SP-XX BRIDGE – PIER DRILLED SHAFT 8.5 FT DIAMETER
SP-XX BRIDGE – PIER DRILLED SHAFT 8.0 FT DIAMETER – ROCK SOCKET
SP-XX BRIDGE – ABUTMENT DRILLED SHAFT 5.5 FT DIAMETER
SP-XX BRIDGE – ABUTMENT DRILLED SHAFT 5.0 FT DIAMETER – ROCK SOCKET
SP-XX BRIDGE – DRILLED SHAFT - CROSSHOLE SONIC LOG (CSL) TEST
SP-XX BRIDGE – DRILLED SHAFT - REMOVAL OF OBSTRUCTIONS (CONTINGENCY AMOUNT)

Description.

1.01 Drilled Shafts

The terms "drilled shaft" or "shaft" have identical meaning herein. **The "drilled shaft" or "shaft" is defined as the portion of the bridge pier below the top of the permanent casing.**

This item of work shall consist of furnishing all materials, labor, tools, equipment, services and incidentals necessary to construct the shafts in accordance with the Plans, the Standard Specifications, and the Special Provisions. Work shall include performing Crosshole Sonic Log (CSL) Testing as described herein.

Materials.

2.01 Casing

A. Permanent casing is defined as casing designed as part of the drilled shaft and installed to remain in place after construction is complete. Temporary casing is defined as casing installed to facilitate shaft construction only, which is not designed as part of the drilled shaft, and which shall be completely removed, unless otherwise shown in the Plans.

B. All permanent casing shall be of steel base metal conforming to AASHTO M 270, meeting as a minimum the requirements of Grade 36. Contractor shall provide higher strength permanent steel casing if needed to resist damage and deformation from transportation and handling, installation stresses, and all pressures and forces acting on the casing.

C. The permanent casing shall be watertight and clean prior to placement in the excavation.

D. Where the minimum thickness of the permanent casing is specified in the Plans, it is specified to satisfy structural design requirements only. The Contractor shall increase the casing thickness as necessary to satisfy the requirements of item B of this section.

E. The diameter and thickness of the permanent casing shall be such that the permanent casing can be installed and seated into the annular rock cut described in subsection 3.03.C of this Special Provision.

F. If used, temporary casing shall be a smooth wall structure of steel base metal. All temporary casing shall be of sufficient strength to resist damage and deformation from transportation and handling, installation and extraction stresses, and all pressures and forces acting on the casing. The casing shall be capable of being removed without deforming and causing damage to the completed shaft, and without disturbing the surrounding soil.

2.02 Reinforcing Steel

A. Reinforcing steel used in the construction of shafts shall conform to Section 503.

2.03 Concrete

A. Concrete used in the construction of shafts shall be Class 40 conforming to Section 502, except as here-in specified.

B. Classification:

Concrete Class in (100 psi) (28 day)	Minimum Cement Content, lb/cy	Max. Water to Cement (Plus Fly Ash) Ratio	Slump, In.	Air Content Percent
40	675	0.42	7-9	0-3

NOTE: Lithium or other mitigating measures may be required.

C. Fine aggregate for drilled shaft concrete Class 40 shall conform to the gradation specified in Section 703.02.

D. Coarse aggregate for drilled shaft concrete Class 40 shall conform to the Size 1 gradation specified in Section 703.03.

E. Water reducing/retarding admixture for concrete Class 40 is required and shall conform to ASTM C 494 Type D. .

2.04 Slurry

Slurry, if used, shall conform to one of the following:

A. Mineral Slurry
1. Mineral slurry shall conform to the following requirements:

Property	**Test**	**Requirement**
Density (pounds per cubic foot)	Mud Weight (Density) API 13B-1, Section 1	64 to 75
Viscosity (seconds/quart)	Marsh Funnel and Cup API 13b-1, Section 2.2	26 to 50
pH	Glass Electrode, pH Meter, or pH Paper	8 to 11
Sand Content (percent) -immediately prior to placing concrete	Sand API 13B-1, Section 5	4.0 max.

Quality control testing will be by the Contractor. Slurry temperature shall be at least 40°F when tested.

B. Synthetic Slurries

1. Synthetic slurries shall be used in conformance with the manufacturer's recommendations, the quality control plan specified in subsection 3.02.B.5, and these Special Provisions. The following synthetic slurries may be used:

Product	**Manufacturer**
1. SlurryPro CDP	KB Technologies Ltd. Suite 216, 735 Broad Street Chattanooga, TN 37402
2. Super Mud	PDS Company 8140 East Rosecrans Ave. Paramount, CA 90723
3. ShorePac GCV	CETCO 1350 West Shure Drive Arlington Heights, IL 60004

2. The sand content of synthetic slurry immediately prior to placing concrete shall be less than 2.0 percent, in accordance with API 13B-1, Section 5.

C. Water

1. Water may be used when casing is used for the entire length of the drilled hole in soils. Use of water without full-length casing may only be used with the approval of the Engineer.

2. The sand content in water immediately prior to placing concrete shall be less than 4.0 percent, in accordance with API 13B-1, Section 5.

2.05 Access Tubes for Crosshole Sonic Log (CSL) Testing

A. Access tubes for Crosshole Sonic Log (CSL) testing shall be steel pipe of 0.145 inches minimum wall thickness and at least 1 ½ inches inside diameter and not greater than 2 inches inside diameter.

B. The access tubes shall have a round, regular inside diameter free of defects and obstructions, including all pipe joints, in order to permit the free, unobstructed passage of $1\ ^{5}/_{16}$ inches maximum diameter source and receiver probes used for the Crosshole Sonic Log (CSL) tests. The access tubes shall be watertight, free from corrosion with clean internal and external faces to ensure good bond between the concrete and the access tubes. The access tubes shall be fitted with watertight caps on the bottom and the top.

2.06 Grout; Grout for filling the access tubes at the completion of the Crosshole Sonic Log (CSL) tests shall conform to Section 506.03(H), Type B, Class 1.

Construction Requirements.

3.01 Quality Assurance

A. Shaft Construction Tolerances

1. Shafts shall be constructed so that the center at the top of the shaft is within the following tolerances from the plan location:

Shaft Diameter	**Tolerance**
Less than or equal to 2 feet	2 inches
Greater than 2 feet	3 inches

2. Shafts shall be within 1.5 percent of plumb.

3. During drilling or excavation of the shaft, the Contractor shall make frequent checks on the plumbness, alignment, and dimensions of the shaft. Any deviation exceeding the allowable tolerances shall be corrected with a procedure approved by the Engineer.

B. Nondestructive Testing of Shafts

1. The Contractor's approved consultant will perform Crosshole Sonic Log (CSL) testing of shafts selected in accordance with subsection 3.09.A of this Special Provision. The Contractor shall accommodate the Crosshole Sonic Log (CSL) testing by furnishing and installing access tubes in accordance with subsection 3.06 of this Special Provision.

C. Drilled Shaft Conference

1. A drilled shaft conference shall be held after approval of the drilled shaft installation plan and Contractor's personnel at least five working days prior to the Contractor beginning any shaft construction work at the site to discuss construction procedures, personnel, and equipment to be used, and other elements of the approved shaft installation plan as specified in subsection 3.02 of this Special Provision. Those attending shall include:

   a. Representing the Drilling Contractor: The superintendent, on site supervisors, and all foremen in charge of excavating the shaft, placing the casing and slurry as applicable, placing the steel reinforcing bars, placing the concrete, and CSL testing organization representative. Also the certified slurry representative, if slurry is to be used on the project.

   b. Representing the Engineer: The Project Engineer, key inspection personnel and ITD Bridge and Materials representatives.

2. After the conference, if the Drilling Contractor's key personnel change, or if the Contractor proposes a significant revision of the approved shaft installation plan, an additional conference shall be held before any additional shaft construction operations are performed.

3. No work shall begin until after the drilled shaft conference meeting is held and the drilled shaft installation plan is approved by the Engineer.

3.02 Submittals

Work shall not begin until all the required submittals have been approved in writing by the Engineer. The Engineer will require up to 15 working days from the date the submittals or re-submittals are received until they are returned to the Contractor. Re-submittals shall be required for all submittals that do not meet contract requirements, do not contain sufficient detail, or are otherwise not approved by the Engineer. All procedural approvals given by the Engineer will be subject to trial in the field and shall not relieve the Contractor of the responsibility to complete the work satisfactorily.

A. Contractor's Experience

1. The Contractor shall submit a project reference list to the Engineer for approval verifying the successful completion by the Contractor, including the superintendents, on-site supervisors and drill rig operators of at least three separate bridge foundation projects within the past five years with drilled shafts of diameters and depths equal to or larger than those shown in the Plans. The projects being used to support the Contractor's experience must be of similar size or greater than the project shown in the Plans. The projects quoted for experience must be in geotechnical conditions similar to those shown in the Plans. A brief description of each project and the owner's contact person's name and current phone number shall be included for each project listed.

2. The Contractor shall submit a list identifying the superintendents, on-site supervisors, and drill rig operators assigned to the project. On-site superintendents and supervisors shall have documented experience in direct on-site supervisory responsibility for construction of at least three separate bridge drilled shaft foundation projects including drilling operations, casing and slurry installations, rebar cage installations and drilled shaft concrete placements. The related projects shall be of similar size and scope to those shown in the Plans. The drill rig operators shall also have documented experience in construction of at least three separate drilled shaft foundation projects of similar size and scope to those shown in the Plans. The list shall contain a summary of each individual's experience including list of related projects and reference contacts. The list shall also include the reference contacts' current phone numbers.

3. The Engineer will approve or reject the Contractor's qualifications and field personnel within 15 working days after receipt of the submittal. Work shall not be started on any drilled shaft until the Contractor's qualifications and field personnel are approved by the Engineer. The Engineer may suspend the drilled shaft construction if the Contractor substitutes personnel not approved as described in paragraphs 1 and 2 above. The Contractor shall be fully liable for the additional costs resulting from the suspension of work and no adjustments in contract time resulting from the suspension of work will be allowed.

B. Shaft Installation Plan

The Contractor shall submit four copies of a shaft installation narrative for approval by the Engineer. In preparing the narrative, the Contractor shall reference the available subsurface data provided in the Phase IV-Foundation Investigation Report prepared for this project. This narrative shall provide at least the following information:

1. An overall construction operation sequence and the sequence of drilled shaft construction, including use of temporary casing and methods of installation of permanent casing.

2. List, description and capacities of proposed equipment, including but not limited to cranes, drills, auger, bailing buckets, final cleaning equipment and drilling unit. The narrative shall describe why the equipment was selected, and describe equipment suitability to the anticipated site and subsurface conditions. The narrative shall include a project history of the drilling equipment demonstrating the successful use of the equipment on shafts of equal or greater size in similar conditions.

3. Details of shaft excavation methods, including proposed drilling methods, methods for cleanout of the shafts and a disposal plan for excavated material and drilling slurry (if used). This shall include a review of method suitability to the anticipated site and subsurface conditions.

4. 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. This shall include a review of method suitability to the anticipated site and subsurface conditions. Casing dimensions and detailed procedures for permanent casing installation, and temporary casing installation and removal shall be provided.

5. Detailed procedures for mixing, using, maintaining, and disposing of the slurry shall be provided (if used). A detailed mix design, and a discussion of its suitability to the anticipated subsurface conditions, shall also be provided for the proposed slurry.

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

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

6. Reinforcing steel shop drawings, details of reinforcement placement, including bracing, centering, and lifting methods, and the method to assure the reinforcing cage position is maintained during construction.

7. Details of the method used to construct portions of the shaft containing column reinforcement.

8. Details of concrete placement, including proposed operational procedures for pumping and/or tremie methods.

9. The method to be used to form an emergency horizontal construction joint during concrete placement.

10. Details of the devices or methods used to prevent unauthorized entry into a shaft excavation.

11. Description of the material used to temporarily backfill a shaft excavation during a stoppage of the excavation operation, as well as the method used to place and remove the material.

12. The method and equipment to be used to drill and remove concrete cores from the shaft. The coring method and equipment shall provide for complete core recovery and shall minimize abrasion and erosion of the core and adjacent portions of the shaft. The Contractor shall be responsible for core recovery.

C. Synthetic Slurry Technical Assistance

1. If synthetic slurry is used to construct the shafts, the Contractor shall provide or arrange for technical assistance in the use of the synthetic slurry as specified in subsection 3.04.A.1 of this Special Provision. The Contractor shall submit one of the following to the Engineer for approval:

a. The name and current phone number of the synthetic slurry manufacturer's technical representative assigned to the project.

b. The name(s) of the Contractor’s personnel assigned to the project and trained by the synthetic slurry manufacturer in the proper use of the synthetic slurry. The submittal shall include a signed training certification letter from the synthetic slurry manufacturer for each trained Contractor’s employee listed, including the date of the training.

D. Crosshole Sonic Log (CSL) Testing Organization and Personnel

1. At least 15 working days prior to beginning shaft construction, the Contractor shall submit the name and qualifications of the independent testing organization that will be conducting the Crosshole Sonic Log (CSL) tests and providing written analysis to the Engineer for approval. The submittal shall include a list identifying all office and field personnel, including the person responsible for analyzing and interpreting the data and the person or persons who will perform the on site testing. The CSL

testing organization shall have a minimum of five years experience in performing CSL testing and analysis on drilled shafts. Persons with a minimum of five years experience shall be available by phone, fax, or e-mail, as needed by the Engineer, during the CSL testing and analysis phases of the work. The on-site person(s) and those performing data analysis and interpretation shall have at least three years experience in performing the CSL testing and analysis. The submittal shall include a summary of each individual's experience and reference contacts.

2. At least 15 working days prior to beginning drilled shaft construction, the Contractor shall submit a project reference list to the Engineer describing at least three separate drilled shaft projects, comparable in scope and complexity to this project, performed by the CSL testing organization and personnel proposed for this project within the previous five years. The submittal will be used to verify successful completion of the projects by the CSL testing organization. The submittal shall include the names, addresses and telephone numbers of Owners, Engineers or other responsible persons to contact for verification of all information relative to experience of the organization, referenced projects and listed testing personnel. Notwithstanding qualification, the CSL contractor may be required to submit additional information and, if so required, shall submit the additional information prior to the start of work.

3. The Engineer will approve or reject the CSL testing organization and personnel qualifications within 15 working days after receipt of the submittal. Work shall not be started on any drilled shaft until the CSL testing organization and personnel qualifications are approved by the Engineer. The Engineer may suspend the drilled shaft CSL testing if the organization substitutes unqualified personnel, or personnel for whom qualifications have not been previously approved by the Engineer. The Contractor shall be fully liable for the additional costs resulting from the suspension of work and no adjustments in contract time resulting from the suspension of work will be allowed.

3.03 Shaft Excavation

A. Shafts shall be excavated to the required depth and minimum penetration into the bearing layer as shown in the Plans or as directed by the Engineer.

Unless casing is used in excavation, the soil excavation shall be conducted in a continuous operation until the excavation is completed. Pauses or stops, defined as momentary interruptions during such excavation shall not be allowed, except for casing splicing, tooling changes, slurry maintenance, and removal of obstructions. Shafts shall not be left open overnight unless they are supported by casing to the bottom of soil excavation. The shaft shall not be left in a situation where the shaft excavation could become unstable because of a pause or stop.

If temporary casing is used in excavation, the Contractor shall provide temporary casing at the site in sufficient quantities to meet the needs of the anticipated construction method.

Variations in the bearing layer elevation from that shown in the Plans are anticipated. The Contractor shall have equipment on-site capable of excavating an additional 20 percent of depth below that shown in the Plans to accommodate these variations.

B. The top of the temporary and permanent drilled shaft casings shall extend to an elevation above the ground surface at all times during the shaft installation and construction.

The Contractor shall furnish each shaft permanent casing 20 percent longer than indicated by the elevations shown in the Plans.

C. Prior to excavation of the bedrock, an annular cut in the bedrock with a diameter equal to an outside diameter of the permanent casing and a minimum depth as shown in the Plans and as required to prevent cave-ins and blow-ins, centered on the drilled shaft, shall be made. The base of the annular cut shall be level so that when seated the permanent casing is plumb. After the annular cut has been made into the top of the bedrock, the permanent casing shall be installed into the annular cut and the rock socket having shall be excavated inside the permanent casing to the diameter and depth shown in the plans. If the excavator equipment creates an inverted cone type excavation that is deeper in the center than at the perimeter, the excavation shall continue until the perimeter depth of the excavation meets the plan requirements.

Alternative methods of installing the permanent casing may be proposed by the Contractor, but may only be utilized if approved by the Engineer.

D. The Contractor shall demonstrate to the satisfaction of the Engineer that stable conditions are being maintained during excavation, and prior to placement of the reinforcement cage and concrete. Piping or caving of soil into the drilled shaft excavation shall not be permitted. If the Engineer determines that stable conditions are not being maintained, the Contractor shall immediately take action to stabilize the shaft excavation. The Contractor shall submit a revised shaft installation plan, which addresses the problem and prevents future instability. The Contractor shall not continue with shaft construction until the damage that has already occurred is repaired in accordance with the Specifications, and until receiving the Engineer's approval of the revised shaft installation plan.

E. The Contractor shall use appropriate means such as a cleanout bucket or air lift to clean the bottom of the excavation of all shafts. No more than 2 inches of loose or disturbed bedrock material shall be present at the bottom of the shaft just prior to placing shaft concrete. For shaft excavations underwater, several cleanouts may be necessary to remove the suspended soil and ground rock sediment that settles out of the water to the bottom of the shaft with time. If the excavating equipment creates an inverted cone shape at the bottom of the socket, an airlift shall be required to clean the bottom of the shaft. The bedrock excavation and cleanout equipment shall stay on site until after placement of the shaft reinforcement cage and concrete.

F. The excavated shaft shall be inspected and approved by the Engineer prior to proceeding with placement of the reinforcement cage and concrete. The Contractor shall notify the Engineer at least 24 hours prior to when the Contractor expects to begin excavation of the bedrock layer so that the Engineer can be present during the excavation and clean out. The bottom of the excavated shaft shall be sounded with an airlift pipe, a tape with a

heavy weight attached to the end of the tape, or other means acceptable to the Engineer to determine that the shaft bottom meets the requirements of the Contract.

G. When obstructions are encountered, the Contractor shall notify the Engineer promptly. An obstruction is defined as a specific object (e.g., including, but not limited to, natural boulders, logs, old foundations) which causes a significant reduction in the rate of advance of the shaft drilling equipment relative to the rate of advance for the rest of the shaft excavation. The method of removal of such obstruction and the continuation of excavation shall be as proposed by the Contractor and approved by the Engineer. Disposal of removed obstructions shall be in accordance with Section 203 of the Standard Specifications.

3.04 Slurry Installation Requirements

Slurry shall not be used without prior approval of the Engineer. If slurry is used, the Contractor shall demonstrate to the satisfaction of the Engineer that the slurry does not reduce or otherwise affect the side friction bond between the concrete in the shaft and the rock socket.

A. Synthetic Slurry Technical Assistance

1. If synthetic slurry is used, either a manufacturer's representative or a Contractor's employee trained in the use of the synthetic slurry, as approved by the Engineer in accordance with subsection 3.02.C of this Special Provision, shall provide technical assistance for the use of the synthetic slurry, shall be at the site prior to introduction of the synthetic slurry into a drilled hole, and shall remain at the site during the construction and completion of a minimum of one shaft to adjust the slurry mix to the specific site conditions.

B. Minimum Level of Slurry in the Excavation

1. If the Contractor uses slurry in shafts installed below groundwater and in caving or sloughing soils, the slurry level in the excavation shall be monitored and maintained at the greater of the following elevations:

a. No lower than the water level elevation outside the shaft.

b. Elevation as required to provide and maintain a stable hole.

c. Sufficient distance above all unstable zones to prevent bottom heave, caving or sloughing of those zones

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

C. Slurry Sampling and Testing

1. Mineral slurry and synthetic slurry shall be mixed and thoroughly hydrated in slurry tanks, ponds, or storage areas. The Contractor shall draw sample sets from the slurry storage facility and test the samples for conformance with the appropriate specified material properties before beginning slurry placement in the drilled hole. Mineral and synthetic slurries shall conform to the quality control

plan included in the shaft installation plan in accordance with subsection 3.02.B.5, and shall conform to the materials requirements in subsections 2.04 A and 2.04.B of this Special Provision, respectively, and as approved by the Engineer. A sample set shall be composed of samples taken at mid-height and within 2 feet of the bottom of the storage area.

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

3. Sample sets of all slurry, composed of samples taken at mid-height and within 2 feet of the bottom of the shaft, shall be taken and tested during drilling as necessary to verify the control of the properties of the slurry. As a minimum, sample sets of synthetic slurry shall be taken and tested at least once every four hours after beginning its use during each shift. Sample sets of all slurry shall be taken and tested at least once every two hours if the slurry is not recirculated in the drilled hole or if the previous sample set did not have consistent specified properties. The sand content test need only be performed immediately prior to placing concrete in the shaft. All slurry shall be recirculated, or agitated with the drilling equipment, when tests show that the sample sets do not have consistent specified properties.

4. Sample sets of all slurry, as specified, shall be taken and tested prior to final cleaning of the bottom of the hole and again just prior to placing concrete. Cleaning of the bottom of the hole and placement of the concrete shall not start until tests show that the samples taken at mid-height and within 2 feet of the bottom of the hole have consistent specified properties.

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

3.05 Assembly And Placement of Reinforcing Steel

A. The reinforcing cage shall be rigidly braced to retain its configuration during handling and construction. Individual or loose bars shall not be permitted. The Contractor shall show bracing and any extra reinforcing steel required for fabrication of the cage on the shop drawings.

B. The reinforcement shall be carefully positioned and securely fastened to provide the minimum clearances shown in the Plans, and to ensure that no displacement of the reinforcing steel bars occurs during placement of the concrete. The Contractor shall submit details of the proposed reinforcing cage spacers along with the shop drawings in accordance with Section 3.02.B.6.

C. Shaft excavation shall not be started until the Contractor has received approval from the Engineer for the reinforcing steel spacers that will be required to maintain the minimum concrete cover during installation of the reinforcement cage in the drilled shaft.

D. For drilled shafts with a specified minimum penetration into the bearing layer, the Contractor shall furnish each shaft steel reinforcing bar cage 20 percent longer than indicated by the elevations shown in the Plans. The Contractor shall add the increased length to the bottom of the cage. The Contractor shall trim the shaft steel reinforcing bar cage to the proper length prior to placing it into the excavation. If trimming the cage is required and access tubes for Crosshole Sonic Log (CSL) testing are attached to the cage, the Contractor shall either shift the access tubes up the cage, or cut the access tubes provided that the cut tube ends are adapted to receive the watertight cap as specified.

3.06 Access Tubes for Crosshole Sonic Log (CSL) Testing

A. The Contractor shall install vertical access tubes for Crosshole Sonic Log (CSL) testing in all drilled shafts to permit access for the Crosshole Sonic Log (CSL) test probes.

B. The Contractor shall securely attach the access tubes to the interior of the reinforcement cage of the shaft. One access tubes shall be installed for each approximately 2.75 feet of cage circumference in each shaft at evenly spaced intervals around the reinforcement cage.

C. The access tubes shall be installed in straight alignment and as near to parallel to the vertical axis of the reinforcement cage as possible. The access tubes shall extend from the bottom of the reinforcement cage to at least 3 feet above the top of the shaft. The Contractor shall furnish access tubes for each reinforcement cage increased by 20 percent of the length indicated by the elevations shown in the Plans. Joints required to achieve full length access tubes shall be watertight. The Contractor shall clear the access tubes of all debris and extraneous materials before installing the access tubes. Care shall be taken to prevent damaging the access tubes during reinforcement cage installation operations in the shaft excavation.

D. The access tubes shall be filled with potable water immediately before concrete placement, and the top watertight caps shall be reinstalled.

3.07 Placing Concrete

A. Concrete placement shall commence immediately after completion of excavation of a shaft by the Contractor and inspection by the Engineer, and as directed by the Engineer. Immediately prior to commencing concrete placement, the shaft excavation shall conform to the requirements of subsection 3.03 F, and the properties of the slurry (if used) shall conform to subsection 3.04 of this Special Provision. Also, immediately prior to concrete placement, slurry sand content (if used) shall be checked and meet requirements of subsection 2.04. Concrete placement shall continue in one operation from the bottom to the top of the shaft, or as shown in the Plans.

B. The Contractor shall use a concrete pump or tremie to place concrete into the shaft. The tremie shall have a hopper at the top that empties into a watertight tube at least 8 inches in diameter. If a pump is used, a watertight tube shall be used with a minimum diameter of 4 inches. The discharge end of the tremie or concrete pump shall include a plug device to seal water out of the tube prior to placement of the concrete, or an effective “pig type” device that shall pass through the concrete tube immediately ahead of the initial charge of concrete. Rigid steel pipes are required for at least the lower 18 feet of the concrete

pump tube or tremie tube. Rubber type hoses are not allowed for the lower 18 feet of the tubes.

To prevent possible racking of the reinforcement cage during upward or downward movements of the concrete pump piping, the vertical watertight concrete pump tube shall be long enough so that the elbows of the concrete pump piping do not extend into the inside diameter of the reinforcement cage during concrete placement.

C. The initial charge of concrete shall be large enough to displace the water, or slurry, and embed the bottom of the tremie or concrete pump tube so that water or slurry can not enter the bottom of the tube. Throughout the underwater or slurry concrete placement operation, the discharge end of the tube shall remain submerged in the concrete at least 8 feet and the tube shall always contain enough concrete to prevent water from entering. The concrete placement shall begin within 1 foot of the bottom of the drilled hole and be continuous until the work is completed, resulting in a seamless, uniform shaft. During concrete placement, the Contractor shall monitor and maintain the difference in concrete level inside and outside of the reinforcing steel cage at 1 foot or less. If the concrete placement operation is interrupted, the Engineer may require the Contractor to prove by CSL testing, core drilling or other tests that the shaft contains no voids or horizontal joints. If testing reveals voids or joints, the Contractor shall repair the voids or joints, or replace the shaft, at the Contractor's sole expense.

D. During underwater concrete placement, the Contractor shall collect and dispose of any water or slurry that flows out of the top of the permanent casing in accordance with the applicable requirements of Section 107 of the Standard Specifications.

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

F. The Contractor's construction operation in the vicinity of a drilled shaft excavation with freshly placed concrete and curing concrete are subject to the following restrictions:

1. The Contractor shall not place or advance a casing, or perform drilling, within four shaft diameters or 30 feet of the centerline of the concreted shaft, whichever is greater, during the time period between six hours after beginning concrete placement operations and eight days after completing concrete placement operations, except after satisfying one of the following conditions:

   a. The compressive strength of the concrete in the concreted shaft shall have reached 3000 psi. The Contractor shall obtain and test concrete test cylinders for this early concrete strength measurement in accordance with Section 502.01(A) of the Standard Specifications.

   b. The Contractor shall implement a shaft vibration monitoring plan as follows:

      (1). The Contractor shall submit a shaft vibration monitoring plan to the Engineer for approval, including a description of the monitoring

equipment, the calibration records for the monitoring equipment and the installation and monitoring procedure.

(2). The Contractor shall furnish and install monitoring equipment in accordance with the shaft vibration monitoring plan as approved by the Engineer. The Contractor shall locate the monitoring sensor at the concreted shaft and on a line between the concreted shaft and the construction operation within the specified boundary causing the vibration. The monitoring equipment shall be sensitive enough to detect a peak particle velocity of ¼ inch per second.

(3). The Contractor shall cease all construction operations within the specified boundary when monitoring equipment detects Peak Particle velocities exceeding the following values:

Concrete Age	Peak Particle Velocity
6 hours to 72 hours	¼ inch per second
72 hours to 8 days	2 inches per second

(4). The Contractor shall furnish, install, and operate the monitoring equipment at no additional expense to the State.

3.08 Casing Removal

A. Permanent casings for the shafts shall be cut off at the elevations shown on the Plans, unless directed otherwise by the Engineer.

B. The Contractor shall completely remove all temporary casings.

3.09 Nondestructive Testing of Shafts - Crosshole Sonic Log (CSL) Testing

A. The Contractor shall provide for Crosshole Sonic Log (CSL) testing and analysis on all completed shafts, or as directed by the Engineer. The purpose of the testing is to determine the presence of voids, intrusions, or zones of unconsolidated concrete in the drilled shaft. The testing and analysis shall be performed by the independent testing organization submitted by the Contractor and approved by the Engineer in accordance with subsection 3.02.D of this Special Provision.

The testing shall be performed after the shaft concrete has cured at least 48 hours. Additional curing time prior to testing may be required if the shaft concrete contains admixtures, such as set retarding admixture or water reducing admixture, added in accordance with Section 502. The additional curing time prior to testing required under these circumstances shall not be grounds for additional compensation or extension of time to the Contractor.

B. After placing the shaft concrete and before beginning the Crosshole Sonic Log (CSL) testing of a shaft, the Contractor shall inspect the access tubes. Each access tube that the test probe cannot pass through shall be 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, cored holes shall be located approximately 6 inches

inside the reinforcement and shall not damage the shaft reinforcement. Descriptions of inclusions and voids in cored holes shall be logged and a copy of the log shall be submitted to the Engineer. The cores from the cored holes shall be preserved, identified as to location, and submitted to the Engineer for inspection.

C. The Contractor shall submit the results and the analysis of the Crosshole Sonic Log (CSL) testing for each shaft tested to the Engineer for approval. The Engineer will determine final acceptance of each shaft, based on the Crosshole Sonic Log (CSL) test results, analysis for the tested shafts, visual inspection and installation field records, and will provide a response to the Contractor within two working days after receiving the test results and analysis submittal.

D. The Contractor may commence subsequent shaft construction prior to receiving the Engineer's approval and acceptance of the first drilled shaft constructed, provided that the following conditions are satisfied:

1) Subsequent shaft excavations meet the requirements of subsection 3.07.G.1 and will remain stable prior to acceptance and approval of the first drilled shaft.

2) The Engineer approves continuing of the 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 the Contractor's daily reports and the inspector's daily logs concerning excavation, drilled shaft steel reinforcing bar placement and concrete placement.

If the CSL testing on any shaft constructed after the first shaft indicates the presence of defects, the drilled shaft reinforcement or concrete shall not be placed in any subsequent drilled shaft excavations until after receiving the Engineer's approval.

E. If the CSL testing indicates the presence of defects, the Engineer may require coring of the shaft as described in subsection 3.09.H, or additional testing of the shaft may be performed at the Contractor's option.

F. All testing shall be performed prior to demobilization by the Contractor of any equipment and personnel deemed necessary to perform any remedial action if required. For all shafts determined to be unacceptable, the Contractor shall submit a plan for remedial action to the Engineer for approval. All modifications to the dimensions of the shafts, as shown in the Plans, required by the remedial action plan shall be supported by calculations and working drawings as specified in Section 105.02. All remedial correction procedures and designs shall be submitted to the Engineer for approval. The Contractor shall not begin repair operations until receiving the Engineer's approval of the remedial action plan.

The remedial action plan shall include the following:

1. The location of the shaft(s) addressed by the remedial action plan.
2. A review of the structural and geotechnical requirements of the rejected shaft.
3. A step by step description of the remedial work to be performed, including drawings.
4. An assessment of how the proposed remedial work will address the structural and geotechnical requirements of the rejected shaft.
5. A list of materials with quantity estimates, and personnel with qualifications, to be used to perform the remedial work.

6. The seal and signature of a licensed professional engineer licensed in the State of Idaho.
7. The proposed location and size of additional shafts, if required.
8. Structural details and calculations for any modification to the structure to accommodate the replacement or supplemental shaft.

The contractor shall repair, replace, or supplement the defective shaft as approved by the Engineer, at the Contractor's sole expense.

G. If the Engineer determines that the concrete placed under slurry for a given shaft is structurally inadequate, that shaft will be rejected. The Contractor shall submit to the Engineer for approval a mitigation plan for supplementation or replacement of the rejected shaft supported by calculations and working drawings as specified above and in Section 105.02. The placement of concrete under slurry shall be suspended until the Contractor submits to the Engineer written changes to the methods of shaft construction needed to prevent future structurally inadequate shafts, and receives the Engineer's written approval of the submittal.

H. At the Engineer's direction, a corehole shall be drilled in any shaft of questionable quality (as determined from Crosshole Sonic Log (CSL) testing and analysis, or by observation of the Engineer) to explore the shaft condition.

If the Engineer requires coring based on CSL testing results or other data or information, and a defect is not identified by the coring, those coring costs associated with this specific request will be paid as extra work in accordance with section 109.03 of the standard specifications, and, if the shaft construction is on the critical path of the Contractor's schedule, compensation for the delay attributable to the coring will be granted by an appropriate time extension in accordance with Section 108.06 of the standard specifications.

Should any coring confirm defects, the coring shall be at the Contractor's expense, and there shall be no extension of time granted for the coring or for required corrections or repairs of the defects. Materials and work necessary, including engineering analysis and redesign, to effect corrections for shaft defects shall be furnished to the Engineer's satisfaction at no additional cost to the Engineer.

I. All access tubes and cored holes shall be dewatered and filled with grout after tests are completed. The access tubes and cored holes shall be filled using grout tubes that extend to the bottom of the access tube or hole or into the grout already placed.

Method of Measurement. Measurement for drilled shafts will be made by the foot for the length of the permanent casing and for the rock socket portions of the drilled shafts. The cost of each unit shall include all excavation, hauling and disposal of excavated material, casing, reinforcing steel, access tubes, concrete, and other elements of the completed shafts in place. The cost of each unit shall include all labor, materials, supplies, equipment necessary to complete all aspects of the drilled shaft construction and testing.

Removal of Obstructions, if required, will be measured by contingency amount and shall include disposal as specified in subsection 3.03 G of this Special Provision.

Cross hole sonic log tests shall be measured by one test per each shaft.

Basis of Payment. Payment for accepted work will be made as follows:

Pay Item	**Pay Unit**
SP-XX Bridge – Pier Drilled Shaft 8.5 FT Diameter	Feet
SP-XX Bridge – Pier Drilled Shaft 8.0 FT Diameter – Rock Socket	Feet
SP-XX Bridge – Abutment Drilled Shaft 5.5 FT Diameter	Feet
SP-XX Bridge – Abutment Drilled Shaft 5.0 FT Diameter – Rock Socket	Feet
SP-XX Bridge – Drilled Shaft - Crosshole Sonic Log (CSL) Test	Each
SP-XX Bridge – Drilled Shaft - Removal of Obstructions	CA