DRILLED SHAFT FOUNDATION

CONSTRUCTION INSPECTION MANUAL

Louisiana Department of Transportation and Development
Pavement & Geotechnical Design

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DRILLED SHAFT INSPECTION

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INTRODUCTION

The drilled shaft inspection manual will help the inspector understand the proper construction procedures necessary for inspecting and installing a drilled shaft foundation. This manual may be used as a guide for the construction of test drilled shafts and production drilled shaft foundations. It will give the inspector a better understanding of the construction requirements using the specifications under section 814, Drilled Shaft Foundations, of the Louisiana Department of Transportation & Development Standard Specifications for Roads & Bridges, 2000 edition. The inspector should read and follow the project specifications.

Drilled shafts are construction sensitive foundations and require thorough inspection. Drilled shafts are unlike driven piling, where capacity can be monitored with each blow of the hammer. During drilled shaft construction, the capacity and integrity of the shaft cannot be readily checked as it is being constructed. The inspector's job is to insure that the proper construction procedures and testing procedures are being followed. Also, if the field conditions warrant any deviations from the plans, the inspector must insure that the deviations are within acceptable limits.

All of these construction factors determine the integrity and safety of the drilled shaft foundation. Without proper construction, inspection, and design, a drilled shaft foundation may cause serious injury to the public.

TERMS & DEFINITIONS

The following terms may be encountered when working with drilled shafts.

ACCESS TUBES - Access tubes are needed to perform the crosshole sonic logging (CSL) test. The tubes are also used as a guide for the source and receiver from the CSL testing equipment. A minimum of two, 2" tubes filled with water, are needed to perform the CSL test for a drilled shaft. (shown in Fig. A-3)

AIR LIFT - An air lift is a device that uses air pressure to suck water and soil from the shaft bottom. An air line is run to the bottom of a pipe called an air lift pipe. Inside the bottom of the air lift pipe the air is discharged upward causing the water in the pipe to flow upward, discharging out of the top of the pipe. As water flows upward it draws in more water at the bottom of the pipe creating a suction. This pulls the finer material up with the water, cleaning the bottom.

ARTESIAN PRESSURE - Artesian pressure is the ability of water, located under a confining layer, to rise to the surface if the confining layer is removed or disturbed.

CASING - Casing is used to help hold the drilled shaft excavation open and is usually made of spiral welded steel pipe.

CENTRIFUGAL PUMP - A centrifugal air pump is usually used to pump slurry to and from the slurry holding tank.

CLEANOUT BUCKET - The cleanout bucket is used to remove material located at the bottom of the shaft. The bucket typically has a bottom that opens up when turned clockwise and closes when turned counterclockwise. (shown in Fig. A-1)

CONCRETE PUMP - A concrete pump is used to pump concrete from one point to another and is usually done with a pump truck. The concrete pump lines must be a minimum of four inches in diameter.

CROSS HOLE SONIC LOGGING TEST - The cross hole sonic logging (CSL) test is a nondestructive testing method used to check the integrity of the concrete placed in drilled shafts. The CSL test measures the time it takes for an ultrasonic pulse to travel from a source in one access tube to the receiver in another access tube. The CSL results are plotted graphically. (shown in Fig. A-5)

CYCLONES - Cyclones are used in the desander to remove sand and fine silt particles suspended in the slurry. They are usually located on the slurry storage tank near the vibrating screens.

DESANDER - A desander is a machine used to reduce the sand content of the drilling slurry. The drilling slurry is circulated through the sander which removes the sand that is held in suspension in the slurry. (shown in Fig. A-6)

TERMS & DEFINITIONS

DRILLING TOOLS - Drilling tools are the tools used at the end of the kelly bar to excavate the soil. For Louisiana soils, they usually consist of a soil auger and a cleanout bucket. (shown in Figures A-1 & A-2)

ELECTRIC SUBMERSIBLE PUMP - The electric submersible pump is lowered into the slurry to the bottom of the drilled shaft where it pumps the slurry and suspended material from the bottom of the shaft to the desander or waste tank.

END BEARING - End bearing is the amount of capacity that is contributed by the end of the drilled shaft. This portion of the capacity can be used for compressive loads.

HYDRAULIC PUMP - The hydraulic pump is also used to pump slurry from the bottom of the drilled shaft. It performs the same functions as the electric submersible pump except it is hydraulic.

KELLY BAR -The kelly bar is located on the drill rig and transfers the force from the drive motor to the drilling tool (soil auger, cleanout bucket). The kelly bar is also used to raise and lower the drilling tool in the shaft. It may be solid or hollow with two are more bars telescoping inside of each other. This telescoping ability, allows excavation to greater depths than the boom height would otherwise allow. (shown in Fig. A-9)

NECKING - Necking is the reducing of the shaft diameter. This can be caused by soil falling into the shaft during concrete placement when the concrete fails to displace the soil up & out of the shaft.

OVER REAMING - Over reaming removes slurry cake buildup, clay smears, and softened soils along the walls of the shaft. The soil softening is a result of the soils absorbing moisture from the slurry mix. The removal of the slurry and soft soils is done to increase the skin friction of the shaft sides.

PIEZOMETRIC HEAD - Piezometric head is the height the water would stabilize in an open pipe. For example, if a drilled shaft is constructed and the water height stabilizes at elevation +15, then elevation +15 is the piezometric head. Different soil layers have different piezometric heads.

PIG - A pig is a device used to seal the end of the tremie pipe or pump line to prevent slurry from entering the line and contaminating the concrete. A thick sponge is usually used for this task. A pig is shown in Figure A-16.

SKIN FRICTION - Skin friction is the portion of capacity the drilled shaft gets from the soil along the sides of the shaft. This capacity can be used for compressive and tension loads.

TERMS & DEFINITIONS

SLURRY - Slurry is the liquid used to help support the shaft sides during excavation and allow acceptable concrete placement when water seepage into the drilled shaft is too severe to permit concreting in the dry. Slurry may be water, a manufactured drilling slurry (water & bentonite or water & polymer), or water and the natural soils mixed together. (shown in Figures A-7 & A-8)

SLURRY CAKE - A membrane formed by the slurry at the walls of the shaft. This membrane acts to prevent caving and forms and impermeable layer at the shaft walls.

SOIL AUGER - The soil auger is used for cutting and removing the soil from the shaft volume. It typically has several flights of 30 degrees or less. (shown in Figures A-2 & A-8)

SHELBY TUBE - A thin-walled tube mechanically pushed in the ground to obtain clay soil samples. Usually used with most boring crews.

SPACERS - Spacers are used to keep the steel cage centered in the drilled shaft and insure proper concrete cover during placement. The spacers may be concrete wheels, plastic wheels, or other approved non-corrosive devices. (shown in Fig. A-10)

STANDARD PENETRATION TEST - Standard Penetration Test (SPT) samples the soil for classification and provides an indication of the relative density in non-cohesive soils and consistency in cohesive soils.

TEST HOLE - The contractor must use a test hole to demonstrate that his construction methods and equipment are sufficient for the job. A test hole is typically the same size as the shaft.

TREMIE PIPE - The tremie pipe is used to place concrete in the drilled shaft. In shafts constructed by the dry method, the tremie pipe must extend to within five feet from the shaft bottom. In shafts constructed by the wet method, the tremie pipe must extend to the bottom of the drilled shaft. The tremie pipe transports concrete through the slurry and keeps the concrete from segregating during concrete placement. It also keeps the concrete from mixing with the drilling slurry at the slurry/concrete interface. (shown in Fig. A-11)

VIBRATING SCREENS - Wire mesh vibrating screens are usually located on the slurry storage tank, and are used to sieve the suspended sands and silts from the slurry. The screens are located under the cyclones, which remove the sandy material from the slurry. The sieved material or waste is deposited at the side of the slurry tank and removed from the site.

CONSTRUCTION DOCUMENTATION

I. MINERAL SLURRY FORM

The mineral slurry form gives information on the type of slurry used for construction and the size and type of the mineral storage tank. It also indicates the type of recycling unit used for desanding the slurry. It shows the testing properties needed for testing slurry and the testing frequency during construction. Slurry testing procedures are shown in Figures A13 - A15.

II. EXCAVATION LOG FORM

The soil boring log(s) in the vicinity of the shaft should be reviewed before starting shaft excavation. This will familiarize the inspector with the general soil types, which should be encountered during excavation. The soil excavation log form provides information on the types of soils encountered during drilling. If the excavated soil does not match the boring(s), shaft capacity problems may develop and the project engineer should be notified. These forms are helpful in evaluating soil problems that may occur during shaft excavation and also serve as documentation for drilled shaft construction.

III. CONCRETING PROCEDURES & RESULTS FORM

This form is a log of the amount of concrete placed during construction of the drilled shaft. It indicates the placement methods and line volumes of the concrete pump truck. It documents various information such as arrival time of the concrete truck, the start of concrete placement, and the end of concrete placement. The information documented on this form may be used to plot the theoretical concrete volume vs. actual concrete volume in the shaft. The volumes may be plotted against depth using the drilled shaft construction form.

IV. DRILLED SHAFT CONSTRUCTION FORM

This form may be used to graph the theoretical volume of concrete vs. the actual volume of concrete used in the shaft. If the actual concrete volume is running more than theoretical, this may indicate that the shaft sides have caved in during excavation or a void was encountered. This would appear as an increase in the shaft cross-sectional area. If the actual concrete volume is running less than the theoretical, the sides of the drilled shaft above that point may have caved in after completion of the excavation and the cleaning of the shaft. This would give a reduction in the cross-sectional area. This would indicate that proper concrete cover on the rebar is not being met and necking has occurred. This form may also be used to compute the drilled shaft diameter. An example of theoretical volume vs. actual volume and actual shaft

CONSTRUCTION DOCUMENTATION

diameter vs. theoretical shaft diameter is shown in Appendix D. Blank forms along with example forms are shown in Appendix D.

SHAFT CONSTRUCTION

There are three main methods for constructing drilled shafts. The dry method, wet method, and the casing method. The dry method consists of shaft construction without the use of a slurry. The wet method consists of shaft construction with the use of a mineral or polymer slurry. Using the casing method, either temporary or permanent casing is driven into the soil. The soil is then excavated out of the casing using either the wet or the dry method depending on the site conditions. A combination of casing and dry or casing and wet methods may be used. A temporary surface casing may also be used to prevent caving of the surface soils and aid in maintaining shaft alignment.

I. WET METHOD

The wet construction method consists of drilling the shaft excavation below the water table, keeping the shaft filled with slurry, desanding and cleaning the slurry, and cleaning the bottom of the shaft using a cleanout bucket or other approved devices. During this type of construction, concrete is placed in the shaft bottom using a tremie, which displaces the slurry as the concrete is pumped in the shaft.

II. SLURRY

A mineral or polymer slurry may be used in the wet construction drilling process. The purpose of the slurry is to support the shaft sides during excavation and allow acceptable concrete placement when water seepage is severe.

A positive head must be maintained at all times (a minimum of 5 ft./1.5 m above the highest piezometric head). This positive head maintains a confining pressure on the shaft sides, which helps hold them in place during excavation. If the slurry is allowed to drop below the piezometric head, a negative head is produced. A negative head creates an inward pressure, which may cause the shaft sides to cave in. Therefore, it is very important not to allow a negative head to occur in the shaft.

An additive (mineral or polymer) is added to the water to reduce the permeability of the various soil layers, such as sand and silt, and increase the density of the fluid. This reduces the amount of fluid loss into the soils along the shaft walls, making it easier to maintain the required fluid head.

SHAFT CONSTRUCTION

The drilling fluids should be premixed thoroughly with clean fresh water prior to introduction into the shaft. When using a polymer slurry, a water hardness test should be performed prior to mixing to meet the manufacturer's water requirements. The drilling fluids should be introduced before encountering the water table in order to prevent caving in. Once the drilled shaft sides begin to cave in, the drilling fluids are not as effective in maintaining the shaft side stability.

The slurry, proposed by the contractor, may be used in a test hole to evaluate the slurry's performance during the drilled shaft excavation. The contractor's procedures for mixing and testing the slurry should be submitted in the Drilled Shaft Installation Plan and approved before construction.

The slurry should be in contact with the bottom 5 ft.(1.5m) of the shaft for a maximum of 12 hours. If this time is exceeded, over reaming of the shaft may be necessary.

Polymer and mineral specifications are shown below in Tables 1A & 2A respectively.

TABLE 1A - POLYMER SLURRY SPECIFICATIONS

Property (Units)	At Time of Slurry Introduction	In Hole at Time of Concreting	Test Method
Density	995 – 1018 kg/m^3 (62.1 – 63.5 pcf) (fresh water)	1000 – 1018 kg/m^3 (62.4 – 63.5 pcf) (fresh water)	Mud Balance (API 13B- Sec 1)
Viscosity (minimum)	45 sec/.95 liter (45 sec/quart)	45 sec/.95 liter (45 sec/quart)	Marsh Funnel (API 13B- Sec 2)
pH	8 – 10	8 - 10	pH Paper pH Meter (API 13B-Sec6)
Max. Sand Content (% by Volume)	1	1	Sand Screen Set (API 13B- Sec 4)

SHAFT CONSTRUCTION

TABLE 2A - MINERAL SLURRY SPECIFICATIONS

Property (Units)	At Time of Slurry Introduction	In Hole at Time of Concreting	Test Method
Density	1030 – 1107 kg/m^3 (64.3 - 69.1pcf) (fresh water)	1030 – 1202 kg/m^3 (64.3 – 75.0 pcf) (fresh water)	Mud Balance (API 13B- Sec 1)
Viscosity	28 – 45 sec/.95 liter 28 – 45 sec/quart	28 – 45 sec/.95 liter 28 – 45 sec/quart	Marsh Funnel (API 13B- Sec 2)
pH	8 - 11	8 – 11	pH Paper pH Meter (API 13B- Sec 6)
Max. Sand Content (% by Volume)	4	4	Sand Screen Set (API 13B- Sec 4)

NOTE: The slurry shall not stand for more than 4 hours in the excavation without agitation.

III. DRY METHOD

The dry construction method shall be used only at sites where it is feasible to construct a dry excavation with stable sides and a stable bottom. This usually occurs in stiff to hard clays above the water table. When using the dry method, a seepage amount of 12 inches (300mm) or less is allowed to collect in the bottom of the shaft over a 4-hour period. If the flow or seepage rate is greater than this, the contractor is required to switch to the wet method of installation.

IV. CASING METHOD

A temporary removable surface casing may be required to prevent caving of the surface soils but will not be required if the contractor demonstrates the casing is not needed. The contractor may elect to use casing all the way to the bottom of the shaft or only part of the way. The casing can be used to help penetrate loose soils and voids. This is done where the slurry method may not be sufficient to maintain the sides of the shaft from caving in. It can also be used to seal off an upper water table to allow the shaft to be constructed by the dry method.

SHAFT CONSTRUCTION

Typically, the casing is either vibrated into the soil or screwed in with downward pressure. Once the casing is in place, the contractor then excavates the soil inside the casing.

I. GENERAL REQUIREMENTS FOR BOTH WET AND DRY METHODS

A. ALIGNMENT PLUMBNESS TOLERANCE

The vertical alignment shall be within 1.5 % plumb. The top elevation of the shaft concrete shall be within 2 inches of the top of the plan shaft elevation. For shafts supporting a single column, the center of the top of the shaft shall not vary more than 3 inches. Tolerances for all other drilled shafts are shown below:

Drilled Shaft Diameter	Horizontal Tolerance
D $\leq$ 2' (600mm)	3" (75mm)
2' (600mm) < D $\leq$ 3' (900mm)	3.5" (90mm)
3' (900mm) < D $\leq$ 4' (1200mm)	4" (100mm)
D $\geq$ 4' (1200mm)	6" (150mm)

B. DRILLING

Drilling is normally done with an auger. The auger is screwed into the soil then pulled up with the material retained on the auger flights. The driller should not take too large of a bite with the auger or a suction may be created below the auger. A suction acts like a negative head. It can cause the shaft walls to cave in or disturb the soils on the shaft bottom. Check alignment and plumbness of the shaft against the tolerances discussed under Drilled Shaft Construction Tolerances, 814.17.

C. SHAFT CLEANING

Once the shaft has been excavated to the proper depth, the bottom of the shaft is cleaned. A cleanout bucket is usually used for this task. If further cleaning of the shaft is needed, either an air lift pump or submersible pump is used in shafts using the wet method. An air lift pump should not be used in shafts with sand bottoms because the air lift may loosen the sands and decrease the bearing capacity.

D. REBAR CAGE

Once the shaft is cleaned and accepted, the rebar cage is lowered into place. The rebar cage steel must be sufficiently tied so that it will not deform or rack when it is picked up and set into place. Temporary H beams or stiffeners may be used for lifting the cage to prevent cage deformation.

SHAFT CONSTRUCTION

The cage must be held in the proper position both vertically and horizontally. As the concrete is poured, the concrete may try to lift the cage. This would require the rebar cage to be tied down as well as held up. The side spacers should be made of concrete or a non-corrosive material and should not break as the cage is lowered in the hole. The spacers should also hold the cage centered in the shaft as concrete is placed to insure proper concrete cover.

A minimum of one spacer, per 3 ft.(900mm) of circumference of cage, with a minimum of 3 spacers at each level is required. For longitudinal reinforcement less than 1 in.(25mm) in diameter, spacers shall be placed at intervals not exceeding 5 ft.(1.5m) along the shaft. For longitudinal reinforcement greater than 1 in. in diameter, spacers shall be placed at intervals not exceeding 10ft.(3m) along the shaft.

When rebar cages must be spliced, a lap splice or mechanical butt splice device may be used to attach additional longitudinal reinforcement in accordance with Sec. 806.

E. CONCRETE TIME LIMITS

The time from beginning to completion of concrete placement in the drilled shaft shall not exceed 2 hours for drilled shafts less than 5 ft.(1.5m) in diameter, unless approved by the engineer. The minimum concrete placing rate for drilled shafts 5 ft. and larger in diameter shall be 30 yd^3 (23 m^3) per hour.

F. CONCRETE PLACEMENT

Before placing concrete in the shaft, the shaft shall be excavated to the correct elevation, cleaned using a cleanout bucket, and inspected. After inspection, the reinforcing cage should be placed in the shaft and set at the proper elevation and location. A slurry test is required before placement of the concrete. (The slurry test is usually done right before the cage is placed in the shaft) Concrete shall be continuous for the shaft length and should continue to be placed until good, clean concrete is over flowing from the top of the shaft. This will insure quality concrete in the shaft.

Using the wet method of construction, concrete placement shall begin with the tremie pipe on the bottom of the drilled shaft. The tremie pipe's end should be sealed with a pig or other device until the tremie and hopper, or pump line is charged with concrete. The tremie pipe is then slowly raised until the concrete flows out, then it is quickly set back on the shaft bottom until the hopper is refilled. This continues until the contractor can maintain concrete in the hopper.

There must always be a minimum head of 5 ft. (1.5m) of concrete above the bottom of the tremie pipe or pump line end. The concrete head keeps the water and slurry from mixing with the concrete and allows the concrete to push out the

SHAFT CONSTRUCTION

water, slurry, and soil from the shaft. It also scours the drilled shaft sides of loose material and thin slurry buildup.

APPENDIX A

FIELD INSPECTION PICTURES

Figure A-1: Drilled Shaft Cleanout Bucket

Figure A-2: Drilled Shaft Soil Auger or Flight Auger

Figure A-3: 4-PVC CSL Access Tubes & 4" Steel Tremie pipe

Figure A-4: 3' Diameter Test Drilled Shaft

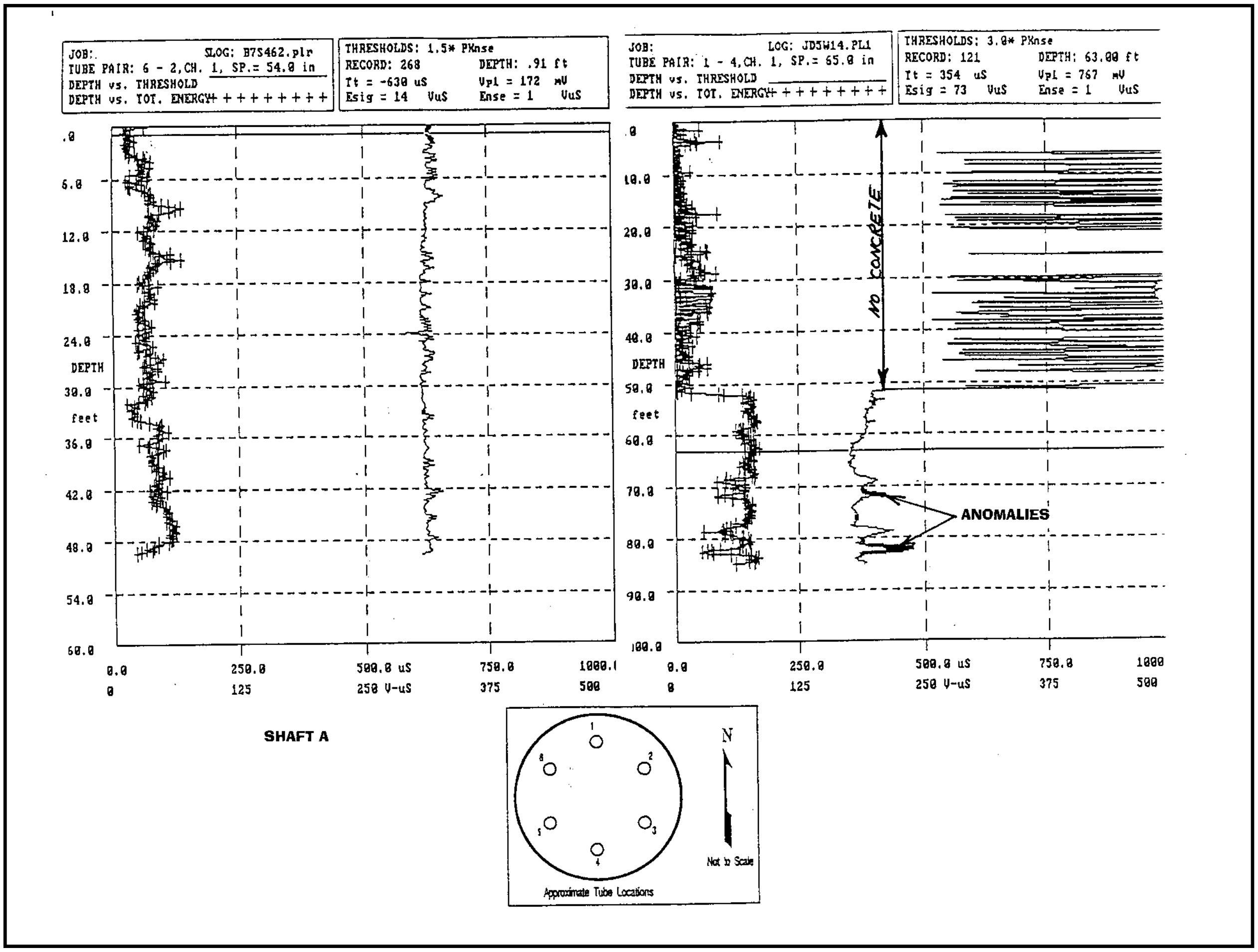

Figure A-5: CSL Test Results

Figure A-6: Slurry Tank(yellow tank) & Desander .The desander is the device that looks like an engine on the top of the tank. Notice the auger and cleanout bucket being unloaded off the truck.

Figure A-7: 3' Drilled Shaft Hole with Bentonite Slurry in hole.

Figure A-8: Drilling shaft with polymer slurry.

Figure A-9: The front-end loader removes excavated material while the Kelly Bar places the auger in the hole.

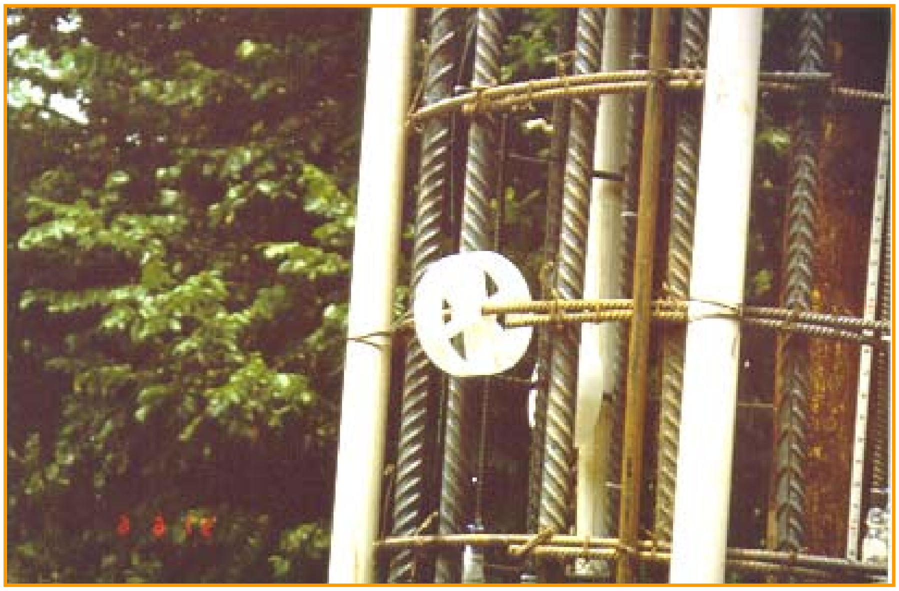

Figure A-10: Rebar Cage with Plastic Spacers attached to spiral reinforcing bars

Figure A-11: Tremie Pipe and Test Shaft instrumentation.

Figure A-12: Cone Slurry Density sampler.

Figure A-13: Marsh Funnel Viscosity Test

Figure A-14: Testing the slurry for sand content

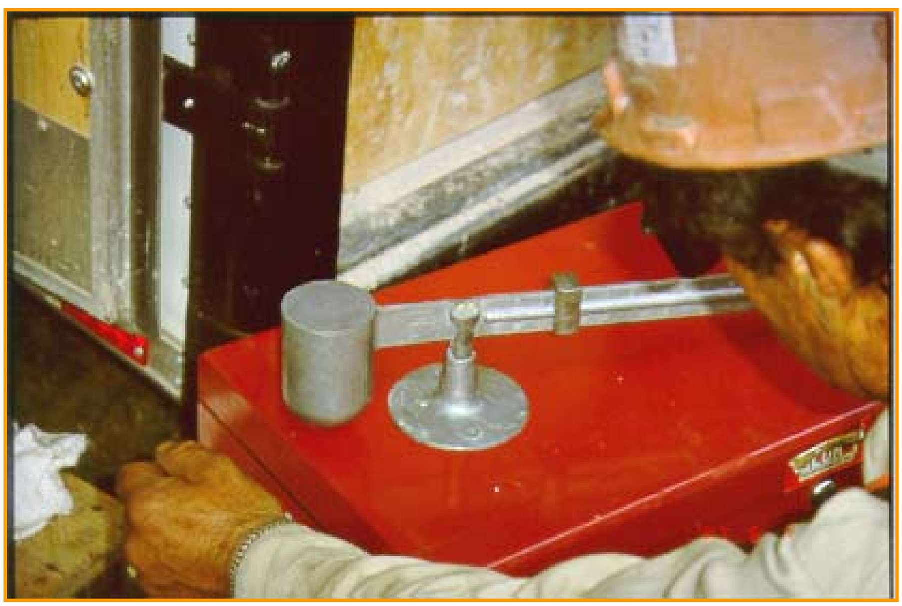

Figure A-15: Testing the density of the Bentonite Slurry

Figure A-16: Installing the PIG in the Tremie Pipe

Figure A-17: View on top of test shaft as the rising concrete approaches the surface.

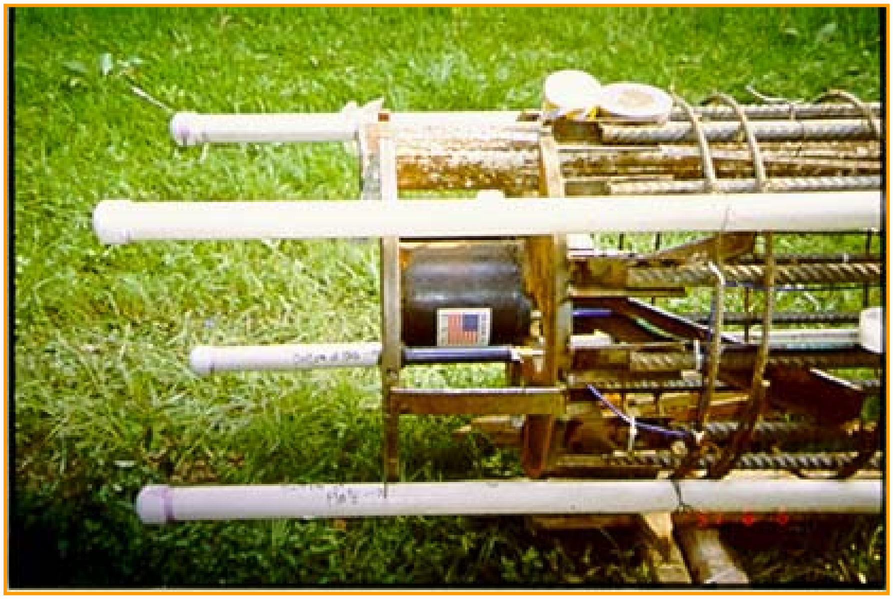

Figure A-18: Osterberg Load Cell shown with the CSL access tubes extended to the bottom of the shaft.

Figure A-19: Happy Drilled Shaft Foundation Contractors.

Figure A-20: The reinforcing cage is lifted into place with the crane.

Figure A-21: The Drilled Shaft reinforcing cage and access tubes are lowered into the shaft.

Figure A-22: Two types of Drilled Shaft Foundation Construction Equipment.

APPENDIX B

LADOTD CONCRETE MIX DESIGN

FOR

DRILLED SHAFTS

LADOTD CONCRETE MIX DESIGN

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CONCRETE SPECIFICATIONS FOR DRILLED SHAFTS

STRUCTURAL TYPE S CONCRETE – STRUCTURAL CLASS

* CEMENT	- minimum of 7 bags/yd^3
* WATER	- maximum of 6 gal./bag of cement
* AIR CONTENT	- 5% (range of 3% to 7%)
* SLUMP	- ranges from 6” to 8”
* COARSE AGGREGATE	- Grade A

NOTES:

The concrete shall be Class S with a water reducing, set retarding admixture.

THE MAXIMUM WATER-TO-CEMENT RATIO:

Max. Water-to-Cement Ratio = 6 gal * 8.34 lbs./gal. / 94 lbs. = .53

The maximum water-to-cement ratio shall be reduced 5% when using a water- reducing admixture. This will give you a water-to-cement ratio = .48.

The average compressive strength at 28 days = 3800 psi.

APPENDIX C

DRILLED SHAFT

SUBMITTAL REQUIREMENTS

REVIEW FORM

DRILLED SHAFT SUBMITTAL REQUIREMENTS
REVIEW FORM

I. **EXPERIENCE REQUIREMENTS** *Circle one answer below*

1) Does the contractor have 3 years of experience within the last 5 years?(Re:814.04) Y N N/A

2) Has the contractor submitted experience descriptions with names and phone numbers? Y N N/A

3) Does the on-site superintendent have 2 or more years of construction experience? Y N N/A

4) Does the Drilling Operator have 1 or more years of drilling experience? Y N N/A

Comments: ______________________________________
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DRILLED SHAFT INSTALLATION PLAN

1) Has the contractor made a list of the proposed construction equipment? Y N N/A

Comments: ________________________________
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2) Has the contractor submitted a safety plan? (Re:814.07) Y N N/A

   a) Will the contractor be using a gasoline engine within the excavation? Y N N/A

   b) Does the contractor have the proper safety equipment necessary to enter the excavation? Y N N/A

   c) Does the contractor have the proper safety lines and radio communication equipment for entering the excavation? Y N N/A

Comments:____
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d) Will the open excavations be protected using a solid cover during non-working hours? Y N N/A

e) Will a safety harness be used to lower a worker in the excavation? Y N N/A

f) Does the lighting equipment have protection against short-circuiting? Y N N/A

Comments:____
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3) Has the contractor submitted an overall construction operation sequence and a proposed sequence of shaft construction?(Re:814.09,f) Y N N/A

Comments:____
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4) Has the contractor submitted the planned shaft excavation methods and the final shaft dimensions?(Re:814.08) Y N N/A

a) Is the excavation equipment capable of excavating 16 feet below the deepest shaft shown on the plans? Y N N/A

b) Will the contractor use the Dry Construction Method? Y N N/A

c) Will the contractor use the Wet Construction Method? Y N N/A

d) Will temporary casing be used?(Re:814.08,d) Y N N/A

e) Will permanent casing be used?(Re:814.08,e) Y N N/A

f) Does the contractor specify the size of the drilling auger? Y N N/A

g) Does the contractor specify the size of the casing? Y N N/A

Comments:____
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5) Has the contractor submitted the proposed excavation contingency plans?(Re:814.09,d)	Y	N	N/A
a) Is the contractor prepared to take soil samples at the bottom of the excavation if necessary?	Y	N	N/A
b) Has the contractor submitted the type of soil sampling device that will be used?	Y	N	N/A
c) Does the contractor have a designated person assigned to identify soils during excavation to complete the excavation log?	Y	N	N/A
d) Does the contractor have a plan for dealing with bound and fouled casings?(814.11,c)	Y	N	N/A
e) Does the contractor have an installation and removal plan for casings?	Y	N	N/A

Comments:____________________________________
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6) Has the contractor submitted the details of the slurry type, mixing method, storage method, circulating & desanding method, and disposal method when using the slurry method of construction?(Re:814.12)	Y	N	N/A

Comments:____________________________________
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a) Is the proper slurry testing equipment listed to test density, viscosity, pH, & sand content?	Y	N	N/A
b) If polymer slurry is being used, does the contractor have a water hardness test scheduled for the water source?	Y	N	N/A
c) If a new polymer slurry is used, does the contractor have the information necessary for the approval request?(Re:814.12,b)	Y	N	N/A

d) If mineral/polymer slurry is used, does the contractor have the proper mixing & storage tanks along with desanding equipment? Y N N/A

e) Has the contractor submitted the method used to agitate the mineral slurry in the hole to prevent "setting up"? Y N N/A

f) Is there a person designated to complete the mineral slurry test report? Y N N/A

g) What is the brand name of polymer/mineral slurry to be used for the job? __________________________ Y N N/A

Comments:______________________________________
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7) Has the contractor submitted the proposed methods to clean the drilled shaft excavation?(Re:814.13) Y N N/A

Comments:______________________________________
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a) Does the contractor have the proper equipment for checking the dimensions & alignment of each shaft excavation? Y N N/A

b) Does the contractor specify the size and type of cleanout bucket? Y N N/A

c) Does the contractor specify an estimated time of shaft construction from beginning to completion? (Re:814.13,d) Y N N/A

Comments:______________________________________
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8) Has the contractor submitted the proposed reinforcement placement including support & centering methods? (Re:814.14) Y N N/A

Comments:______________________________________
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a) Has the contractor proposed a method for support, alignment, and tolerance of the reinforcing steel? Y N N/A

b) Does the contractor submit a size and type of spacer to be used in the excavation?(Re:814.14,d) Y N N/A

Comments:____
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9) Has the contractor submitted the proposed concrete placement methods?(Re:814.15) Y N N/A

Comments:____________________________________
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Will the contractor be using a tremie? Y N N/A

a) What size tremie will be used and does it meet the requirements in section 814.15,c-1? Y N N/A

b) Will the concrete be placed with a concrete pump? Y N N/A

c) Does the concrete pump have sufficient capacity to place the concrete within the concrete placement time limitations shown in section 814.16,e? Y N N/A

d) Does the contractor designate a concrete supplier? Y N N/A

e) Has the contractor submitted a concrete placement contingency plan?(Re:814.16,c) Y N N/A

f) What method will be used to demonstrate the performance on the concrete slump? Y N N/A

Comments:_______________________________________
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APPENDIX D

DRILLED

SHAFT

CHECK LIST

The following checklist should be followed when constructing a drilled shaft. The answer to each of these questions should be yes unless plans, specifications, or specific approval has been given otherwise.

	YES	**NO**	
			EARLY REQUIREMENTS
1.	☐	☐	Has the contractor submitted his drilled shaft installation plan (814.03,a)?
2.	☐	☐	Has the Drilled Shaft Installation Plan been approved (814.05)?
3.	☐	☐	Does the contractor have an approved concrete mix design?
4.	☐	☐	Has the contractor run the required slump loss test for his drilled shaft concrete mix design (814.16,e,1&2)?
5.	☐	☐	If concreting is estimated to take over 2 hours, has the contractor performed a satisfactory slump loss test in accordance with Section 814.15,e Concrete Placement Time Limitations ?
6.	☐	☐	If the CSL device is used, has the contractor submitted his projected drilled shaft CSL testing schedule?
7.	☐	☐	How many CSL tubes are required (814.19,d)?
			PRE-INSTALLATION REQUIREMENTS
8.	☐	☐	If the CSL device is to be used, has the contractor provided the required equipment specified in section 814.19,e CSL Test Equipment?
9.	☐	☐	Has the contractor met the requirements of 814.06 Protection of Existing Structures and Utilities?
10.	☐	☐	Does the contractor have all of the equipment and tools shown in his drilled shaft installation plan to install the drilled shaft?
11.	☐	☐	Is the contractor using a surface casing as in 814.08,a ?
12.	☐	☐	If temporary casing is to be used, is it the correct size and in accordance with section 814.11, Temporary Casing?

	YES	**NO**	
13.	☐	☐	If the contractor is planning to use a manufactured slurry, does he have the correct mixing equipment (814.12,c,2)?
14.	☐	☐	Is a desander required for the slurry (814.12,c,3)?
15.	☐	☐	If a desander is required, does the contractor have it on site and is it operational?
16.	☐	☐	Does the contractor have the proper spacers for the steel cage in accordance with section 814.14,d Reinforcing Steel Construction & Placement?
17.	☐	☐	Does the contractor have the proper amount of spacers for the steel cage (814.14,d)?
18.	☐	☐	Does the contractor have an approved method for centering and supporting the rebar cage configuration (814.14,a)?
19.	☐	☐	Does the contractor's tremie meet the requirements of section 814.15,c Tremies?
20.	☐	☐	Do you have the required drilled shaft report forms that need to be filled out during construction?
21.	☐	☐	Do you understand the drilled shaft documentation forms?
22.	☐	☐	If the contractor is using a concrete pump, does it meet the requirements in section 814.15,c,2?
23.	☐	☐	Does the contractor have the proper steel?
24.	☐	☐	Has the contractor insured proper and timely delivery of concrete from the concrete plant (814.16,e)?

TEST HOLE

	YES	**NO**	
25.	☐	☐	Is a test hole specified for this job?
26.	☐	☐	Has the contractor performed a successful test hole in accordance with section 814.21?

	YES	NO	
27.	☐	☐	Has the contractor revised his drilling technique and drilling equipment to successfully construct a shaft?

SHAFT CONSTRUCTION

EXCAVATION

	YES	NO	
28.	☐	☐	Is the shaft being constructed in the correct location and within tolerance (814.13)?
29.	☐	☐	Does the contractor have a benchmark so the shaft can be constructed and inspected to the proper elevations?
30.	☐	☐	If the contractor is using slurry, does he have someone certified to test the slurry and report the results in accordance with section 814.12?
31.	☐	☐	Is the slurry level being properly maintained (a minimum of 5 feet above the highest expected piezometric head) in accordance with section 814.12,h?
32.	☐	☐	Is the proper type and number of tests being run on the slurry in accordance with section 814.12,d?
33.	☐	☐	Are you filling out the mineral slurry report?
34.	☐	☐	Is the shaft drilled to the proper depth or elevation?
35.	☐	☐	Is the shaft placement tolerance in accordance with section 814.17 Drilled Shaft Construction Tolerances?
36.	☐	☐	Is the contractor filling out the excavation log?
37.	☐	☐	Does the shaft bottom meet the requirements of section 814.13,c Drilled Shaft Cleanliness Requirements?
38.	☐	☐	Does the shaft excavation time meet the time restraints given in section 814.13,d Time of Excavation?
39.	☐	☐	If the shaft was not excavated within the time constraints, has the shaft been over reamed in accordance with section 814.13,d Time of Excavation ?

PLACING STEEL

	YES	NO	
40.	☐	☐	Is the rebar properly tied in accordance with section 806.06, Placing & Fastening?
41.	☐	☐	If the cage was spliced, was it done in accordance with section 814.14,b?
42.	☐	☐	Is the top of the steel cage at the proper elevation in accordance with section 814.14,e Reinforcement Cage Elevation?
43.	☐	☐	Is the steel cage secured to prevent settling and moving during concrete placement?

CONCRETE PLACEMENT

44.	☐	☐	Prior to concrete placement, has the slurry been tested in accordance with section 814.12,d Slurry Testing Frequency?
45.	☐	☐	Is the tremie size and type in accordance with section 814.15,c Tremie?
46.	☐	☐	Is the tremie maintained in the concrete mass with proper concrete head maintained (814.15,c,3)?
47.	☐	☐	If a pump truck is used, has the volume of the pipelines been determined?
48.	☐	☐	Are you filling out the Concrete Procedures & Results form?
49.	☐	☐	When placing the concrete, did the contractor over flow the shaft until good concrete was visible?

POST INSTALLATION

50.	☐	☐	Is all casing removed to the proper elevation?
51.	☐	☐	Does the drilled shaft meet the tolerances given in section 814.17 Drilled Shaft Construction Tolerances?
52.	☐	☐	If slurry was used, has the contractor provided the required signed Mineral Slurry Report?
53.	☐	☐	Has the contractor completed the Excavation Log?

APPENDIX E

DRILLED SHAFT

DOCUMENTATION FORMS

&

EXAMPLES

Drilled Shaft Construction Report

Form Rev. 6/5/1997

Date: Sheet of

Project Number:	Project Name:
General Contractor:	Drilling Contractor:
Drilled Shaft No.	Shaft Location:

Ground Elev.:

Date	Time	Depth	Elev.				
			Scale:				

Completed By: ______________________________ Date: __________

Concreting Procedures and Results

~~Form~~ Rev. 6/5/1997

Date: Sheet of

Project Number:	Project Name:
General Contractor:	Drilling Contractor:
Drilled Shaft No.	Shaft Location:

Placement Method	Volume In Lines	#	ID	Length	Volume
Tremie: ☐ Pipe: ☐					
Deairing Method					
Relief Valve ☐ Tremie Plug ☐ Tremie Cap ☐					
Reference Elevation:					
Shaft Top Elevation:					
Shaft Bottom Elevation:	Total Volume in Lines:				

Depth To Water Outside of Casing @ Start of Concreting:

Rebar Cage Top Elev. @ Start: Rebar Cage Top Elev. @ Finish:

Truck No.	Concrete Volume	Slump	Arrival Time	Start Time	Finish Time	Tremie Depth	Depth To Concrete	Notes

Total Concrete Volume Delivered: Total Placement Time (Casing Removed):

	OD	Top Elev.	Bottom Elev.	Start	Finish
Casing					
Removal					

NOTES:

Rebar Cage Centered: Concrete Finished:

State Inspector: ____________________ Date: __________

Drilled Shaft Construction Report
Excavation Log

Form Rev. 6/5/1997

Date: Sheet of

Project Number:	Project Name:

General Contractor:	Drilling Contractor:

Drilled Shaft No.	Shaft Location:				
Ground Elev. @ Time of Drilling:	Shaft Top Elev.	Plan		Shaft Bottom Elev.	Plan
		Actual			Actual
Plan Shaft Diameter:	Surface Casing Top Elevation			Surface Casing Bottom Elevation	

Date	Time	Depth	Elev.	Soil Description	Drilling Tool		Observations
					Type	Details	

Contractor Representative: ______________________ Date: __________

State Inspector: ______________________ Date: __________

Drilled Shaft Construction Report
Mineral Slurry Report

Form Rev. 6/9/1997

Project No.	Project Name:	Date:
Drilled Shaft No.	Shaft Location:	

Composition:	Brand	Type	Proportions	Mineral Storage:	Sacks ☐ Silos ☐
Mineral Type				Slurry Mixing	"Mud Hopper" Pulverizer ☐
Additives					Agitator Deflocculator ☐
					Centrifugal Pump ☐
				Slurry Tanks	Type:
					Number:
					Unit:
					Capacity:
Water Source:					

TREATMENT OF RECYCLING UNIT

Vibrating Screen	Cyclones	Circulation Pump
Model:	Type:	Type:
Mesh:	Number:	Output:

TEST PROPERTIES

Sampling	Initial After Mixing	Before Introduction of Slurry	During Construction	During Construction	At End Of Excavation	Before Concreting Test 1	Before Concreting Test 2
Date:							
Time:							
Properties	Test Depth @ Levels:				@ Bottom	@ Bottom	
Density							
Viscosity							
% Sand							
ph							
Cake/Filtrate							

Contractor Representative: ____________________ Date: ____________

State Inspector: ____________________ Date: ____________

Drilled Shaft Construction Report EXAMPLE

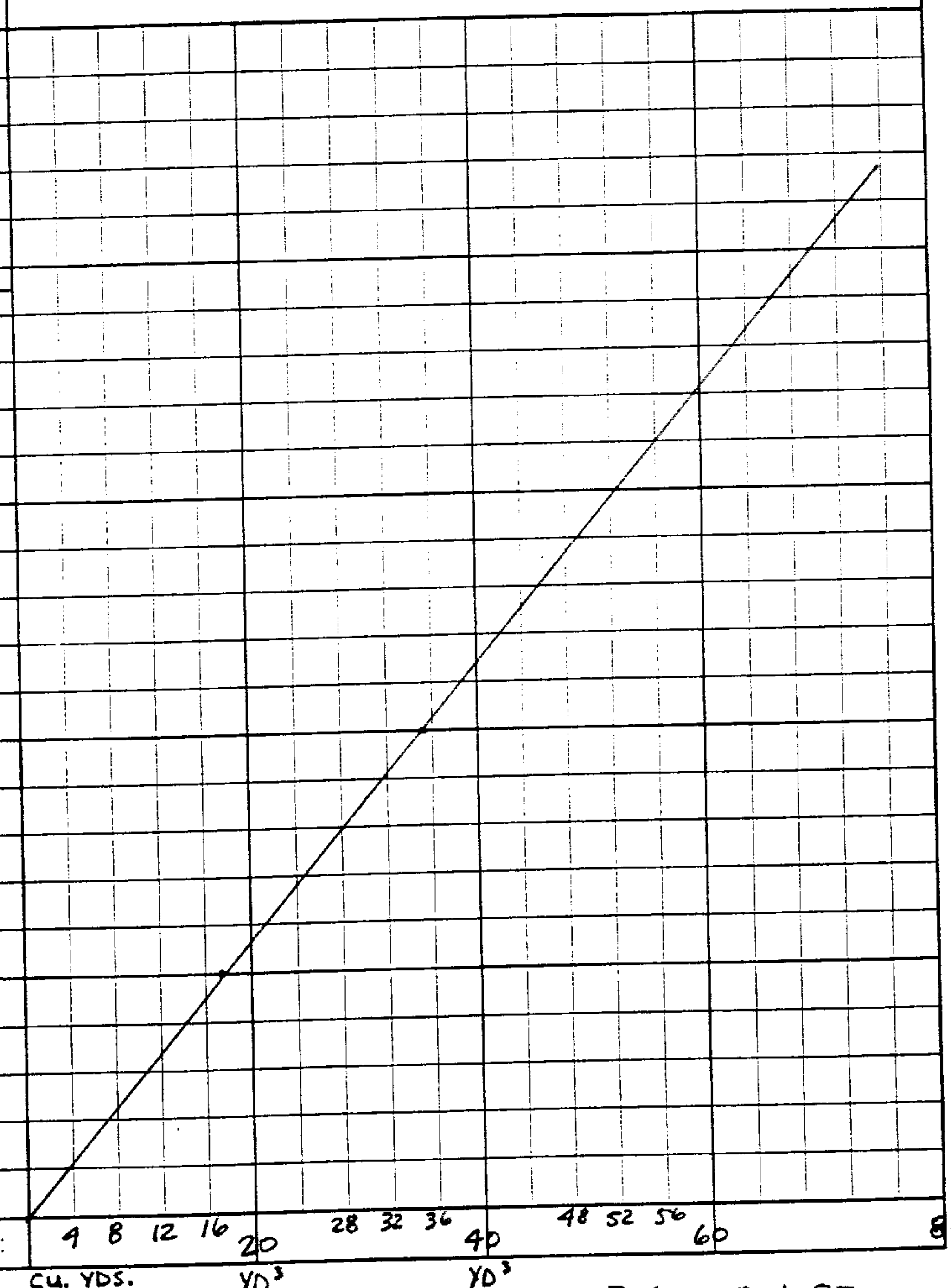
Form Rev. 6/5/1997

Sheet 1 of 1

Date:

Project Number: 158-01-0016	Project Name: JCT. LA. 838 – JCT. I-20 LA. 546
General Contractor: L. & A. CONTRACTORS	Drilling Contractor: R. R. CASSIDY
Drilled Shaft No. 1-A	Shaft Location: BENT 1, SHAFT A
Ground Elev.: ≈ 87.0	

Date	Time	Depth	Elev.
		0	87
		1	86
		5	82
		9	78
		13	74
		17	70
		21	66
		25	62
		29	58
		33	54
		37	50
		41	46
		45	42
		49	38
		53	34
		57	30
		61	26
		65	22
		69	18
		73	14
		77	10



Completed By: [signature]

Date: 8-1-97

Concreting Procedures and Results

EXAMPLE

Form Rev. 6/5/1997

Date: Sheet of

Project Number:	Project Name:
General Contractor:	Drilling Contractor:
Drilled Shaft No.	Shaft Location:

Placement Method	Volume In Lines	#	ID	Length	Volume
Tremie: ☐ Pipe: ☐					
Deairing Method					
Relief Valve ☐ Tremie Plug ☐ Tremie Cap ☐					
Reference Elevation:					
Shaft Top Elevation:					
Shaft Bottom Elevation:	Total Volume in Lines:				

Depth To Water Outside of Casing @ Start of Concreting:

Rebar Cage Top Elev. @ Start:	Rebar Cage Top Elev. @ Finish:

Truck No.	Concrete Volume	Slump	Arrival Time	Start Time	Finish Time	Tremie Depth	Depth To Concrete	Notes

Total Concrete Volume Delivered:	Total Placement Time (Casing Removed):

	OD	Top Elev.	Bottom Elev.	Start	Finish
Casing					
Removal					

NOTES:

Rebar Cage Centered:	Concrete Finished:

State Inspector: ____________________ Date: ____________

Drilled Shaft Construction Report
Excavation Log

Form Rev. 6/5/1997

Sheet 1 of 1

Date: 6-4-97

Project Number: 454-01-0054	Project Name: JEFFERSON HWY / I-12
General Contractor: DENTON CONST.	Drilling Contractor: A.H. BECK
Drilled Shaft No. X1	Shaft Location: BENT A1, W.B.
Ground Elev. @ Time of Drilling: 32.7'	Shaft Top Elev. — Plan: ; Actual: 30.00 — Shaft Bottom Elev. — Plan: ; Actual: -20.00
Plan Shaft Diameter: 30"	Surface Casing Top Elevation: NONE — Surface Casing Bottom Elevation: NONE

Date	Time	Depth	Elev.	Soil Description	Drilling Tool Type	Drilling Tool Details	Observations
6-4-97	7:30	0-4'		DK. GR. SI. CL.	Auger	single flight	
6-4-97	7:35	5'		GR & BR. SI. CL.			
6-4-97	7:43	10'		GR. CL, SI.			
6-4-97	7:50	15'		GR & BR. CL.			
6-4-97	7:53	20'		GR. CL. SI.			
6-4-97	8:00	25'		GR. CL.			
6-4-97	8:05	30'		GR. & BR CL.			
6-4-97	8:10	35'		GR. CL.			
6-4-97	8:15	40'		GR. CL.			
6-4-97	8:20	45'		GR. & BR. SA. CL.			
6-4-97	8:25	50'		GR. CL.			

Contractor Representative: A.H. Beck Date: 6-4-97

State Inspector: D.O.T.D. Date: 6-4-97

Drilled Shaft Construction Report
Mineral Slurry Report

Form Rev. 6/9/1997

Project No. 454-01-0054			Project Name: JEFFERSON HWY / I-12		Date: 6-4-97
Drilled Shaft No. X1			Shaft Location: BENT A1, W.B.		
Composition:	Brand	Type	Proportions	Mineral Storage: Sacks ☒ Silos ☐	
Mineral Type	BAROID	AQUAGEL		Slurry Mixing	"Mud Hopper" Pulverizer ☑
Additives	N/A				Agitator Deflocculator ☐
					Centrifugal Pump ☑
				Slurry Tanks	Type: MUD TANK
					Number:
					Unit: MT-4
Water Source: CITY OF BATON ROUGE					Capacity: 20,000 gal / 500 BBL

TREATMENT OF RECYCLING UNIT

Vibrating Screen	Cyclones	Circulation Pump
Model: Milchem	Type: 5" Desilt / 10" Desand	Type:
Mesh: 150 mesh	Number: 10 EA. 2 EA.	Output:

TEST PROPERTIES

Sampling	Initial After Mixing	Before Introduction of Slurry	During Construction	During Construction	At End Of Excavation	Before Concreting Test 1	Before Concreting Test 2
Date:	6-4-97	6-4-97			6-4-97	6-4-97	
Time:	8:10 A.M.	9:49 A.M.			11:30 A.M.	12:30 P.M.	
Properties	Test Depth @ Levels:				@ Bottom	@ Bottom	
Density	8.6 lb/gal = 64.3 lb/ft³	9.2 lb/gal = 68.8 lb/ft³			9.3 lb/gal 69.6 lb/ft³	9.3 lb/gal 69.6 lb/ft³	
Viscosity	38	44			45	44	
% Sand	1/4 %	3.5 %			3.0 %	3.5 %	
ph	9	9			8	8	
Cake/Filtrate							

Contractor Representative: A.H. BECK Date: 6-4-97

State Inspector: D.O.T.D. Date: 6-4-97