MICHIGAN

DEPARTMENT OF TRANSPORTATION

SPECIAL PROVISION

FOR

**BRIDGE DRILLED SHAFT FOUNDATION**

BRG:JST 1 of 10 APPR:RWS:JAB:09-27-22

**a. Description.** This work consists of constructing a bridge drilled shaft foundation in accordance with the standard specifications, the details shown on the project plans and this special provision.

Representative samples of the soil and bedrock (if encountered) materials are available for review. Please contact MDOT Geotechnical Services Section at SnookR@michigan.gov prior to the letting date to arrange a viewing.

Ensure the drilled shaft contractor is prequalified in MDOT’s construction prequalification work classification N9-5E Drilled Shafts/Complex, as of the letting date. Drilled shaft contractors without this qualification as of the letting date will not be considered.

**b. Materials.**

1. Furnish concrete mix as specified in subsection 718.02 of the Standard Specifications for Construction except ensure the aggregate is modified to 26A gradation. Air entrainment is required for this project per subsection 1004.03.D of the Standard Specifications for Construction.

2. Furnish casing material as specified in subsection 919.10 of the Standard Specifications for Construction.

3. Furnish steel reinforcement for all drilled shafts as specified in section 905 of the Standard Specifications for Construction.

4. Furnish slurry as recommended by the slurry manufacturer. Do not use mineral slurries. When testing slurry, the slurry temperature should be at least 40 °F.

5. Furnish access tubes for crosshole sonic log testing consisting of Schedule 40 (or greater) steel pipe in accordance with *ASTM A53/A53M, grade B, Type E, F or S* and at least 1.5 inch inside diameter. The access tubes must have a round, regular inside diameter free of defects and obstructions, including all pipe joints, in order to permit the free, unobstructed passage source and receiver probes used for the crosshole sonic log tests. Ensure the access tubes are watertight, free from corrosion with clean internal and external faces to ensure good bond between the concrete and the access tubes. Ensure the access tubes are fitted with watertight threaded PVC caps on the bottom and the top.

6. Furnish grout for filling the access tubes at the completion of the crosshole sonic log tests that is a neat cement grout with a maximum water/cement ratio of 0.45.

**c. Construction**. Unless directed otherwise by the Engineer, construct the drilled shaft foundation in accordance with the details on the plans, section 718 of the Standard Specification for Construction, and this special provision.

1. Qualifications.

A. Supervisor and drillers must provide:

(1) Three projects with installed drilled shafts with diameters and lengths through soil and rock similar to those shown on the plans.

(2) Drilled Shaft Contractor's fulltime onsite supervisor must have at least 5 years of acceptable experience in installing similar types of drilled shafts in similar subsurface conditions to this project.

B. Non-Destructive Testing Firm. The Contractor must submit the qualifications of the independent crosshole sonic log testing firm performing the non-destructive testing on this project to the Engineer. The testing agency and on-site person must have 5 years minimum experience in testing projects of similar size and nature. Ensure the managing person is a Professional Engineer licensed in the State of Michigan.

C. At least 45 calendar days before the planned start of drilled shaft construction, the drilled shaft contractor must electronically submit the required information from subsections c.1.A and c.1.B of this special provision for approval. The Engineer will approve or reject within 14 calendar days of receipt of complete submission. The project reference list must include a brief project description with the owner’s name and current phone number so the Department can verify the experience. The personnel list must provide a summary of each individual’s experience and be complete enough for the Engineer to determine whether each individual satisfies the required qualifications. Additional time required due to incomplete or unacceptable submittals will not be justification for time extension or impact or delay claims. All such costs associated with incomplete or unacceptable submittals must be borne by the Contractor. If the Department determines the specialty contractor’s experience is not sufficient, submit qualifications for a replacement.

Do not start work, nor order materials, until the Engineer’s written approval of the drilled shaft contractor's personnel qualifications is given. The Engineer may suspend the work if the drilled shaft contractor uses non-approved supervisors and drillers. If work is suspended, the Contractor will be fully liable for all resulting costs and no adjustment in contract time will result from the suspension.

2. Drilled Shaft Installation Plan. Submit a drilled shaft installation plan as described in subsection 718.03.A of the Standard Specifications for Construction. In addition, a procedure for lifting, splicing (if required) and installing the reinforcing steel cage needs to be submitted with the drilled shaft installation plan. The procedure for lifting, splicing and installing the reinforcing steel cage needs to ensure that the access tubes for crosshole sonic log testing are not bent. The drilled shaft installation plan must address the existing groundwater and/or surface water conditions.

3. Preconstruction Meeting. The preconstruction meeting will take place at the project site and will be scheduled by the Engineer. The meeting will occur a minimum of 21 days prior to mobilization, with the drilled shaft installation plan submitted 7 days prior to the preconstruction meeting. The drilled shaft contractor and drilled shaft designer should attend the meeting.

4. Survey. From existing survey control complete the detailed shaft layout. Do layout for each shaft to the lines and levels required before excavation, and the actual measurements of each shaft's horizontal axial location, bottom and top elevations, deviations from specified tolerances, and other data as required. Record and maintain all information pertinent to each shaft and cooperate with any other testing and inspection personnel of the Engineer to provide data for required reports.

5. Construction Method Log. The drilled shaft contractor must submit to the Engineer a daily construction method log during drilled shaft excavation and construction. This log must contain the following information for each drilled shaft:

A. Date (start date and completion date).

B. Drilled shaft identification number.

C. Location.

D. Actual top and bottom elevation of drilled shaft.

E. Shaft diameter.

F. Final centerline location at top.

G. Variation of drilled shaft from plumb.

H. Top and bottom elevations as well as diameter of all casing used.

I. Description of each soil and rock material encountered during excavating and their approximate top and bottom depths or elevations.

J. Depth drilled into bearing stratum.

K. Top and bottom elevations of obstructions encountered.

L. Amount of obstruction time, if any.

M. Depth or elevation of encountered seepage or groundwater.

N. Type of drilling fluid used and the results of any slurry testing.

O. Method(s) used for cleaning the bottom of the drilled shaft.

P. Quantity of concrete placed.

Q. Remarks.

6.Subsurface Data. The geotechnical report outlining the subsurface exploration conducted during the design phase is included in the Reference Information Documents. The soil boring logs represent point information. Presentation of this information in no way implies that subsurface conditions are the same at locations other than the exact location of the boring. It is expressly understood that the Department will not be responsible for interpretations or conclusions drawn therefore by the Contractor. Additional soil test borings and other exploratory procedures may be performed by the Contractor at no additional cost to the Department.

7. Casing. Case shaft excavation as shown on the plans or as determined by the Contractor. Install casing such that intimate contact with the surrounding earth or rock is maintained. Take precautions to prevent damaging existing structures and utilities by selecting appropriate casing installation methods and procedures. Cut off casing to the elevation shown on the plans. Hand chip and patch unsound concrete areas identified by the Engineer in accordance with section 712 of the Standard Specifications for Construction.

8. Protection of Existing Structures. Control operations to prevent damage to the existing structures and utilities. Preventative measures must include, but are not limited to, selecting construction methods and procedures that will prevent caving of the shaft excavation, monitoring and controlling the vibrations from construction activities (such as installation of casing and drilling of the shaft), and monitoring and controlling the depth of excavation. Repair any damage to existing structures or utilities at the Contractors expense to the satisfaction of the Engineer, including engineering analysis and redesign, and without any extension of the completion dates for the project.

9. Construction Tolerances.

A. Horizontal Alignment. Ensure the drilled shaft actual centerlines are within 3 inches of plan centerlines at the plan elevation for the top of the shaft.

B. Plumb. At the drilled shaft actual bottom elevation, ensure the out-of plumb is no greater than 1 percent of the drilled shaft length as measured from the actual center of the shaft at the shaft design top elevation.

C. Reinforcing Steel. After all the shaft concrete is placed, ensure the top of the reinforcing steel cage is no more than 3 inches above or below plan position.

D. Top of Shaft Elevation. Ensure the top elevation of the shaft is within +1 inch to -3 inches from the plan top of shaft elevation.

Drilled shaft excavations and completed shafts not constructed within the required tolerances will be considered unacceptable. Correct all unacceptable shaft excavations and completed shafts to the satisfaction of the Engineer. Ensure materials and work necessary to complete corrections for out of tolerance drilled shafts, including engineering analysis and redesign, are furnished without cost to the contract, and without an extension of the completion dates for the project.

10. Ensure reinforcing steel cage construction and placement are in accordance with subsection 706.03.E of the Standard Specifications for Construction and the following:

A. Ensure a reinforcing cage, when called for on the plans, consisting of longitudinal bars, stiffener bars, centralizers and tie reinforcement or spiral reinforcement is completely assembled prior to placement in the shaft excavation. Place the steel reinforcement as a unit immediately after the shaft excavation is inspected and approved, and prior to concrete placement.

B. Use non-corrosive spacers on the exterior of the reinforcing cage, near the bottom of the cage and at sufficient intervals to ensure concentric spacing of the cage for its entire length within the shaft excavation. Provide spacers of adequate dimensions to ensure a minimum 3 inches annular space between the outside of the reinforcing cage and the perimeter of the excavated shaft. Maintain the bottom of the cage the proper distance above the shaft base using approved concrete bottom supports, by supporting the cage with cables hooked to a crane, or by other methods approved by the Engineer.

C. Tie and support the reinforcing steel in the shaft during concrete placement and temporary casing removal such that the reinforcing steel will remain within the allowable tolerances. Check the elevation of the top of the steel cage before and after the concrete is placed. If the reinforcing steel cage is not maintained within the specified tolerances, ensure corrections are made to the satisfaction of the Engineer. Construct no additional shafts until the steel cage support is modified in a manner satisfactory to the Engineer.

11. Access Tubes for Crosshole Sonic Log Testing.

A. Install access tubes for crosshole sonic log testing in all drilled shafts, except as otherwise noted, to permit access for the crosshole sonic log test probes. If, in the opinion of the Engineer, the conditions of the shaft excavations permit shaft construction in the dry, the Engineer may specify that the access tubes be omitted.

B. Securely attach the access tubes to the interior of the reinforcement cage of the shaft. Furnish and install one access tube for each foot of shaft diameter, rounded to the nearest whole number, as shown on the plans. Round the number of access tubes for shaft diameters specified as “X feet 6 inches” up to the next higher whole number. Place the access tubes around the shaft, inside the spiral or hoop reinforcement and 3 inches clear of the vertical reinforcement, at a uniform spacing measured along the circle passing through the centers of the access tubes. If the vertical reinforcement is not bundled and each bar is not more than 1 inch in diameter, place the access tubes 2 inches clear of the vertical reinforcement. If these minimums cannot be met due to close spacing of the vertical reinforcement, then ensure the access tubes are bundled with the vertical reinforcement.

C. Install the access tubes in straight alignment and as near to parallel to the vertical axis of the reinforcement cage as possible. The access tubes must extend from the bottom of the reinforcement cage to at least 3 feet above the top of the shaft. Ensure splice joints in the access tubes, if required to achieve full length access tubes, use watertight couplers. Butt welding access tubes is prohibited. Clear the access tubes of all debris and extraneous materials before installing the access tubes. Take care to prevent damaging the access tubes during reinforcement cage installation and concrete placement operations in the shaft excavation.

D. Fill the access tubes with potable water within 4 hours after concrete placement, and reinstall the top watertight threaded PVC caps. Check the water level in the access tubes 8 hours after concrete placement and refill as necessary.

12. Excavations. Maintain the stability of the excavation sidewalls and extend the shaft excavation to the elevation specified on the plans or as directed by the Engineer. If drilling slurry is used, test slurry in accordance with the manufacturer’s recommendations, except as modified by this special provision, and testing procedures in subsection 718.03.E of the Standard Specifications for Construction. Take slurry samples from within 2 feet of the bottom of the drilled shaft and at mid-height of the drilled shaft. Take slurry samples every 4 hours within each shift after initiating use and immediately prior to pouring concrete. Extend drilled shaft tip elevations when the Engineer determines any soil stratum encountered during excavation is unsuitable and/or differs from that anticipated in the design of the drilled shaft. Variations in the shaft bottom elevation from that shown on the plans may occur. Ensure equipment on-site is capable of excavating an additional 20 percent of depth below that shown on the plans. Ensure the Engineer has access to auger cuttings and/or rock cores/cuttings of all excavated material for additional analysis. Fill over-excavation of shafts with concrete and will be paid for at the unit rate specified for that type of formation. Ensure unauthorized shaft excavations extended below required depths/elevations are filled with concrete at no additional cost to the contract.

Sequence shaft excavations directly adjacent to one another to allow a minimum of 24 hours between the end of concrete placement and the start of adjacent shaft excavation. Additional time beyond 24 hours may be needed if the concrete has not set within this time period. Additional set time beyond 24 hours will not be grounds for additional compensation or an extension of time.

Dispose of excavated materials removed from shaft excavations in accordance with section 205 of the Standard Specifications for Construction. Keep excavated materials away from each open shaft excavation. Direct surface water away from shaft excavations. Ensure no excavated materials are allowed to enter the waters of the state or storm drainage system when present.

13. Obstructions. Remove surface and subsurface obstructions encountered in the length of excavation at drilled shaft locations. Such obstructions may include materials such as old concrete foundations, boulders, abandoned utilities and riprap. Cemented soil, weathered bedrock and fresh bedrock are not considered obstructions. Employ special procedures and/or tools after the excavation cannot be advanced using conventional augers fitted with soil or rock teeth, drilling buckets and/or under-reaming tools. Such special procedures/tools may include, but are not limited to: chisels, boulder breakers, core barrels, air tools (i.e. down hole air hammer), hand excavation, temporary casing, and enlarging the hole diameter. Removal of such obstructions will be paid as Obstruction Removal. Payment for Obstruction Removal will be made only when such special procedures/tools are utilized and approved by the Engineer.

14. Ensure excavation inspection is in accordance with subsection 718.03.F.1 of the Standard Specifications for Construction, with the following addition: After shaft excavation, provide access and time for the Engineer to inspect the shaft through video methods as long as a tremie pour is not required. Provide suitable lighting.

15. Concrete Placement. Place concrete for drilled shafts in accordance with the applicable portions of section 706 and subsection 718.03.H of the Standard Specifications for Construction and as modified herein.

A. Placement Methods. Deliver concrete to the site from the batch plant in a continuous manner to help avoid interruption of placement. Place concrete either by free-fall or through a tremie or concrete pump the same day the shaft is excavated. If concrete is not placed the same day as shaft excavation, additional excavations may be required by the Engineer to satisfy design elevations at no additional cost to the contract.

Free-fall placement is permitted only in dry excavations where free water accumulation of 3 inches or less and an entry rate of less than 12 inches per hour can be maintained immediately prior to concrete placement.

B. Temporary Casing. Coordinate temporary casing withdrawal carefully with concrete placement. When temporary casing is being withdrawn, maintain a sufficient head of concrete above the bottom of the casing to prevent reduction in the shaft diameter due to earth and/or hydrostatic pressure on the fresh concrete, and to prevent extraneous material from mixing with fresh concrete. Check the concrete level in the temporary casing prior to, and after casing withdrawal to confirm that separation of the shaft concrete has not occurred.

C. Protection of Concrete. Protect fresh concrete from flowing water and damage from mechanical equipment and nearby construction vibrations. Vibrations from construction operations (vibratory casing installation, concrete demolition etc.) will not be permitted within a radius of 25 feet until the concrete has attained 75 percent of its specified minimum strength. Protect concrete from strength reduction caused by heat, frost or freezing actions.

D. Concrete Volume. Check the actual volume of concrete placed with the theoretically calculated concrete volume to detect any large voids or intrusions of extraneous material. Include results in Construction Method Log.

16. Nondestructive Testing of Shafts (Crosshole Sonic Log Testing).

A. Provide for crosshole sonic log testing (*ASTM D6760*), analysis and data interpretation with recommendations, on all completed shafts designated for testing by the Engineer. Ensure the testing, analysis and data interpretation with recommendations is performed by the independent testing firm submitted by the Contractor and approved by the Engineer in accordance with subsections c.1.B and c.1.C of this special provision.

Perform the testing after the shaft concrete has cured at least 96 hours or as directed by the Engineer. Additional curing time prior to testing may be required if the shaft concrete contains admixtures, such as set retarding admixture or water reducing admixture. The additional curing time prior to testing required under these circumstances is not grounds for additional compensation or extension of time. Additional testing due to inconclusive initial results due to cure time will not be grounds for additional compensation or extension of time.

Conduct crosshole sonic log testing at all shafts in which access tubes for test probe access have been installed (see subsection c.11.A of this special provision). Provide results from these tests to the Engineer no later than 3 working days from the test date.

B. After placing the shaft concrete and before beginning the crosshole sonic log testing of a shaft, inspect the access tubes. Ensure each access tube that the test probe cannot pass through is replaced, at the Contractor's expense, with a 2 inch diameter hole cored through the concrete for the entire length of the shaft. Unless directed otherwise by the Engineer, locate cored holes approximately 6 inches inside the reinforcement and must not damage the shaft reinforcement. Log descriptions of inclusions and voids in cored holes and a copy of the log submitted to the Engineer. Preserve findings from cored holes, identify the location, and make available for inspection by the Engineer.

C. Submit the crosshole sonic log testing results, analysis and data interpretation with recommendations for each shaft tested to the Engineer for approval. The Engineer will determine final acceptance of each shaft, based on the crosshole sonic log test results, analysis and data interpretation with recommendations for the tested shafts, and will provide a response to the Contractor within 3 working days after receiving the submittal.

D. Except as otherwise noted, do not commence subsequent shaft excavations until receiving the Engineer's approval and acceptance of the first shaft, based on the results and analysis of the crosshole sonic log testing for the first shaft. Commencement of subsequent shaft excavations prior to receiving the Engineer’s approval and acceptance of the first shaft, is allowed provided the following condition is satisfied:

(1) The Engineer approves continuing with shaft construction based on the Engineer’s observations of the construction of the first shaft, including, but not limited to, conformance to the shaft installation plan as approved by the Engineer, and the Engineer’s review of Contractor’s daily reports and Inspector’s daily logs concerning excavation, steel reinforcing bar placement, and concrete placement.

E. The Engineer may direct that additional testing be performed at a shaft. Ensure if subsequent testing at a shaft indicates the presence of a defect(s) in the shaft, the testing costs and the delay costs resulting from the additional testing will be at the Contractors expense. If this additional testing indicates that the shaft has no defect, the testing costs and the delay costs resulting from the additional testing will be paid by the Department in accordance with section 103.02 of the Standard Specifications for Construction. If the shaft construction is on the critical path of the Contractor’s schedule, a time extension equal to the delay created by the additional testing will be granted.

F. For all shafts determined to be unacceptable by the Engineer, must submit a plan for further investigation or remedial action to the Engineer for approval. Ensure all modifications to the dimensions of the shafts, as shown on the plans, required by the investigation and remedial action plan are supported by calculations and detailed working drawings stamped by a Professional Engineer licensed in the State of Michigan. Submit all investigation and remedial correction procedures and designs to the Engineer for approval. Do not begin repair operations until receiving the Engineer's approval of the investigation and remedial action plan.

G. If the Engineer determines that the concrete placed under slurry for a given shaft is structurally inadequate, that shaft will be rejected. Suspend the placement of concrete under slurry until written changes to the methods of shaft construction needed to prevent future structurally inadequate shafts, are submitted to the Engineer and written approval is received.

H. At the Engineer's request, drill a corehole in any questionable quality shaft (as determined from crosshole sonic log testing and analysis or by observation of the Engineer) to explore the shaft condition.

Prior to beginning coring, submit the method and equipment used to drill and remove cores from shaft concrete to the Engineer and written approval is received. The coring method and equipment must provide for complete core recovery and must minimize abrasion and erosion of the core.

If a defect is confirmed, all coring costs will be at the Contractor’s expense. If no defect is encountered, the Department will pay for all coring costs in accordance with section 103.02 of the Standard Specifications for Construction. If the shaft construction is on the critical path of the Contractor’s schedule, a time extension equal to the delay created by the additional testing will be granted if no defects are encountered following coring and/or testing. No time extensions will be granted if a defect is confirmed. Ensure materials and work necessary, including engineering analysis and redesign by a Professional Engineer licensed in the State of Michigan, to effect corrections for shaft defects to the Engineer's satisfaction are at no additional cost to the contract.

I. Ensure all access tubes and cored holes are dewatered and filled with grout after tests are completed and the drilled shaft is accepted. Cut off all access tubes flush with the top of the drilled shaft after the drilled shaft is accepted. Ensure the access tubes and cored holes are filled using grout tubes that extend to the bottom of the tube or hole or into the grout already placed.

**d. Measurement and Payment.** The completed work, as described, will be measured and paid for at the contract unit price for the following pay items:

**Pay Item** **Pay Unit**

Drilled Shaft, Std, \_\_ inch Foot

Drilled Shaft Equipment, Furn, Spec (Structure Identification) Lump Sum

Obstruction Rem, Spec Dollar

Crosshole Sonic Logging Access Tube Foot

Crosshole Sonic Log Testing Each

1. **Drilled Shaft, Std, \_\_ inch** includes the drilled shaft excavation, temporary casings, hand chipping and patching, slurry, shaft concrete, steel reinforcement cage, disposal of excavated material and slurry necessary for construction, and preventative measures required to prevent cuttings or slurry from entering the rivers or drains when present. **Drilled Shaft, Std, \_\_ inch** includes excavation of all materials, including sand, silt, clay, peat, gravel, cobbles, cemented soil, weathered or fresh bedrock and combinations thereof.

2. **Drilled Shaft Equipment, Furn, Spec (Structure Identification)** includes furnishing and removing equipment for constructing the drilled shaft. This will include furnishing and removing equipment for all soil and/or rock excavation.

3. **Obstruction Rem, Spec** will be paid at invoice cost in accordance with subsection 103.02 of the Standard Specification for Construction. After designation as an obstruction by the Engineer, the Contractor is required to remove the obstruction and resume excavation. A budget amount has been established for payment for the removal of obstructions. If the Contractor and Engineer do not agree on a unit or lump sum price, the Engineer may order the work to be performed on a force account basis in accordance with subsection 109.05.

4. **Crosshole Sonic Logging Access Tube** includes installing the access tubes in the drilled shaft per the limits noted in this special provision.

5. **Crosshole Sonic Log Testing** will be measured and paid for each shaft constructed unless modified by the Engineer. This pay item includes mobilization, materials, tools, labor, engineering analysis, and reporting as specified in this special provision.

No unit price adjustment will be made in the event of increased or decreased contract quantities for Crosshole Sonic Log Testing.