly bars, drill rigs, vibratory hammers, augers, core barrels, cleanout buckets, airlifts and/or submersible pumps, tremies and/or concrete pumps, casing (diameters, thicknesses, and lengths), etc.

**3.** Details of the sequence and proposed schedule of drilled shaft construction, including the anticipated order in which shafts will be constructed.

**4.** Details of excavation methods.

**5.** Details of proposed methods to clean the excavation bottom.

**6.** Details of the method(s) to be used to ensure shaft stability (i.e., prevention of caving, bottom heave, etc. using temporary casing, slurry, or other means) during excavation and concrete placement. If appropriate, this shall include a review of method suitability to the anticipated site and subsurface geotechnical conditions.

**7.** Details of reinforcement placement including support and method to center in the excavation.

**8.** Details of concrete placement including proposed operational procedures for the concrete tremie or pump (if applicable); including initial placement, how the tremie or pump will be raised during concrete placement and what type of discharge control will be used to prevent concrete contamination when the tremie or pump is initially placed in the excavation.

**9.** If applicable, details of casing installation and temporary casing removal including order of telescoped casing removal and minimum concrete head in each casing during removal.

**10.** Required submittals for concrete mix designs.

**11.** Details on how drilling spoils will be handled including environmental control procedures used to prevent the loss of concrete and spoils.

**12.** Detailed procedures for mixing, using, maintaining, and disposing of 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 geotechnical conditions, shall also be provided for the proposed slurry.

**13.** Other information shown in the Plans or requested by the Engineer.

The Engineer will review the Drilled Shaft Work Plan for conformance with the Plans and Specifications. Within 15 days of receiving the plan, the Engineer will notify the Contractor of any additional information required and/or changes that may be necessary to satisfy the Plans, Specifications, and special provisions. If any part of the plan that is unsatisfactory and rejected by the Engineer, submit proposed changes for re-evaluation. The Engineer will respond to the Contractor within 7 days after receiving the proposed changes.

Review of the Drilled Shaft Work Plan by the Engineer does not relieve the Contractor of the responsibility to perform the work in accordance with Plans and Specifications. The Drilled Shaft Work Plan is intended to provide an opportunity to explain the approach to the work and to allow the Engineer to comment on equipment and procedures before Work begins.

### 625.04 Preconstruction Conference

After the Drilled Shaft Work Plan has been reviewed by the Engineer, a drilled shaft preconstruction conference shall be scheduled with the Contractor/Drilling Subcontractor to discuss construction and inspection of the drilled shafts. At a minimum, the attendees should include the General Contractor's Superintendent, the Drilling Subcontractor's Superintendent, the State's representatives, the Geotechnical Engineer, the Structural Engineer, and members of the Inspection Team. This conference shall be completed prior to beginning any drilled shaft work.

## Construction Requirements

### 625.05 Materials

All materials shall be in accordance with the Plans and in accordance with other Specifications included in the contract document.

### 625.06 Self-Consolidating Concrete (SCC)

Drilled shafts shall be constructed of the class concrete and concrete strength specified on Plans, and all material, proportioning, mixing, and transporting of concrete shall be in accordance with Standard Specifications for Road and Bridge Construction. The concrete mix for drilled shafts shall be dense, homogeneous, fluid, and resistant to segregation, and shall consolidate under self-weight such that vibrating, or rodding will not be required as specified in **604.03.A.1.b** Self-Consolidating Concrete (SCC) Design and Production Parameters. The concrete mix shall have a set time that ensures that fluidity is maintained throughout the shaft concrete placement and removal of temporary casing, if used.

### 625.07 Casing

When applicable, select the rigid casing used to stabilize shaft during construction unless casing is specified on Plans. A casing with sufficient strength to safely resist all imposed loads, including those from the soil and ground water, shall be used. Insure the stability of casing during all drilled shaft operations.

Shop drawings for permanent steel casings shall be submitted to and approved by the Engineer prior to installation of the casings.

Casings shall be smooth, clean, and watertight. Out-of-round tolerance shall not exceed one inch at any portion of the casing. Demonstrate the casing is within tolerance after installation. Telescoping casing shall not be allowed in bridges located in Seismic Zones 3 or 4.

Permanent casings, if required, shall be continuous wherever possible or practical. The permanent casing shall terminate at the specified elevation. Where drilled shafts are located in open water areas, casings shall be extended at least 18 inches above the datum defined water elevation as shown on the plans. Adjustment casing at the time of installation due to water fluctuations, if needed.

The casing may be fabricated with teeth or a cutting edge to facilitate insertion into the rock.

Splicing of permanent casings is not desirable and will only be permitted when approved by the Engineer. If splices are required, the welding process shall be in accordance with the requirements specified in **602.19**. Ensure the adequacy of welds during driving.

Welding of casings shall be in accordance with the current edition of *AASHTO/AWS Bridge Welding Code* and Standard Specification for Road and Bridge Construction and as specified in Plans, except that shop welding of casings will not require radiographic inspection. Inspection of welds will be of a visual nature. If evidence indicating poor welding is found, the Engineer may require ultrasonic testing at no additional cost to the Department.

### 625.08 Slurry

Drilling slurry will be defined as mineral slurry, polymer slurry, natural slurry formed during the drilling process, water or other fluids used to maintain stability of the drilled shaft excavation to aid in the drilling process or to maintain the quality of the rock socket. In addition, the terms

mineral slurry and polymer slurry, as used herein, will be defined as the final mixed composite of all additives, including manufactured mineral or polymer slurry additives required to produce the acceptable drilling slurry.

Drilling slurry shall be used if detailed in the approved installation plan, if in accordance with the contract documents or if approved in writing by the Engineer. Drilling slurry may be used at the Contractor's option if the slurry is not in accordance with the contract documents; however, any slurry shall be approved by the Engineer prior to use. Drilling slurry, when used, will be non-compensable and effect on time of performance due to the use of the slurry will be non-excusable.

The material used to make the slurry shall not be detrimental to the concrete or surrounding ground strata. Mineral slurries shall have both a mineral grain size that remains in suspension and sufficient viscosity and gel characteristics to transport excavated material to a suitable screening system. Polymer slurries shall have sufficient viscosity and gel characteristics to transport excavated material to suitable screening systems or settling tanks. The percentage and specific gravity of the material used to make the slurry shall be sufficient to maintain the stability of the excavation and to allow proper concrete placement. If approved by the Engineer, water and on-site soils as drilling slurry may be used. In that case, the range of acceptable values for density, viscosity, and pH, as shown in the following table for bentonite slurry, shall be met, except that maximum density (unit weight) shall not exceed 70 pounds/cubic foot. When water is used as the drilling fluid to construct rock sockets in limestone, dolomite, sandstone, or other formations that are not erodible, the requirements for slurry testing will not apply.

Prior to introduction into the shaft excavation, the manufactured mineral or polymer slurry admixture shall be pre-mixed thoroughly with clean, fresh water and for adequate time in accordance with the slurry admixture manufacturer's recommendations allotted for hydration. Potable water can be used for mixing although stream or river water may be used when approved by the engineer. Slurry tanks of adequate capacity will be required for slurry mixing, circulation, storage, and treatment. No excavated slurry pits will be allowed in lieu of slurry tanks without written approval from the Engineer. Adequate de-sanding equipment will be required as necessary to control slurry properties during the drilled shaft excavation in accordance with the values provided in the table below.

Perform the Control tests using suitable apparatus on the slurry to determine density, viscosity, sand content and pH of freshly mixed slurry, recycled slurry, and slurry in the excavation. Tests of slurry samples from within one foot of the bottom and at mid-height of the shaft shall be conducted in each shaft excavation during the excavation process to establish a consistent working pattern. A minimum of four sets of tests shall be conducted during the first eight hours of slurry use on the project. When the results show consistent behavior, the testing frequency may be decreased to one set every four hours of slurry use, or as otherwise approved by the Engineer. Reports of all tests, signed by an authorized representative, shall be furnished to the Engineer on completion of each drilled shaft. An acceptance range of values for the physical properties will be as shown in the table 625.08-01.

When slurry samples are found to be unacceptable, bring the slurry in the shaft excavation to within specification requirements. Concrete shall not be poured until re-sampling and testing results produce acceptable values. Prior to placing shaft concrete, take slurry samples from within one foot of the bottom and at mid-height of the shaft. Any heavily contaminated slurry that has accumulated at the bottom of the shaft shall be removed. Disposal of all slurry shall be done in areas approved by the Engineer. Perform final shaft bottom cleaning after suspended solids have settled from the slurry mix.

### Table 625.08-01: Slurry Control Test Physical Properties

| Range of Acceptable Values for Mineral and Polymer Slurries in Fresh Water Without Additives | | | | | |
|---|---|---|---|---|---|
| **Property** | **Bentonite** | **Emulsified Polymer** | **Dry Polymer** | **Units** | **Test Method** |
| **Density (Unit Weight)** | | | | | |
| At Introduction | 63.5- 66.8 | < 63 | < 63 | lb/ft3 | Density Balance |
| Prior to Concreting | 63.5- 70.5 | < 63 | < 63 | | |
| **Marsh Funnel Viscosity** | | | | | |
| At Introduction | 32 – 60 | 33 – 43 **b** | 50 – 80 **b** | sec/qt | Marsh Funnel |
| Prior to Concreting | 32 – 60 | 33 – 43 **b** | 50 – 80 **b** | | |
| **pH** | | | | | pH |
| At Introduction | 8 – 10 | 8 – 11 | 7 – 11 | -- | Paper or pH |
| Prior to Concreting | 8 – 10 | 8 – 11 | 7 – 11 | -- | Meter |
| **Sand Content** | | | | | |
| At Introduction | < 4 | < 1 | < 1 | Percent by Volume | API Sand Content Kit |
| Prior to Concreting | < 2 | < 1 | < 1 | | |
| **Maximum Contact Time** **a** | 4 | 72 | 72 | Hours | |

a. Without agitation and sidewall cleaning.

b. Higher viscosities may be required to maintain excavation stability in loose or gravelly sand deposits.

## 625.09 Protection of Existing Structures

All precautions shall be taken to prevent damage to existing structures and utilities as stated in Standard Specifications for Road and Bridge Construction or noted in plans. These measures shall include, but are not limited to, monitoring and controlling the vibrations from the driving of casing or drilling of the shaft, and selecting construction methods and procedures that shall prevent excessive caving of the shaft excavation.

### 625.10 Technique Shafts

When required by the contract documents, demonstrate the adequacy of methods and equipment used during construction of the first drilled shaft, which shall be an out of position technique shaft, constructed with reinforcement as identified for production shafts on the Plans. This technique shaft shall be drilled in the position as directed by the Engineer and drilled to the maximum depth for any production shaft shown on the Plans. If at any time the demonstration of the adequacy of methods or equipment and alterations required, at the Engineers discretion, an additional technique shaft(s) may be required. Technique shafts shall be cut off three feet below ground line, buried, or otherwise disposed of as specified in the contract documents or as directed by the Engineer. Once approval has been given to construct production shafts, no changes will be permitted in the methods of equipment used to construct the shaft without approval from the Engineer. When a technique shaft is not required, construction of the first production shaft will be used to determine if the methods and equipment used are acceptable. Failure at any time to demonstrate to the Engineer the adequacy of methods or equipment will be cause for the Engineer to require appropriate alterations in equipment or methods to eliminate unsatisfactory results.

### 625.11 Construction Sequence

Where construction of a footing is applicable, excavation to footing elevation shall be completed before shaft construction begins, unless otherwise authorized by the Engineer. Any disturbance to the footing area caused by shaft installation shall be repaired prior to pouring the footing. When drilled shafts are to be installed in conjunction with embankment placement, the construct drilled shafts after placement of fills. Drilled shafts constructed prior to the completion of fills shall not be capped until the fills have been placed as near to final grade as possible, leaving only the necessary work room for construction of the caps.

### 625.12 General Equipment and Methods

Perform excavations through whatever material is encountered to the dimensions and elevations shown on the Plans. The methods and equipment shall be suitable for the intended purpose and for whatever material is encountered.

Provide equipment capable of constructing the shafts to a depth equal to the deepest shaft tip elevation shown on the Plans plus a minimum of 15 feet. When a rock socket is identified on the Plans at a shaft location, the definition of “shaft tip elevation”, for the purposes of this subsection, shall be taken to refer to the bottom of the rock socket.

Excavations required for shafts and rock sockets shall be completed in a continuous operation. ensure the stability of the shaft excavation and the surrounding soil. When obstructions, either expected or unexpected, are encountered, notify the Engineer promptly. The dry method, wet method, temporary casing method, permanent casing method if specified, or combinations, as necessary, shall be used to produce sound, durable concrete drilled shafts free of defects and or anomalies. The permanent casing method shall be used only when required by the contract documents or approved by the Engineer. Blasting excavation methods will not be permitted. When a rock socket is required, the Engineer will be the sole judge as to what constitutes the top of sound rock. The Engineer may order in writing additional depths of rock socket below the top of sound rock as considered necessary to improve the foundation. If the top surface of the sound rock is found to be inclined across the width of the shaft, immediately notify the Engineer. Use an airlift, or other method approved by the Engineer, to clean the bottom of the shaft excavation.

### 625.13 Dry Construction Method

The dry construction method shall be used only at sites where the groundwater table and site conditions, generally stiff to hard clays or rock above the water table, are suitable to permit construction of the shaft in a relatively dry excavation and where the sides and bottom of the shaft remain stable without any caving, sloughing, or swelling and allow visual inspection prior to concrete placement. The dry method shall consist of drilling the shaft excavation, removing accumulated seepage water and loose material from the excavation, and placing the shaft reinforcing and concrete in a relatively dry excavation. Dry construction will be allowed only if less than 3 inches of standing water is found at the bottom of the shaft and the seepage rate is less than 12 inches of water per hour. Loose material and water shall be satisfactorily removed from the shaft before inspection and placement of rebar and concrete.

### 625.14 Wet Construction Method

The wet construction method shall be used at sites where a dry excavation cannot be maintained for placement of the shaft concrete. This method shall consist of drilling the shaft excavation below the water table, keeping the shaft filled with water, natural slurry formed during the drilling process, mineral slurry, or polymer slurry to control seepage, groundwater movement and stability of the hole perimeter until excavation to the final depth and placement of the reinforcing cage and concrete has been completed. This procedure will require placing the shaft concrete with either a tremie or concrete pump beginning at the shaft bottom, and displacing the water or slurry as concrete is placed. Temporary partial depth casings near the ground surface shall be provided to aid shaft alignment and position and to prevent sloughing of the top of the shaft excavation. Where drilled shafts are located in open water areas, shafts shall be constructed by the wet method using casings extending from above the water elevation to the Plans casing tip elevation or top of rock socket to protect the shaft concrete from water action during placement and curing. The casing shall be installed in a manner that produces a positive seal at the bottom of the casing.

### 625.15 Temporary Casing Construction Method

The temporary casing construction method shall be used at all sites where the stability of the excavated hole, the effects of groundwater cannot be controlled by other means, or other conditions exist in which the Engineer deems it necessary. In this method, the hole shall be advanced through caving material by the wet method in accordance with **625.14**. When a formation is reached that is nearly impervious, a casing shall be placed in the hole and sealed. Drilling may proceed by the dry method to the projected depth. The placement of concrete shall proceed by the dry or wet method, except that the casing shall be withdrawn after the concrete is placed. In the event seepage conditions prevent use of the dry method, excavation shall be completed by the wet method. Before and during casing withdrawal, a 5-foot minimum head of fresh concrete above the bottom of the casing shall be maintained at such a level that fluid trapped behind the casing is displaced upward out of the shaft excavation without mixing with or displacing the shaft concrete. Casing extraction shall be at a slow, uniform rate with the pull in line with the axis of the shaft. Temporary casings shall be removed while the concrete is still workable, and the slump of the concrete is between four and eight inches. Vibratory hammers shall not be used for casing installation or removal with a clear spacing between the edge of the shafts less than three shaft diameters 3 shaft diameters of other shafts that have been completed less than 24 hours earlier. The reinforcing cage shall not be damaged or displaced when withdrawing the temporary casing.

### 625.16 Permanent Casing Construction Method

The permanent casing construction method shall be used only when required by the contract documents or authorized by the Engineer. The casing shall be continuous between top and bottom elevations shown on the Plans. Vibratory hammers shall not be used for casing installation within

a clear spacing between the edge of the shafts less than 3 shaft diameters of shafts which have had concrete poured within the past 24 hours

### 625.17 Time Limitations

When bentonite slurry is used, adjust operations such that the maximum time that slurry is in contact with the bottom five feet of the shaft, the time from the end of drilling to the beginning of concrete placement, does not exceed four hours without agitation. If the four-hour limit is exceeded, the bottom five feet of the shaft shall be over reamed prior to performing other operations in the shaft. For rock sockets constructed in shale using polymer slurry, concrete placement shall begin within 72 hours of starting the rock socket excavation to avoid degradation of the shaft sidewall. Before concrete placement begins, foundation inspection, when required, cleaning operations, and reinforcing steel placement shall be completed and approved by the Engineer. These operations will be included in the 72 hour time limit. If concrete placement is not begun within the time limit, take corrective measures to the satisfaction of the Engineer.

### 625.18 Level of Slurry

During construction, the level of slurry is not less than five feet above the water table and shall be maintained at a height sufficient to prevent caving of the excavation. If the Engineer determines that the slurry construction method is failing to produce the desired final results, discontinue operations and propose an alternate method for approval from the Engineer. Correction for a failed slurry construction method will be non- compensable and any effect on time of performance non-excusable.

### 625.19 Slurry Manufacturer's Representative

When manufactured mineral or polymer slurry additives are to be incorporated into the drilling slurry mix, provide the technical assistance of a representative of the mineral or polymer slurry additive manufacturer at the site prior to introduction of the slurry into the first shaft where slurry use will be required, and during drilling and completion of a minimum of one shaft to adjust the slurry mix to the specific site conditions.

### 625.20 Cleaning of Shaft or Casing Sidewalls

Cleaning of the shaft or casing sidewalls shall occur by a method approved by the Engineer as necessary to remove the depth of softening or to remove excessive slurry cake buildup.

### 625.21 General Excavation Considerations

The Plans will indicate the top of shaft elevations and the estimated bottom of shaft elevations between which the drilled shaft shall be constructed. Drilled shafts may be extended or shortened as approved by TDOT Geotechnical Engineering Section and TDOT Structures if the foundation material encountered is unsuitable or better than anticipated, or based on the results of load tests.

### 625.22 Time Restrictions

Drilled shaft excavation shall begin only if, the excavation, perform foundation inspection and testing, and place the reinforcement and concrete as a complete continuous daily operation. No shaft with a clear spacing between the edge of the shafts less than 3 shaft diameters of another shaft shall be excavated at the same time. Shafts shall not be constructed within 24 hours of the completion of an adjacent shaft if the clear spacing between the edge of the shafts is less than 3 shaft diameters.

### 625.23 Disposal of Excavated Material

Excavated material removed from the shaft and any drilling fluids used shall be disposed of in accordance with the contract documents, as directed by the Engineer, and in compliance with federal and state regulatory requirements.

### 625.24 Worker Entry Into Shaft Excavation

Do not allow workers to enter the shaft excavation for any reason, unless both a suitable casing has been installed and adequate safety equipment and procedures have been provided to workers entering the excavation.

### 625.25 Rock and Obstructions

Subsurface obstructions at drilled shaft locations shall be removed. Employ special procedures or tools when the hole cannot be advanced using conventional equipment. Blasting will not be permitted. Any man-made material that significantly limits excavation advancement such as concrete, steel, timber, etc. will be classified as an "obstruction". Drilling tools lost in the excavation will not be considered obstructions and shall be promptly removed. The presence of an obstruction for pay purposes must be verified by the Engineer. Boulders or rock layers of such size that do not allow the use of soil excavation tools as described will not be considered an obstruction but will be considered Drilled Caisson Rock as described.

### 625.26 Inspection Equipment

Maintain at the job at all times, all equipment suitable for use in the shaft inspection.

### 625.27 Removal of Excess Sediment

Final shaft depth shall be measured with approved methods after final cleaning by airlift, or other method approved by the Engineer. Unless otherwise stated in the contract documents, a minimum of 50 percent of the base of each shaft shall have less than ½ inch of sediment at the time of concrete placement. The maximum depth of sediment or any debris at any place on the base of the shaft shall not exceed 1 ½ inches. Shaft cleanliness will be verified by the Engineer for wet or dry shafts.

### 625.28 Inspection, Supervision, and Records

Provide aid to the Engineer in maintaining accurate records during all phases of the drilled shaft installation. Provide the Engineer with any information required for the drilled shaft inspection reports. Provide bosun chairs, gas meters, safety equipment, lights, mirrors, weighted tape measures, steel probes, cameras, personnel, etc. and all assistance that may be required for the Engineer to inspect the drilled shaft excavations. Perform any corrective work found necessary as a result of inspections. Necessary time shall be allowed for performance of these inspections.

### 625.29 Inspection for Side Walls

At the Engineer's request, lower the Inspector to the level of the bottom of the casing and allow visual examination of the side walls of the rock socket to confirm the top of rock socket has been reached once the casing has been extended to the top of rock. Preferably, the sidewall inspection should not be performed until the drilled shaft excavation has extended to the anticipated base of rock socket and before any inner casing is set below the top of rock. Should the observed rock excavation reveal soil inclusions or voids, the drilled shaft excavation shall be extended as directed

by the Engineer. Where groundwater cannot be controlled or other conditions prevent safe down-hole entry, side wall inspection will be performed using a camera. The camera should include any light source needed to allow for clear imaging. Provide sufficient proof that casing has been properly seated into rock and that side walls are free from soil inclusions or voids.

### 625.30 Inspection of Bottom of Shaft

Where groundwater can be effectively controlled (that is, less than one foot of standing water is maintained in excavation bottom) after reaching the anticipated base of rock socket, lower the Inspector to the level of the bottom of the socket and allow visual examination of the bottom of the shaft. Temporary casing should extend to the base of the rock socket to allow the Inspector to safely enter the excavation. Where groundwater cannot be controlled or other conditions prevent safe down-hole entry, bottom of shaft inspection will be performed using a camera. The camera should include any light source needed to allow for clear imaging. Provide sufficient proof that excess sediment has been removed in accordance with **625.27**. The determination of the shaft's tip elevation after excavation to the anticipated base of rock socket will either be made by the Engineer's judgment of conditions found in previously performed test borings drilled within the dimensions of the rock socket, examination of rock socket shaft excavation results (recovered cores or observation of shaft drilling response) or by examination of rock cores taken at least 8 feet below the shaft bottom as required in **625.31**.

### 625.31 Core Drilling

When required by contract documents, core drilling shall be performed as described in the Plans and paid for under Core Drilling and Sampling at the contract unit price. The Engineer may require rock core samples to be taken a minimum depth of 8 feet and up to a maximum depth of 20 feet below the bottom of the drilled shaft excavation to either aid in predetermining acceptable rock socket elevations prior to beginning of shaft excavation or to provide information to determine the acceptability of a completed rock socket. Core sampling should be performed in accordance with ASTM D 2113 using a double or triple wall core barrel of NX (54.7 mm / 2.16 in.) or NQ (47.5 mm / 1.87 in.) size. Perform this core sampling or schedule a qualified representative to do the Work.

**625.32 Log of Confirmation Drilling.** Maintain a log of core drilling and sampling (confirmation drilling) for each foundation inspection hole, and such logs shall be delivered to the Engineer within 24 hours of completion of the boring. The log shall include the following:

(a) The amount of NX or NQ cored per run and the amount recovered. All core loss shall be noted and explained. Clay layers shall be noted and located on the log by depth.

(b) The Rock Quality Designation (RQD) for the NX or NQ core. The bedding thickness and degree of weathering shall also be noted.

(c) Location and elevation of holes.

### 625.33 Storage and Labeling of Rock Cores

Rock cores shall be stored in structurally sound core boxes and shall be protected from the elements. The core boxes shall be properly labeled to indicate location, depth, beginning elevation, Contract Number, and date, and shall be delivered to the Engineer.

### 625.34 Reinforcing Steel Cage Fabrication and Placement

The reinforcing steel cage, consisting of the longitudinal bars, ties, spirals, cage stiffener bars, spacers, centering devices, and other necessary appurtenances, shall be completely assembled as a unit, and shall be placed immediately after the shaft excavation is inspected and accepted, and just prior to shaft concrete placement. Temporary internal cage stiffeners shall be removed as the cage is placed in the shaft such that interference with the placement of concrete does not occur. The Contractor shall verify the stability of the reinforcing steel cage. Submit verification calculations to the Engineer for review and approval. Calculations shall be sealed by a Professional Engineer licensed in the State of Tennessee.

### 625.35 Reinforcing Ties, Splices and Clearances

All reinforcing steel in the shaft shall be tied at every intersection and supported such that the steel remains within the allowable tolerances specified in Table 625.35-01 during placement of concrete or casing removal. The reinforcing steel cage shall have sufficient rigidity to prevent racking or permanent deformations during delivery or installation.

**Table 625.35-01: Concrete Cover**

| Concrete Cover | | | |
|---|---|---|---|
| **Shaft Diameter** | **Uncased** | **Casing Remains** | **Casing Withdrawn** |
| 3'-0" or less | 3" | 3" | 4" |
| >3'-0" & <5'-0" | 4" | 4" | 4" |
| 5'-0" or larger | 6" | 6" | 6" |

### 625.36 Spacers

Rolling spacers for reinforcing steel shall be used to minimize disturbance of the shaft sidewalls and to facilitate removal of the casing during concrete placement. Sets of concrete spacers or other approved non-corrosive spacing devices shall be used at sufficient vertical intervals, near the bottom and along the shaft at intervals not exceeding five feet, to ensure concentric location of the cage within the shaft excavation. When the vertical steel is greater than one inch in diameter, the maximum spacing may be increased to 10 feet. As a minimum, a set of spacers shall be provided within two feet of both the top and bottom of the shaft. In addition, one set of spacers shall be provided at both two feet above and below each change in shaft diameter. Non-corrosive spacers shall be provided at a minimum of one spacer per 30 inches of circumference of cage with a minimum of three at each vertical level to maintain the required reinforcement clearances. The spacers shall be of adequate dimension to maintain the specified clearance between the outside of the reinforcing cage and the side of the excavated hole or casing.

### 625.37 General Considerations

Accumulations of water in casings and excess sediment at the base shall be removed as described herein before the concrete is placed. No concrete shall be placed until all casings, if used, within a 15 foot radius has been installed. Within the 15 foot radius, all driving or vibratory installation methods shall be discontinued until the concrete in the last shaft has set at least five days. Concrete placement shall begin as soon as possible after completion of the excavation, inspection and setting of the reinforcing cage, and shall proceed in a continuous operation from the bottom of the shaft to the Plans construction joint or above as specified herein. An unplanned stoppage of work may require an emergency construction joint during the shaft construction.

### 625.38 Placement of Concrete in the Shaft

Concrete shall be placed for each shaft with the flow of concrete directed down the center of the shaft. Concrete shall be placed by free fall or through a tremie or concrete pump. The free fall placement method will only be permitted in dry holes. Concrete placed by free fall shall fall directly to the base without contacting either the reinforcing cage or hole sidewall. Drop chutes may be used to direct concrete to the base during free fall placement.

### 625.39 Time Limitations

Maintain a continuous pour until the shaft is complete. All admixtures shall be adjusted for the conditions encountered on the job, so that the concrete remains in a workable plastic state throughout the two-hour placement limit. Prior to concrete placement, provide test results of a trial mix that demonstrates the concrete meets the two-hour placement limit. When the estimated placement time exceeds the two-hour limit, provide a concrete mix design that will maintain a slump of 4 inches or greater throughout the estimated placement time, as demonstrated by the slump loss test. The trial mix and slump loss tests shall be conducted using concrete and ambient temperatures approved for site conditions and recorded on form MT-0334.

### 625.40 Concrete Placement by Tremie

Tremies used to place concrete shall consist of a tube of sufficient length to discharge concrete at the shaft base elevation. The tremie shall have sufficient weight to rest on the shaft bottom before the start of concrete placement and to prevent curling of the tremie line during placement of the concrete. The tremie shall not contain aluminum parts that may come in contact with the concrete. A tremie shall consist of a watertight tube having an inside diameter of no less than 10 inches and fitted with a hopper at the top. The inside and outside surfaces of the tremie shall be clean and smooth to permit both flow of concrete and unimpeded withdrawal during concrete placement. The tremie wall thickness shall be adequate to prevent crimping or sharp bends that restrict concrete placement.

### 625.41 Tremie Operation

Underwater placement of concrete shall not begin until the tremie is at the shaft base elevation. The discharge end of the tremie shall be constructed to permit the free radial flow of concrete during placement operations. The tremie discharge end shall remain immersed as deep as practical in the concrete, but shall be no less than five feet at all times. The tremie shall be supported such as to permit free movement of the discharge end over the entire top surface of the work and to permit rapid lowering when necessary to retard or stop the flow of concrete. The discharge end shall be sealed closed at the start of work to prevent water from entering the tube before the tube is filled with concrete. After placement has started, the level of the concrete in the tremie shall be maintained above the level of slurry or water in the shaft at all times to prevent water or slurry intrusion into the shaft concrete. If water enters the tube after placement is started, the tremie shall be withdrawn, the discharge end resealed, and the placement restarted. The flow of concrete shall be continuous until the work is completed.

### 625.42 Removal of Tremie Orifice from Concrete

If at any time during the concrete pour, when using the wet construction method, the tremie line orifice is removed from the fluid concrete column and discharges concrete above the rising concrete surface, the entire drilled shaft may be considered defective. Corrections made will be non-compensable and any effect on time of performance non-excusable.

### 625.43 Concrete Placement by Pump

Concrete pumps and lines may be used for concrete placement by either the wet or dry construction method. All pump lines shall have a minimum diameter of 5 inches and shall be constructed with watertight joints. Concrete placement shall not begin until the pump line discharge orifice is at the shaft base elevation. For the wet construction method, a plug or similar device shall be used to separate the concrete from the fluid in the hole until pumping begins. The plug shall either be removed from the excavation or shall be of a material that does not cause a defect in the shaft if the plug is not removed. The discharge orifice shall remain at least 5 feet below the surface of the fluid concrete. If at any time during the concrete pour the pump line orifice is removed from the fluid concrete column and discharges concrete above the rising concrete level, the shaft may be considered defective. Corrections made will be non-compensable and any effect on time of performance non-excusable.

### 625.44 Adjustment of Concrete Free Fall or Rate of Concrete Flow

If the free fall concrete causes the shaft excavation to cave, control the movement of concrete by reducing the free fall of the concrete or the rate of flow of concrete into the excavation and follow the details of the method(s) to be used to ensure shaft stability as required by **625.03.6.**

### 625.45 Drop Chutes

Drop chutes may be used to direct placement of free fall concrete down the center of the shaft excavations. Drop chutes shall be a smooth tube constructed either as a continuous one-piece unit or as removable sections. Aluminum drop chutes will not be permitted. Concrete may be placed through either a hopper at the top of the tube or side openings as the drop chute is retrieved during concrete placement.

### 625.46 Construction Joints

Construction joints shall not be utilized unless otherwise approved by the Structural Engineer. All planned reinforcing steel shall extend uninterrupted through joints. Surfaces of fresh concrete at horizontal construction joints shall be rough floated sufficiently to thoroughly consolidate the surface and to intentionally leave the surface in a roughened condition.

### 625.47 Concrete Curing

Portions of drilled shafts exposed to a body of water shall be protected from the action of water by leaving the temporary casing in place for at least seven days after concrete placement or until the shaft concrete reaches a minimum strength of 3,375 psi. After placement, the temporarily exposed surfaces of the shaft concrete shall be cured to prevent loss of water.

### 625.48 Construction Tolerances

During excavation of the shaft, monitor the plumbness, alignment and dimensions of the shaft. Any deviation exceeding the allowable construction tolerances specified herein shall be corrected with a procedure approved by the Engineer. Drilled shaft excavations constructed in such a manner that the concrete shaft cannot be completed within the required tolerances will not be accepted. Correction methods shall be submitted for the Engineer's approval. Drilled shaft construction shall not begin until final approval has been obtained. When a shaft excavation is completed with unacceptable tolerances, propose, develop and, after approval from the Engineer, implement corrective work. Redesign drawings and computations originally submitted and have signed by a

Professional Engineer licensed in the State of Tennessee. The following construction tolerances will apply to drilled shafts unless stated otherwise in the contract documents:

(a) Temporary casing diameters shall provide a final shaft diameter as shown on the Plans. When approved by the Engineer, the Contractor may provide a larger casing at the Contractor's expense.

(b) Shafts shall be constructed such that the center of the top of the shaft is within 3 inches of Plans position in the horizontal plane at the plan elevation for the top of the shaft.

(c) For shafts in rock, the vertical alignment of a vertical shaft excavation shall not vary from the Plans alignment by more than ¼ inch per foot of depth. For shafts in soil, the vertical alignment of a vertical shaft excavation shall not vary from the Plans alignment by more than 3/16 inch per foot of depth.

(d) The bottom of the shaft excavation shall be normal to the axis of the shaft within a tolerance of 3/8 inch per foot of shaft diameter.

(e) Shaft steel reinforcing bar shall be no higher than six inches above or three inches below Plans elevation.

### 625.49 Integrity Testing

The completed shaft shall be subjected to the testing methods specified by Plans such as concrete coring, cross-hole sonic logging (CSL) , and/or thermal integrity profiling (TIP), to determine the extent of any defects that may be present. If CSL or TIP testing are indicated in the plans, the Department will supply a consultant to perform the testing. If CSL testing reveals voids or discontinuities in the concrete which indicate that the shaft is not structurally adequate, the shaft will be retested within 3 to 7 days of receiving the report or 10 days from test, whichever is sooner. In the event retesting confirms the results of the initial test, further measures as specified in **625.50** shall be conducted at the no additional cost to the Department. The Department may also conduct TIP testing to further evaluate the extent of the integrity of the shaft.

Concrete shall not be placed in additional drilled shafts until the Contractor demonstrates the adequacy of the shaft construction method to the satisfaction of the Engineer. Any additional work required as a result of shaft defects will be non- compensable and any effect on time of performance non-excusable.

### 625.50 Concrete Coring

Upon completion of placing concrete and after waiting a minimum of 48 hours, the top surface of concrete shall be cleaned of laitance and any unsound concrete. One or more core holes, at the location and number indicated in the contract documents or as directed by the Engineer, shall be drilled completely through the shaft concrete and the rock socket to approximately one foot below the bottom of the rock socket of the shaft. Provisions for the inspection of the concrete surface shall be in accordance with the applicable requirements described herein. Core holes shall be drilled at locations specified by the Engineer. The holes shall be drilled to recover 4 inch diameter cores. The core samples recovered shall be labeled as to the location from which the samples were taken. The samples shall be delivered to the Engineer for examination. If the cores indicate defective concrete in the shaft, which in the judgment of the Engineer impairs the strength of the completed shaft, drill additional cores as directed by the Engineer. If the concrete is found to be defective, submit to the Engineer in writing a proposal for correction, and those corrective procedures shall be approved by the Engineer before such corrective work is undertaken. The

cored holes in non-defective concrete shall be filled with grout such that all voids are filled. Grout shall be non-shrink and obtain a compressive strength equal to or in excess of that specified for the drilled shaft concrete. Grout shall be selected from Qualified Products List or alternate submitted for to the Engineer for approval. No direct payment will be made for grout and grouting.

## 625.51 Non-Destructive Testing

### A. Cross-Hole Sonic Logging (CSL)

If CSL testing is indicated on a project with CEI oversight, the CEI firm shall supply a subconsultant that is qualified to perform the testing. If the project does not have CEI oversight, then the Department will supply a consultant to perform the testing. Shafts six feet in diameter and larger require the addition of 3D tomography. Testing will be performed after the shaft concrete has cured as specified in Table 625.51-1. Provide reasonable access to the shaft top for performance of CSL testing.

**Table 625.51-1 Sonic Logging Time Requirements**

| Shaft Diameter | Minimum Cure Time (prior to testing) |
|---|---|
| 4 to 6 ft. | 72 hours |
| 6 to 8 ft. | 96 hours |
| >8 ft. | 120 hours |

Furnish and install ≥1 ½" nominal inside diameter steel pipes with 0.145" minimum wall thickness, ASTM A 53, Standard Weight, for use in sonic testing of each drilled shaft. Pipes shall be installed in each drilled shaft at the locations shown on the Plans, as required by the testing agency, or as directed by the Engineer. The pipes shall be sufficiently regular and free from defects to permit the free and unobstructed passage of the probes. The pipe shall be installed such that all internal joints are flush. Stiffening devices such as mandrels, tape, or similar material to seal the joints shall not be used. Pipe shall be watertight with clean internal and external faces, the latter to ensure a good bond between the concrete and the pipes. The pipes shall be fitted with a screw-on watertight shoe and cap and shall be securely fixed to the interior of the reinforcement cage with a minimum cover of three inches from the shaft periphery. The pipes shall be as near too parallel as possible, equally spaced, and vertical. Where several sections of pipe are required to reach the full length, joints shall be made watertight. The pipes shall be filled with water and plugged or capped before shaft concrete is poured. The upper end of the pipe shall not be left open after the pour. The pipes shall extend at least three feet above the top of the concrete in the shaft to compensate for water displaced by insertion and removal of the transmitter, receiver, and cable. For shafts with a rock socket, the lower end of the pipes shall extend to the bottom of the rock socket. Care shall be taken during the drilled shaft concrete pour to not damage the pipes. If a tremie is used, the tremie shall not be permitted to rest on top of the pipes during the pour. After completion of the sonic logging and final acceptance of the drilled shaft, fill the access pipes with grout.

The sonic logging equipment furnished by the CSL consultant/subconsultant shall consist of all necessary supplies, support equipment and power to perform the sonic logging testing requirements as described herein.

The drilled shaft shall be tested between three and 7 days after concrete placement. The following procedures shall apply:

(a) Pipes shall be checked to ensure the pipes are free from blockages and are filled with water.

(b) Levels shall be taken on top of each pipe; each pipe shall be plumbed, and the length shall be recorded.

(c) Testing shall be performed between each pair of adjacent pipes around the shaft perimeter and also in pairing combinations between each pipe with all other pipes in the shaft.

(d) All tests shall be carried out with the probes in the same horizontal plane unless the Engineer directs that defects be further evaluated with the probes on different horizontal planes.

(e) The probes shall be raised simultaneously from the bottom of the pipes ensuring that all slack is taken out of the cables before the analyzer is switched on, and that the distance between transducers remains constant during the course of the test. The speed of ascent shall be less than 12 inches per second. Measurements shall be taken at three inch intervals or less. Anomalies indicated by longer pulse first- arrival times (FAT) and significantly lower amplitude per energy signals shall be reported. If anomalies are detected, additional tests with two or more sources per receiver vertical offsets of greater than or equal to 20 inches shall be conducted between the same tubes unless the anomaly is within 20 inches of the bottom of the shaft.

(f) The CSL consultant/subconsultant shall provide accurate measurements of probe depths on the logs.

Preliminary results of the testing shall be provided on site prior to the CSL consultant/subconsultant leaving the site. A detailed CSL report and test data shall be submitted to the Engineer within seven days. The CSL report shall be signed and sealed by a Professional Engineer licensed in the State of Tennessee. The CSL report shall include, but is not limited to, the following: project identification and dates of testing, a table and schematic showing shafts tested with accurate identification of tube coordinates and collar elevation, name of personnel that performed the tests and interpretation and those personnel's affiliation, equipment used, data logs, interpretation, analysis, and results. The data logs shall include XY plots of FAT, amplitude, and velocity versus depth. CSL data shall be processed to provide easy to understand 2D cross-sections between tubes for all tube pair combinations. These plots shall be annotated by the CSL consultant/subconsultant as appropriate to delineate anomalous results. For shafts six feet in diameter and larger, 3D tomography will be required along with CSL testing. If 3D tomography is requested, the data shall be submitted to the Engineer within ten days. If offset surveys are performed as part of 3D tomography , data plots shall include 3D volumetric images for the entire shaft, color-coded, to indicate velocity variations along the shaft. Locations and geometry of anomalies or unconsolidated zones shall be identified in 3D color images with detailed discussion. The results for CSL and 3D surveys shall be based on the percentage decrease in velocity as correlated to the Table 625.51-02 Concrete Condition Rating Criteria (CCRC). The velocity datum of good concrete shall be established by averaging the velocities in the good concrete along the drilled shaft. Deviations from the velocity datum shall be used for determining the Concrete Condition Rating.

**Table 625.51-2: Concrete Condition Rating Criteria**

| | | Overall Rating shall be the lower of the two criteria | | |
|---|---|---|---|---|
| **Concrete Condition Rating** | **Rating Symbol** | **Velocity Reduction** | **Signal Distortion/Strength** | **Indicative Results** |
| Good | G | 0 to 10% | None / normal Energy Reduction ≤ 6 dB | Acceptable concrete |
| Questionable | Q | 10% to 20% | Minor / lower Energy reduction = 6.1 to 9 dB | Minor concrete contamination or intrusion. Questionable quality concrete. |
| Poor | P/D | > 20% | Severe / much lower Energy reduction > 9 dB | Defects exist, possible water slurry contamination, soil intrusion, and or poor quality concrete. |
| Water | W | V= 4760 to 5005 ft/sec (≈60% reduction) | Severe / much lower Energy reduction > 12 dB | Water intrusion, or water filled gravel intrusion with few or no fines present. |
| No Signal | NS | No signal received | None | Soil intrusion or other severe defect absorbed the signal, tube debonding if near top. |

a The baseline velocity shall be 13,000 feet per second for normal weight concrete.

The CSL consultant/subconsultant shall immediately inform the Engineer of any suspected anomalies, honeycombing or poor concrete quality detected by testing. The Contractor and CSL consultant/subconsultant shall duly perform further tests as directed by the Engineer to evaluate the extent of any detected anomalies. Core drilling, or other investigative methods as approved by the Engineer, shall be performed to further investigate the anomaly. If a defect is confirmed, the Contractor shall bear all costs involved with the shaft coring, grouting and remediation. Within 14 days of the completion of testing, provide a report signed and sealed by a Professional Engineer licensed in the State of Tennessee providing the results of the additional investigations and recommendations to accept or repair the shaft. The report shall also contain recommendations for modification of construction procedures to prevent defects for subsequent shaft installations. The dates of the completion of drilling, cleaning, steel placement and concrete pour shall also be provided. Work above the top of shaft shall not be performed until the shaft has been accepted by the Engineer.

**B. Thermal Integrity Profiling (TIP)**

TIP testing data, which will monitor the temperature of the shaft concrete while it is curing, will be collected based on the ASTM D7949. The testing period differs based on diameter and testing method. If TIP testing is indicated on a project with CEI oversight, the CEI shall supply a subconsultant that is qualified to perform the testing. If the project does not have CEI oversight, then the Department will supply a consultant to perform the testing.

The installation of Access Ducts method A could allow the use of the CSL tubes to be utilized for the temperature probe to be lowered into the shaft. The depth the probe should be lowered following ASTM D7949 7.2.3.

The installation of Thermal Wire method B will allow for continuous monitoring during the concrete curing cycle. The thermal wire cable with the thermal sensors for the TIP should be attached to the reinforcing cage before placement in the shaft. One cable per foot of diameter of the shaft is expected. All cables should be connected to Thermal Acquisition Port (TAP) that will collect data on site at any given time.

After data collection, the TIP consultant/subconsultant shall provide a written report along with analysis of data within 7 days of the final readings. The TIP report shall include all ASTM D7949 TIP report elements. Analysis should include the Effective Average Radius of the shaft based on the collected data and the location of any anomalies detected in the shaft.

### 625.52 Drilled Shaft Load Tests

All load tests, when required by the contract documents, shall be completed, and submitted to the Engineer for review and approval before construction of any production drilled shafts. The locations of load test shafts, the maximum loads to be applied, the test equipment to be furnished by the Contractor, and the actual sequence of the load testing shall be as shown on the Plans or as specified in the contract documents. After completion of testing, test shafts not used as production shafts shall be cut off at an elevation three feet below the finished ground line. The portion of shafts cut off shall be disposed of, at no additional cost to the department, in a manner approved by the Engineer.

## Compensation

### 625.53 Method of Measurement

**A.** The Department will measure the accepted drilled shafts Drilled Shaft Excavation (Soil) to the nearest 0.10 vertical foot of length along the axis of each shaft. For shafts without a rock socket, measurement will be from the Plans elevation for the top of shaft to the bottom of the shaft. For shafts with a rock socket, measurement will be from the Plans elevation for the top of shaft to the top of the rock socket as defined in section "Drilled Shaft Excavation (Rock)".

**B**. The Department will measure the accepted rock sockets and drilling through rock as Drilled Shaft Excavation (Rock) to the nearest 0.10 vertical foot of length along the axis of the shaft for the cumulative length of rock, as determined by the Engineer. The "top of rock" is defined as the elevation at which natural material cannot be drilled by conventional drilling tools and requires the use of special rock augers, core barrels, air tools, or specialized removal methods.

**C.** The Department will measure Drilled Shaft Concrete by the cubic yard and computed from the dimensions indicated on the Plans or directed in writing by the Engineer.

**D.** The Department will measure Drilled Shaft Reinforcing Steel for payment by the pound, unless otherwise stipulated in the Plans, in accordance with **604.30**.

**E.** The Department will measure Permanent Drilled Shaft Casing by the vertical foot of permanent casing installed. Additional permanent drilled shaft casing installed for the convenience of the Contractor will not be measured for payment.

**F.** The Department will not measure Temporary Drilled Shaft Casing for payment and shall be incidental to the work.

**G.** The Department will measure Foundation probe holes will be measured for payment to the nearest 0.10 linear foot of length along the axis of each hole and paid for as Item Rock Drilling Bridges.

**H.** The Department will measurement Core Drilling And Sampling for foundation core holes to the nearest 0.10 linear foot of length along the axis of each hole.

**I.** The Department will measurement Concrete Coring to the nearest 0.10 vertical foot of length along the axis of the shaft from the top of concrete to a point determined by the Engineer, and may extend the entire length of the shaft plus one foot below the bottom of the rock socket.

**J.** When testing is not performed by the CEI, The Department will measure Sonic Logging Testing per each drilled shaft as required.

**K**. The Department will measure Load tests for each load test performed.

**625.54 Basis of Payment**

The Department will pay for accepted quantities, complete in place, at the contract prices as follows:

| Item No. | Description | Unit |
|---|---|---|
| 625-01.07 | PIEZOMETER | L.F. |
| 625-01.08 | INCLINOMETER | L.F. |
| 625-01.10 | CAMERA INSPECTION - DRILLED SHAFT (DRY) | EACH |
| 625-01.11 | CAMERA INSPECTION-DRILLED SHAFT (UNDERWATER) | EACH |
| 625-02.XX | DRILLED SHAFT-SOIL (DIA.) | V.F. |
| 625-02.XX | DRILLED SHAFT-ROCK (DIA.) | V.F. |
| 625-02.XX | DRILLED SHAFT CASING-PERMANENT (DIA.) | V.F. |
| 625-02.40 | DRILLED SHAFT (SH-SCC) CONCRETE | C.Y. |
| 625-02.43 | CONCRETE CORING | V.F. |
| 625-02.44 | DRILLED SHAFT REINFORCING STEEL | LB. |
| 625-02.45 | DRILLED SHAFT REINFORCING STEEL (GRADE 75) | LB. |
| 625-02.46 | SONIC LOGGING TESTING | EACH |
| 625-02.47 | DRILLED SHAFT LOAD TEST | EACH |
| 204-05.01 | CORE DRILLING AND SAMPLING | L.F. |
| 204-05 | ROCK DRILLING (BRIDGES) | L.F. |

**A.** Such payment for Drilled Shaft (Soil) will be considered full compensation for all temporary steel casing required, costs of drilling, excavation, slurry, dewatering, cleaning, and incidental work, and materials required to complete the excavation. Payment for any drilled shaft excavation will be at the contract unit price per vertical foot for the diameter of the drilled shafts specified. No additional compensation will be made for concrete required to fill an oversized casing or for oversized excavation.

**B**. Such payment for Drilled Shaft (Rock) will be considered full compensation for drilling, excavation, slurry, cleaning, dewatering, and incidental work, and material required to complete the excavation. For payment purposes the length of any rock socket installed and accepted shall be paid for at the contract unit price per vertical foot for the diameter of the rock socket specified. If the method of construction requires that drilled shaft casing be seated into the sound rock such that the bottom of the casing is below the determined top of sound rock elevation, payment for excavation below the top of the sound rock layer (top of the rock socket) will be included in the payment for the rock socket. In the event that the Engineer orders additional rock socket

construction, payment for the additional length will be at the contract unit price per vertical foot of rock socket. Payment will be considered full compensation for the additional excavation into rock including all incidentals necessary to complete the work down to the elevation designated by the Engineer. Additional reinforcing steel and concrete shall be paid for at the contract unit bid price.

**C**. Removal of obstruction(s) will be paid at two times the unit price bid for Item Drilled Shaft (Rock) V.F. for the shaft length from the first occurrence of the obstruction until such depth that the shaft is advanced to the point of removal of the obstruction and normal shaft excavation methods can resume.

**D.** Such payment for Drilled Shaft Concrete will be considered full compensation for all costs associated with furnishing and placing concrete in the drilled shaft in the unit price bid per cubic yard for Drilled Shaft Concrete in accordance with the Contract Plans. Include all costs associated with furnishing and installing Sonic logging access tubes and any required extensions in the unit price bid per cubic yard for Item Drilled Shaft Concrete. No payment will be made for construction delays resulting from the initial sonic logging testing of the drilled shaft. The Department will pay the costs for the initial sonic logging testing. The Contractor shall pay for all costs associated with coring, engineering design, cost required to correct defects and any construction delay costs, if a defect is found based on the sonic logging. The Contractor shall pay the costs of sonic logging testing to re-test the repaired drilled shafts.

**E.** Such payment for Drilled Shaft Reinforcing Steel will be considered full compensation for all costs associated with furnishing and placing reinforcing steel, including but not limited to spacers, ties, and splices, in the drilled shaft at the unit price bid per pound for Reinforcing Steel in accordance with **604.31**

**F.** Such payment for Drilled Shaft Reinforcing Steel will be considered full compensation for all costs associated with furnishing and installing permanent casing in the drilled shaft in the unit price bid per vertical foot of Drilled Shaft Casing. Temporary Casing, including all costs associated with installation and removal, shall be included in the bid price for item Drilled Shaft Excavation.

**G.** Such payment for Core Drilling and Sampling will be considered full compensation for drilling or coring the holes, extracting, and packaging the samples or cores, laboratory testing, delivering the samples or cores to the specified TDOT location and for all other expenses necessary to complete the work. Payment shall be full compensation for completing the core drilling as specified.

**H.** Such payment for concrete coring will be considered full compensation for all material, labor, tools, equipment, grouting and incidentals necessary to complete the work.

**I.** When testing is not performed by the CEI, but required by contract documents, or directed by the Engineer, such payment for sonic logging testing will be considered full compensation for providing all equipment, conducting the actual probing measurements as specified, furnishing reports, removing equipment, and all tools, labor, and any incidentals necessary to complete the work. The number of sonic logging inspections may vary from the estimated quantities, but the contract unit price shall prevail regardless of the variation. No payment will be made for supplementary sonic logging testing to evaluate defects.

**J.** When required by contract documents, such payment for drilled shaft load test will be considered full compensation for all work related to performing and reporting load tests as specified.