

STATE**OF****TENNESSEE**

Effective 05-20-08

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SPECIAL PROVISION
REGARDING
DRILLED SHAFT SPECIFICATIONS

625.01 Description. This work shall consist 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 Contractor/Subcontractor performing the work described herein shall have staff on-site (driller and/or foreman or superintendent) experienced in the drilled shaft specialty and have installed drilled shafts of both diameter and length similar to those shown on the Plans. The Contractor shall have staff (as defined above) on site that have a minimum of three years 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 supervision of the Contractors/Subcontractors superintendent, who is knowledgeable and experienced in the method of constructing drilled shafts as required by the project. The Contractors/Subcontractors equipment shall have the capacity to undertake the work and shall be sufficient to complete the work within the specified contract time. The Contractor shall furnish evidence of experience and expertise that the Contractor/Subcontractor meets the following requirements.

The Contractors/Subcontractors ability to construct the drilled shafts for this project shall be supported by a list containing a description of at least five projects either on-going or completed in the last two years on which the Contractors/Subcontractors staff (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 Contractor/Subcontractors staff participation on the project.

625.03 Drilled Shaft Work Plan. The Contractor shall 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 mentioned in Subsection **625.02** of the Standard Specifications.
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. Any part of the plan that is unsatisfactory will be rejected and the Contractor shall submit changes for re-evaluation. The Engineer will respond to the Contractor within seven 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 for the Contractor to explain his approach to the work and to allow the Engineer to comment on equipment and procedures before field operations begin.

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

625.06 Concrete. 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 *TDOT Standard Specifications for Road and Bridge Construction* except as modified below. 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 roding will not be required. 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. The concrete shall also meet the following requirements:

- 7 inch (1± inch) slump, (Obtained by the use of water reducing admixtures).
- Slump determinations will be made at the time of preparing test cylinders and as directed by the Engineer.
- Coarse aggregate to be size number 67.
- Natural sand content to be 44% maximum, by volume, of the total aggregate.

625.07 Casing. When applicable, the Contractor shall 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. The Contractor must insure the stability of casing during all drilled shaft operations.

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

Condition of Casings. Casings shall be smooth, clean and watertight. For out-of-round tolerance of steel casings before and after installation, the departure of any point on the periphery of the casing from a true circle shall not exceed one inch, measured radially. Telescoping casing shall not be allowed in bridges located in Seismic Performance Categories C or D, where the design earthquake spectral acceleration coefficient at the effective peak ground acceleration, A_s , for the one (1) second period, SD , is equal to or exceeds 0.30g.

Extent of Casing Length. 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 water elevation.

Use of Teeth or Cutting Edge. The casing may be fabricated with teeth or a cutting edge to facilitate insertion into the rock.

Splices. 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 Section 625.13. The Contractor shall be fully responsible for the adequacy of welds during driving.

Welding. Welding of casings shall be in accordance with *AASHTO/AWS Bridge Welding Code* and *TDOT 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 the contractors expense.

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.

Slurry Usage. 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.

General Properties. 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, the Contractor may use water and on-site soils as a drilling slurry. 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.

Preparation. 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. De-sanding will not be required for signposts or lighting mast foundations unless specified in the contract documents.

Control Tests. Control tests using a suitable apparatus shall be performed by the Contractor 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 of the Contractor, 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 below.

Sampling. When slurry samples are found to be unacceptable, the Contractor shall 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, the Contractor shall 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. The Contractor shall perform final shaft bottom cleaning after suspended solids have settled from the slurry mix.

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/ft ³	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					
At Introduction	8 – 10	8 – 11	7 – 11	--	pH Paper or pH Meter
Prior to Concreting	8 – 10	8 – 11	7 – 11	--	
Sand Content					API Sand Content Kit
At Introduction	< 4	< 1	< 1	Percent by Volume	
Prior to Concreting	< 10	< 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. 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, the Contractor shall 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 Contractor is unable to demonstrate, to the satisfaction of the Engineer, the adequacy of methods or equipment and alterations required, 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 by the Contractor 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 method by the Contractor 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 by the Contractor prior to pouring the footing. When drilled shafts are to be installed in conjunction with embankment placement, the Contractor shall 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. The Contractor shall perform excavations through whatever material is encountered to the dimensions and elevations shown on the Plans. The Contractor's methods and equipment shall be suitable for the intended purpose and for whatever material is encountered.

Equipment. The Contractor shall provide equipment capable of constructing shafts to a depth equal to the deepest shaft tip elevation shown on the Plans plus 15 feet, or as otherwise specified in the contract documents. 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.

Excavation Methods. Excavations required for shafts and rock sockets shall be completed in a continuous operation. The Contractor shall be responsible for ensuring the stability of the shaft excavation and the surrounding soil. When obstructions, either expected or unexpected, are encountered, the Contractor shall 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. 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, the Contractor shall immediately notify the Engineer. The Contractor shall 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. The dry construction method shall be used only when shaft excavations have 12 inches per hour or less of seepage and less than 3" of standing water.

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 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 Subsection **625.14** of the Standard Specifications. 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 within 50 feet 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 50 feet of shafts that have been completed less than 24 hours earlier.

625.17 Time Limitations. When bentonite slurry is used, the Contractor shall adjust construction 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, the Contractor shall take corrective measures to the satisfaction of the Engineer.

625.18 Level of Slurry. During construction, the level of slurry not be 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, the Contractor shall 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, the Contractor shall 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 deeper when the Engineer determines that the foundation material encountered while drilling the shaft excavation is unsuitable or is not the same as anticipated in the design of the drilled shaft. Drilled shafts may be shortened when the Engineer determines the material encountered is better than that anticipated, or based on the results of load tests.

625.22 Time Restrictions. Drilled shaft excavation shall begin only if the Contractor can complete the excavation, perform foundation inspection and testing, and place the reinforcement and concrete as a continuous daily operation. No two adjacent shafts shall be excavated at the same time, and shafts shall not be constructed within 24 hours of the completion of an adjacent shaft if the center-to-center spacing is less than three 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 laws.

625.24 Worker Entry Into Shaft Excavation. The Contractor shall 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 by the Contractor. The Contractor shall 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 by the Contractor. The presence of an obstruction for pay purposes must be verified by the Engineer or his representative. Removal of

obstruction(s) will be paid at two times the unit price bid for Item Drilled Caisson (Rock) L.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. Boulders or rock layers of such size that do not allow the use of soil excavation tools as described above will not be considered an obstruction but will be considered Drilled Caisson Rock as described above.

625.26 Inspection Equipment. The Contractor shall 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. The Contractor shall provide aid to the Engineer in maintaining accurate records during all phases of the drilled shaft installation. The Contractor's supervisor shall provide the Engineer with any information required for the drilled shaft inspection reports. The Contractor shall provide boson chairs, gas meters, safety equipment, lights, mirrors, weighted tape measures, steel probes, personnel and all assistance that may be required for the Engineer to inspect the drilled shaft excavations. Contractor shall 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. To confirm that the top of rock socket has been reached once temporary casing has been extended to the top of rock, at the Engineer's request, the Contractor will lower the Inspector to the level of the bottom of the casing and allow visual examination of the side walls of the rock socket. 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.

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, an eight foot deep probe hole shall be drilled near the center of the bottom of each drilled shaft. Temporary casing should extend to the base of the rock socket to allow the Inspector to safely enter the excavation and evaluate conditions within the probe hole. Where groundwater cannot be controlled or other conditions prevent safe down-hole entry, 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 discussed in **Subsection 625.31** of the Standard Specifications.

625.31 Core Drilling. When required by contract documents, core drilling shall be performed as described in the contract plans and paid for under Core Drilling and Sampling at the contract unit price. When core drilling is not included in the contract documents and is required by site conditions and directed by the Engineer, core drilling shall be paid at the contract unit price for Concrete Coring. The Engineer may require rock core samples to be taken 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 or NQ size. The Contractor will perform this core sampling or schedule his qualified representative to do this work.

625.32 Log of Excavated Material. The Contractor shall maintain a log of cored material 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.

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, Contractor 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.

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 herein 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.

Concrete Cover			
Shaft Diameter	Uncased	Casing Remains	<i>Casing Withdrawn</i>
3'-0" or less	3"	3"	4"
>3'-0" & <5'-0"	4"	4"	4"

5'-0" or larger	6"	6"	6"
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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 have 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. The elapsed time from the beginning of concrete placement in the shaft to the completion of the placement shall not exceed two hours. All admixtures shall be adjusted for the conditions encountered on the job so the concrete remains in a workable plastic state throughout the two-hour placement limit. Prior to concrete placement, the Contractor shall provide test results of both a trial mix and a slump loss test conducted by an approved testing laboratory using approved methods to demonstrate that the concrete meets the two-hour requirement. The Contractor may request a longer placement time if a concrete mix is provided that will maintain a slump of 4 inches or greater over the longer placement time in the entire shaft as demonstrated by trial mix and slump loss tests. The trial mix and slump loss tests shall be conducted using concrete and ambient temperatures approved for site conditions.

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 borehole 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 will be considered defective. In such a case, the Contractor shall remove the reinforcing cage and concrete, complete any necessary sidewall cleaning or over-reaming as directed by the Engineer, and repour the shaft. Corrections made by the Contractor 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 will be considered defective. In such a case, the Contractor shall remove the reinforcing cage and concrete, complete any necessary sidewall cleaning or over-reaming as directed by the Engineer, and repour the shaft. Corrections made by the Contractor 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 or slough, the Contractor shall control the movement of concrete by reducing the free fall of the concrete or the rate of flow of concrete into the

excavation. The Contractor shall be responsible for proposing, developing, and after approval from the Engineer, implementing corrective work.

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. Unless otherwise approved by the Engineer, construction joints shall be made only where shown on the Plans. 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 forms in place for at least seven days after concrete placement or until the shaft concrete reaches a minimum strength of 2,500 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, the Contractor shall 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 by the Contractor for the Engineer's approval. Drilled shaft construction shall not begin until approval has been obtained. When a shaft excavation is completed with unacceptable tolerances, the Contractor shall propose, develop and, after approval from the Engineer, implement corrective work. Redesign drawings and computations submitted by the Contractor shall be signed by a professional Engineer registered to practice 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 $\frac{1}{4}$ 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 $\frac{3}{16}$ 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 $\frac{3}{8}$ inch per foot of shaft diameter.
- (e) Shaft steel reinforcing bar shall be no higher than six inches above Plans location 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 or sonic logging testing, to determine the extent of any defects that may be present. Work and material required for testing shall be furnished by the Contractor and will be paid for in accordance with the contract documents. If testing reveals voids or discontinuities in the concrete that, as determined by the Engineer, indicate that the shaft is not structurally adequate, the shaft will be rejected. The Contractor shall then repair, replace or supplement the defective shaft in a method approved by the Engineer. The construction of additional drilled shafts shall be discontinued until the Contractor demonstrates the adequacy of the shaft construction method to the satisfaction of the Engineer. Any additional work required by the Contractor as a result of shaft defects will be non-compensable and any effect on time of performance non-excusable.

625.50 Concrete Coring. At locations where concrete coring is to be provided, as indicated in the contract documents or as directed by the Engineer, the following will apply. 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, and then one core hole shall be drilled completely through the shaft concrete and the rock socket to approximately one foot below the bottom of the rock socket of each 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 NX or NQ size 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, the Contractor shall drill additional cores as directed by the Engineer. If the concrete is found to be defective, the Contractor shall 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 TDOT Qualified Products List or alternate submitted for TDOT approval. No direct payment will be made for grout and grouting.

625.51 Sonic Logging Testing. When required by contract documents, the Contractor shall perform non-destructive integrity testing on completed drilled shafts and rock sockets using the crosshole sonic logging (CSL) method for concrete drilled shafts. The tests shall be conducted as indicated on the Plans or other contract documents, or as directed by the Engineer. Testing will be performed after the shaft concrete has cured at least 72 hours. Sonic logging measurements and data interpretation shall be performed by a CSL consultant with at least two years of experience in CSL drilled shaft testing. The Contractor shall submit the testing organization experience record to the Engineer, along with a written description of the testing procedures, operation manuals for the testing equipment, and samples of previous test results indicating both sound and defective concrete. The Contractor shall inform the Engineer of scheduled test dates at least seven days prior to CSL testing. The Contractor shall provide reasonable access to the shaft top for performance of the sonic logging testing.

Installation of Pipes. The Contractor shall furnish and install $\geq 1 \frac{1}{2}$ " 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 to 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, the Contractor shall fill the access pipes with grout. All cost associated with materials and installation of steel pipes for sonic logging testing shall be included in the cost of Drilled Shaft Concrete.

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

Sonic Logging Test Procedure. The drilled shaft shall be tested between three and 40 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 Contractor shall provide accurate measurements of probe depths on the logs.

Record of Testing. Preliminary results of the testing shall be provided on site prior to the CSL consultant 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. 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 as appropriate to delineate anomalous results. 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 following 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.

Concrete Condition Rating Criteria			
Concrete Condition Rating	Rating Symbol	Velocity Reduction	Indicative Results
Good	G	0 to 10%	Acceptable concrete
Questionable	Q	10% to 25%	Minor concrete contamination or intrusion. Questionable quality concrete.
Poor	P/D	> 25%	Defects exist, possible water slurry contamination, soil intrusion, and or poor quality concrete.
Water	W	V= 4760 to 5005 ft/sec	Water intrusion, or water filled gravel intrusion with few or no fines present.
No Signal	NS	No signal received	Soil intrusion or other severe defect absorbed the signal, tube debonding if near top.

Correction of Unacceptable Results. The Contractor shall immediately inform the Engineer of any suspected anomalies, honeycombing or poor concrete quality detected by testing. The Contractor and CSL consultant 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, the Contractor shall provide a report signed and sealed by a Professional Engineer registered 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. Construction above the top of shaft shall not be performed until the shaft has been accepted by the Engineer.

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 by the Contractor, at the Contractor's expense, in a manner approved by the Engineer.

Compensation

625.53 Method of Measurement.

Drilled Shaft Excavation (Soil). Accepted drilled shafts will be measured for payment 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)".

Drilled Shaft Excavation (Rock). For pay purposes Drilled Shaft Excavation (Rock), 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. The accepted rock sockets and drilling through rock will be measured for payment 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.

Drilled Shaft Concrete. Drilled shaft concrete shall include all cost for materials, placement concrete, and installation of steel pipes, as required by contract documents, for Sonic Logging Testing. Drilled shaft concrete will be measured by the cubic yard and computed from the dimensions indicated on the Plans or ordered in writing by the Engineer.

Drilled Shaft Reinforcing Steel. Drilled shaft reinforcing steel will be measured and computed for payment by the pound, unless otherwise stipulated in the Plans, in accordance with **Subsection 604.30** of the Standard Specifications.

Drilled Shaft Casing (Permanent). Permanent drilled shaft casing will be measured 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.

Drilled Shaft Casing (Temporary). Temporary Drilled shaft Casing will not be measured for payment and shall be incidental to the work.

Foundation Probe Holes. 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.

Foundation Core Holes. Measurement for payment for foundation core holes will be to the nearest 0.10 linear foot of length along the axis of each hole.

Concrete Coring. Measurement for payment for concrete cores will be 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.

Sonic Logging Testing. Sonic logging testing of drilled shafts, as required, will be measured for payment per each drilled shaft.

Drilled Shaft Load Tests. Load tests will be measured for payment per each load test performed.

625.54 Basis of Payment.

Drilled Shaft (Soil). Payment 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.

Drilled Shaft (Rock). Payment 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.

Obstructions. 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.

Drilled Shaft Concrete. Include 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.

Drilled Shaft Reinforcing Steel. Include 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 Subsection **604.31** of the Standard Specifications.

Drilled Shaft Casing (Permanent). Include 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.

Foundation Probe Holes. Payment for Foundation probe holes will be at the contract unit price per linear foot for Item Rock Drilling (Bridges) and shall be full compensation for all equipment and labor to drill the required size and depth probe hole and provide Department personnel access to the probe hole.

Foundation Core Holes. When core drilling is required by contract documents, payment will be at the contract unit price per linear foot for Item Core Drilling and Sampling. Payment 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. When Core Drilling is not included in the contract documents and is required by site conditions and directed by the Engineer, Core Drilling shall be paid at the contract unit price for Item Concrete Coring. Payment shall be full compensation for completing the core drilling as specified above.

Concrete Coring. Payment for concrete coring will be considered full compensation for all material, labor, tools, equipment, grouting and incidentals necessary to complete the work. The field measured quantity shall be paid at the contract unit price per vertical foot for Item Concrete Coring.

Sonic Logging Testing. Payment for sonic logging testing of drilled shafts, when required by contract documents, or directed by the Engineer, will be made at the contract unit price per each drilled shaft for sonic logging testing. No payment will be made for supplementary sonic logging testing to evaluate defects. 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.

Drilled Shaft Load Tests. When required by contract documents, drilled shaft load test will be paid at the contract unit price per each and will be considered full compensation for all costs related to performing and reporting load tests as specified.