Florida Department of Transportation

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KEVIN J. THIBAULT, P.E.
SECRETARY

July 12, 2021

Khoa Nguyen
Director, Office of Technical Services
Federal Highway Administration
3500 Financial Plaza, Suite 400
Tallahassee, Florida 32312

Re: State Specifications Office
Section: **455**
Proposed Specification: **4550501 Structures Foundations.**

Dear Mr. Nguyen:

We are submitting, for your approval, two copies of the above referenced Supplemental Specification.

The changes are proposed by Juan Castellanos from the State Construction Office to provide modifications to the language regarding redrilling hole depths, steel piling measurements, and adjust measurement for grouted performed holes.

Please review and transmit your comments, if any, within two weeks. Comments should be sent via email to daniel.strickland@dot.state.fl.us.

If you have any questions relating to this specification change, please call me at 414-4130.

Sincerely,

Signature on file

Daniel Strickland, P.E.
State Specifications Engineer

DS/ra
Attachment
cc: Florida Transportation Builders' Assoc.
State Construction Engineer

STRUCTURES FOUNDATIONS
(REV 7~~6~~-8~~1~~-21)

SUBARTICLE 455-5.1 is deleted and the following substituted:

455-5 General Requirements.

455-5.1 Predrilling of Pile Holes: Predrilled pile holes are either starter holes to the depth described in this Subarticle or holes drilled through embankment/fill material down to the natural ground surface at no additional cost to the Department. When using low displacement steel piling such as structural shapes, drive them through the compacted fill without the necessity of drilling holes through the fill except when the requirements for predrilling are shown in the Plans. When using concrete or other high displacement piles, drill pile holes through fill, new or existing, to at least the elevation of the natural ground surface. Use the range of drill diameters listed below for square concrete piles.

12 inch square piles	15 to 17 inches
14 inch square piles	18 to 20 inches
18 inch square piles	22 to 26 inches
20 inch square piles	24 to 29 inches
24 inch square piles	30 to 34 inches
30 inch square piles	36 to 43 inches

For other pile sizes, use the diameter of the drills shown in the Plans or approved by the Engineer. Accurately drill the pile holes with the hole centered over the Plan location of the piling. Maintain the location and vertical alignment within the tolerances allowed for the piling.

For predrilled holes required through rock or other hard (i.e. debris, obstructions, etc.) materials that may damage the pile during installation, predrill hole diameters approximately 2 inches larger than the largest dimension across the pile cross-section. Fill the annular space around the piles as described in 455-5. 10.1 with clean A-3 sand or sand meeting the requirements of 902-3.3.

In the setting of permanent and test piling, the Contractor may initially predrill holes to a depth up to ~~10 feet or~~ 20% of the test pile length whichever is greater, unless required otherwise by the Engineer or ~~shown in~~ the Plans. Predrill holes for production piles in the same manner as the test piles. Where installing piles in compacted fill, predrill the holes to the elevation of the natural ground surface. With prior written authorization from the Engineer, the Contractor may predrill holes to greater depths to minimize the effects of vibrations on existing structures adjacent to the work and/or for other reasons the Contractor proposes.

SUBARTICLE 455-5.12.2 is deleted and the following substituted:

455-5.12.2 Wave Equation:

1. Use Wave Equation Analysis for Piles (WEAP) programs to evaluate the suitability of the proposed driving system (including the hammer, follower, capblock and pile

cushions) as well as to estimate the driving resistance, in blows per 12 inches or blows per inch, to achieve the pile bearing requirements and to evaluate pile driving stresses.

Use Wave Equation Analyses to show the hammer meets the requirements described in 455-5.3 and maximum allowed pile stresses are not exceeded.

2. Required Equipment for Driving: Hammer approval is based on satisfactory field performance including dynamic load test results. In the event piles require different hammer sizes, the Contractor may elect to drive with more than one size hammer or with a variable energy hammer, provided the hammer is properly sized and cushioned, will not damage the pile, and will develop the required resistance.

3. Maximum Allowed Pile Stresses:

a. General: The maximum allowed driving stresses for concrete, steel, and timber piles are given below. In the event dynamic load tests show that the hammer will overstress the pile, modify the driving system or method of operation as required to prevent overstressing the pile. In such cases provide additional cushioning, reduce the stroke, or make other appropriate agreed upon changes.

b. Prestressed Concrete Piles: Use the following equations to determine the maximum allowed pile stresses:

$Sapc = 0.7\ f'c - 0.75\ f\ cpe$ $s_{apc} = 0.7\ f'_c - 0.75\ f_{pe}$ (1)

$s_{apt} = 6.5\,(f'_c)^{0.5} + 1.05\ f_{cpe}$ (2a) for piles less than 50 feet long

$s_{apt} = 3.25\,(f'_c)^{0.5} + 1.05\ f_{cpe}$ (2b) for piles 50 feet long and greater

$s_{apt} = 500$ (2c) within 20 feet of a mechanical splice

where:

s_{apc} = maximum allowed pile compressive stress, psi

s_{apt} = maximum allowed pile tensile stress, psi

f'_c = specified minimum compressive strength of concrete, psi

f_{cpe} = effective prestress (after all losses) at the time of driving, psi, taken as 0.8 times the initial prestress force divided by the minimum net concrete cross-sectional area of the pile (f_{cpe} = 0 for dowel spliced piles).

c. Steel Piles: Ensure the maximum pile compression and tensile stresses measured during driving are no greater than 0.9 times the yield strength (0.9 f_y) of the steel.

d. Timber Piles: Ensure the maximum pile compression and tensile stresses measured during driving are no greater than 3.6 ksi for Southern Pine and Pacific Coast Douglas Fir and 0.9 of the ultimate parallel to the grain strength for piles of other wood.

ARTICLE 455-11 is deleted and the following substituted:

455-11 Method of Measurement (All Piling).

455-11.1 General: ~~The quantity to be paid for will be the length, in feet, furnished, placed, and accepted according to the authorized lengths list, including any additions and excluding any deletions thereto, as approved by the Engineer.~~

No adjustments in the length, in feet, of piling will be made if cut-offs are required after the pile has been driven to satisfactory bearing.

455-11.2 Prestressed Concrete Piling:

455-11.2.1 Length: The length of precast concrete piles will be considered as the overall length from head to tip. Final pay length will be based on the casting length as authorized in accordance with 455-5.15.3 subject to provisions of 455-11.2.3, ~~through~~ 455-11.2.4, 455-11.8, 455-11.9, ~~and~~ 455-11.12 and 455-11.13.

455-11.2.2 Driving of Unplanned Epoxy-Bonded Dowel Splice: If a pile is driven below cut-off and satisfactory bearing is not obtained, and additional driving is required after construction of a satisfactory splice, an additional 10 feet of piling will be paid for the additional driving. This compensation for driving of splice, however, will not be allowed for test piles that are spliced and redriven.

455-11.2.3 Extracting Piles: In the event that a pile is driven below cut-off without obtaining the required bearing, and the Engineer elects to have the pile extracted and a longer pile substituted, the pile extraction will be paid for as Unforeseeable Work. In the event a pile is damaged or mislocated, and the damage or mislocation is determined to be the Department's responsibility, and the Engineer elects to have the pile extracted, the pile extraction will be paid for as Unforeseeable Work. If a replacement pile is required, compensation will be made under the item for piling, for both the original pile and replacement pile. Redriving of an extracted and undamaged pile will be paid for at 30% of the Contract unit price for piling.

The Contractor may substitute a longer pile in lieu of splicing and building-up a pile. In this event, the Contractor will be paid for the original authorized length of the pile, plus any additional length furnished by the Contractor up to the authorized length of the build-up, as piling. The Contractor will be paid 30 feet of piling as full compensation for extracting the original pile.

455-11.2.4 Underwater Driving: When the Contractor selects one of the optional underwater driving methods, payment will be made by selecting the applicable method from the following:

1. Using a pile longer than the authorized length: Measurement for piling will be made only for the authorized length at that location unless the length of pile from cut-off elevation to the final tip elevation is greater than the authorized length, in which case payment for piling will be made from cut-off elevation to final tip elevation. No payment will be made for pile splice, when this option is selected, unless the pile is physically spliced and the splice is driven below cut-off elevation to achieve bearing.

2. Using an underwater hammer or a pile follower: Measurement will be in accordance with 455-11.2.1.

455-11.3 Steel Piling:

455-11.3.1 Length: The length of steel piles will be considered as the overall length from head to tip. Final pay length will subject to provisions of 455-11.8, 455-11.9, 455-11.10, 455-11.12, and 455-11.13.

455-11.3.2 ~~Steel Piling –~~ Point Protectors: The quantity to be paid for will be each for the total of point protectors authorized, furnished, and properly installed.

455-11.4 Test Piles: The quantity to be paid for of test piles of various types, will be the length, in feet, of test piling furnished, driven and accepted, according to the authorized length list, and any extensions thereof as approved by the Engineer.

Test piles left in place as permanent piles will be paid for only as test piling. Any extensions necessary to continue driving the pile for test purposes, as authorized by the Engineer, will be paid for as test piles. Other extensions of piles, additional length paid for splicing and build-ups will be included in the quantities of regular piling and will not be paid for as test piling.

455-11.5 Dynamic Load Tests: Payment will be based on the number of dynamic load tests shown in the Plans, authorized by the Engineer, or required in 455-5.12.7, completed and accepted in accordance with the Contract Documents. No separate payment will be made for dynamic load tests used to evaluate changes in the Contractor's driving equipment. No payment will be made for dynamic load tests used to evaluate the integrity of a pre-planned epoxy-bonded dowel splice. Include all costs associated with dynamically testing production piles with epoxy-bonded dowel splices under Pay Item No. 455-34. No payment will be made for dynamic load tests on test piles.

For structures with 100% dynamic testing, the cost of supplying and installing embedded gauges or attaching external gauges to each pile for dynamic load tests is included in the cost of the pile and no separate payment will be made.

For structures without 100% dynamic testing, the cost of supplying and installing embedded gauges or attaching external gauges to each production pile for dynamic load testing prior to initial driving, authorized by the Engineer, will be 20 feet of additional pile. No payment will be made for attaching dynamic testing equipment for set-checks or redrives. No payment will be made for dynamic load testing performed when driving using followers. No payment will be made for any dynamic load testing performed on temporary piles.

455-11.6 Steel Sheet Piling: The quantity to be paid for will be the plan quantity area, in square feet, measured from top of pile elevation to the bottom of pile elevation and beginning and end wall limits as shown in the Plans with no allowance for variable depth surface profiles. Approved alternate support structures would be paid for as plan quantity computed for sheet pile. Sheet piling used in cofferdams and to incorporate the Contractor's specific means and methods, and not ordered by the Engineer, will be paid for as required in Section 125.

455-11.7 Concrete Sheet Piling: The quantity to be paid for will be the product of the number of such piles satisfactorily completed, in place, times their lengths in feet as shown in the Plans or authorized by the Engineer. This quantity will be based upon piles 2-1/2 feet wide.

When the Engineer approves, the Contractor may furnish the concrete sheet piling in widths wider than shown in the Plans; then the number of piles shall be the actual number of units completed times the width used divided by the width in the Plans.

455-11.8 Pile Splices: The quantity to be paid for authorized drivable splices and build-ups greater than 5 feet in length in concrete piling, and test piling, which are made for the purpose of obtaining authorized pile lengths longer than shown as the maximum length in the Standard Plans Indexes, for obtaining greater lengths than originally authorized by the Engineer, to incorporate test piling in the finished structure, for further driving of test piling, or for splices shown in the Plans, will be 30 feet of additional prestressed concrete piling under Pay Item No. 455-34.

For concrete piles and test piles, where the build-up is 5 feet or less in length, the quantity to be paid for will be 9 feet of prestressed concrete piling under Pay Item No. 455-34 as compensation for drilling and grouting the dowels and all other costs for which provision has not otherwise been made.

The quantity to be paid for authorized splices in steel piling and test piling, for the purpose of obtaining lengths longer than the lengths originally authorized by the Engineer, will be 20 feet of additional steel piling under Pay Item No. 455-35.

455-11.9 Set-Checks and Redrives:

455-11.9.1 Set Checks/Test Piles: There will be no separate payment for the initial four set-checks performed the day of and the working day following initial driving. For each additional set-check ordered by the Engineer and performed within the following working day of initial driving, an additional quantity of 10 feet of piling will be paid.

455-11.9.2 Set Checks/Production Piles: There will be no separate payment for the initial two set-checks performed the day of and the working day following initial driving. For each additional set-check ordered by the Engineer and performed within the following working day of initial driving, an additional quantity of 10 feet of piling will be paid.

455-11.9.3 Redrives: The quantity to be paid for will be the number of redrives, each, authorized by the Engineer. Payment for any pile redrive (test pile or production pile) ordered by the Engineer will consist of 20 feet of additional piling.

455-11.10 Pile Extraction: Piles authorized to be extracted by the Engineer and successfully extracted as provided in 455-11.2.3 will be paid for as described in 455-11.2.3. No payment for extraction will be made for piles shown in the Plans to be extracted or piling damaged or mislocated by the Contractor that are ordered to be extracted by the Engineer.

455-11.11 Static Load Tests: The quantity to be paid for will be the number of static load tests of the designated tonnages, each, as shown in the Plans or authorized by the Engineer, actually applied to piles, completed and accepted in accordance with the Plans and these Specifications.

455-11.12 Preformed Pile Holes: The quantity added to the payment for piling will be 30% of the length of completed preformed pile holes from existing ground or the bottom of any required excavation, whichever is lower, to the bottom of preformed hole acceptably provided, complete for the installation of the bearing piles, regardless of the type of pile (test pile or production pile) installed therein. Only those holes authorized to be paid for, as provided in 455-5.10.3, will be included in the measurement for payment. The Engineer will authorize payment for preformed pile holes only when the pile has been placed in proper position and has achieved the required penetration.

455-11.13 Grouted Preformed Pile Holes: The quantity added to the payment for piling will be 70% of the length of grouted preformed pile holes from the bottom of preformed hole acceptably provided to the required top of grouting, regardless of the type of pile (test pile or production pile) installed therein. Only those holes required to be grouted, will be included in the measurement for payment.

SUBARTICLE 455-16.3 is deleted and the following substituted:

455-16.3 Support, Alignment, and Tolerance: Tie and support the reinforcing steel in the shaft so that the reinforcing steel will remain within allowable tolerances as specified in 455-20 and Section 415.

Ensure concentric spacing for the entire length of the cage. As a minimum, use centering devices consisting of wheels or other approved noncorrosive spacing devices within 3 feet of the bottom, within 6 feet of the top, and intervals not exceeding 10 feet along the cage length. When a casing with an inside diameter (I.D.) larger than the required shaft diameter is used, provide, within the portion of the oversized casing, centering devices specially dimensioned or other means to ensure the casing and the cage are concentric. Do not use block or wire type spacers. Ensure no permanent metallic elements will be within the concrete cover space. Use a minimum of one spacer per 30 inches of circumference of cage with a minimum of four at each level. Provide spacers at the bottom of the drilled shaft reinforcing cage as required to maintain the proper position of the cage.

Check the elevation of the top of the steel cage before and after placing the concrete. If the cage is not within the specified tolerances, correct, and submit a revised DSIP to the Engineer for approval. Do not construct additional shafts until receiving approval from the Engineer.

SUBARTICLE 455-17.6.1.3 is deleted and the following substituted:

455-17.6.1.3 Required TITDS Reports: Submit the TITDS data and analysis results to the Engineer in a signed and sealed report, together with all electronic data, within 48 hours of testing. The report shall include as minimum the following items:

1. Graphs displaying all temperature measurements and average temperature versus depth.

2. Indication of unusual temperatures, including cooler local deviations from the average at any depth from the overall average over the entire length.

3. A graph displaying the average temperature and theoretical temperature versus depth.

4. Variations in temperature between access tubes which may indicate variations in cage alignment.

5. The calculated radius of the shaft throughout the entire depth.

~~6. Alignment of the reinforcing cage along the shaft.~~

6~~7~~. Calculated concrete cover throughout the entire depth.

7~~8~~. Shaft Details, Probe Details, Environmental Details, Tube Run Selection and Shaft Adjustment Data that show the measurements, inputs and adjustments to the data. Screen captures of these pages from the TIP Reporter software will be acceptable.

8~~9~~. A conclusion stating whether the tested shaft is free from integrity defects, ~~and~~ meets the minimum concrete cover and diameter requirements by the specifications and the cage is properly aligned. When anomalies are detected, include in the report a three- ~~-~~dimensional rendering of the shape of the shaft.

SUBARTICLE 455-17.6.2 is deleted and the following substituted:

455-17.6.2 Cross Sonic Logging (CSL) and Tomography: When required by the Engineer, perform CSL testing in accordance with ASTM D6760. Engage a qualified Specialty Engineer to perform the CSL testing. The qualified CSL Specialty Engineer must be a Professional Engineer in the State of Florida and have a minimum six months experience of CSL

testing, supervising the collection of CSL data and interpretation of CSL results. The individual performing the CLS testing in the field must work for the Specialty Engineer firm and have a minimum of six months experience of CSL testing. The Contractor shall provide all necessary access and assistance to the CSL Specialty Engineer to satisfactorily perform the testing.

When a shaft contains four tubes, test every possible tube combination. For shafts with five or more tubes, test all pairs of adjacent tubes around the perimeter, and one-half of the remaining number of tube combinations, as chosen by the Engineer. Pull the probes simultaneously, starting from the bottoms of the tubes, over an electronic depth measuring device. Perform the CSL tests with the source and receiver probes in the same horizontal plane. Continuously record CSL signals at depth intervals of 2-1/2 inches or less from the bottom of the tubes to the top of each shaft. Remove all slack from the cables prior to pulling to provide accurate depth measurements in the CSL records. When the measurements indicate a 30% or greater reduction in velocity between one or more pairs, take one or two concrete cores to allow further evaluation and repair, or replace the shaft as directed by the Engineer. Determine the location of the concrete cores by performing 3D tomographic analysis using the CSL measurements. The core depths shall be at least 5 feet deeper than the bottom of the anomaly determined by the 3D tomography analysis or full depth if the anomaly is within 5 feet of the bottom of the shaft. The Engineer may accept a drilled shaft without rock cores if an EAR demonstrates that the anomaly does not affect the structural and the geotechnical axial capacity, the structural and geotechnical lateral stability, the settlement behavior of the shaft, and that the anomaly will not impact the durability of the foundation.

When repairs are done, perform CSL measurements in all tube pair combinations with the source and receiver running at the same horizonal plane and at the vertical offsets of 45 degrees above and below. Perform all measurements including the offset measurements from the point where the higher probe is at least 5 feet below the lower limit of the repaired zone to the point where the lower probe is at least 5 feet above the upper limit of the repaired zone. Offset measurements must be as follows: plus 45 degrees (source below receiver) and minus 45 degrees (source above receiver). Use the measurements of these two offsets in combination with the horizontal measurements to perform the 3D tomography. Provide the CSL measurements, CSL logs and 3D tomographic analysis at no additional cost to the Department.

After acceptance of production shafts by the Engineer, fill the tubes or core holes with a structural non-shrink grout in accordance with 455-17.6.1.

If the Contractor determines at any time during the non-destructive testing and evaluation of the drilled shaft that the drilled shaft should be replaced, no further testing or evaluation of that shaft is required.

ARTICLE 455-20 is deleted and the following substituted:

455-20 Construction Tolerances.

Meet the following construction tolerances for drilled shafts:

1. Ensure that the top of the drilled shaft is no more than 3 inches laterally in the X or Y coordinate from the position indicated in the Plans.

2. Ensure that the vertical alignment of the shaft excavation does not vary from the alignment shown in the Plans by more than 1/4 inches per foot of depth.

3. After placing all the concrete, ensure that the top of the reinforcing steel cage is no more than 6 inches above and no more than 3 inches below plan position.

4. Ensure that the reinforcing cage is concentric with the shaft within a tolerance of 1-1/2 inches. Ensure that concrete cover is a minimum of 4-1/2 inches unless shown otherwise in the Plans.

5. Ensure that the minimum diameter of the drilled shaft is not smaller than the specified shaft diameter minus 1 inch. All casing diameters shown in the Plans refer to I.D. (inside diameter) dimensions. However, the Contractor may use casing with an outside diameter equal to the specified shaft diameter if the extra length described in 455-15.7 is provided. In this case, ensure that the I.D. of the casing is not smaller~~less~~ than the specified shaft diameter minus~~less~~ 1 inch. When approved, the Contractor may elect to provide a casing larger in diameter than shown in the Plans to facilitate meeting this requirement. ~~Ensure that the minimum diameter of the drilled shaft is 1 inch less than the specified shaft diameter.~~ When conditions are such that a series of telescoping casings are used, provide the casing sized to maintain the minimum shaft diameters listed above.

6. Except when abutting or encroaching within a sidewalk, ensure that the top elevation of the drilled shaft concrete has a tolerance of plus 1 inch and minus 3 inches from the top of shaft elevation shown in the Plans.

7. When abutting or encroaching within a sidewalk, ensure that the top elevation of the drilled shaft is flush with the sidewalk surface.

8. The dimensions of casings are subject to American Petroleum Institute tolerances applicable to regular steel pipe.

9. Use excavation equipment and methods designed so that the completed shaft excavation will have a flat bottom. Ensure that the cutting edges of excavation equipment are normal to the vertical axis of the equipment within a tolerance of plus or minus 3/8 inches per foot of diameter.

ARTICLE 455-44 is deleted and the following substituted:

455-44 Pile Installation.

Meet the following requirements:

1. Locate the piles as shown on the drawings.

2. Should soft, compressible muck, organics, clay or other unsuitable materials (non A-1, A-3, A-2-4 or limestone materials) be encountered, remove the unsuitable material to a maximum depth of 5 feet and a radial distance around the pile centerline of two pile diameters, unless otherwise indicated in the Plans. Backfill with clean granular backfill materials (A-1, A-3, A-2-4), placed and compacted in maximum 12 inch lifts to at least 95% of maximum dry density as determined by FM 1-T180. Complete this work to the Engineer's satisfaction prior to ACP construction. Should more than 5 feet depth or excessive quantities of unsuitable material be encountered, immediately advise the Engineer and proceed with the work as directed by the Engineer.

3. Provide continuous auger flighting from the bottom of the pile to the top of ground at the time of drilling with no gaps or other breaks, except for connections. Ensure the auger flights are uniform in diameter throughout its length, and of the diameter specified for the piles less a maximum of 3%. Provide augers with a distance between flights of approximately half the diameter of the auger.

4. Use augers with the grout injection hole located at the bottom of the auger head below the bar containing the cutting teeth, and with pile auger leads containing a bottom guide.

5. Construct piles of the length and diameter shown on the Plans.

6. Clearly mark the auger leads to facilitate monitoring of the incremental drilling and grout placement. Provide individual foot marks with 5 foot increments highlighted and clearly visible. Provide a clear reference mark on the moving auger assembly to facilitate accurately monitoring the vertical movement of the auger.

7. Place piles by rotating a continuous flight hollow shaft auger into the ground at a continuous rate that prevents removal of excess soil. Stop advancement after reaching the predetermined depth.

8. Should auger penetration to the required depth prove difficult due to hard materials/refusal, the pile location may be predrilled, upon approval of the Engineer, through the obstruction using appropriate drilling equipment, to a diameter no larger than one-half the prescribed finish diameter of the ACP. Commence ~~ACP construction~~grouting immediately upon ~~completion of~~reaching the required tip elevation ~~predrilling~~ to minimize ground loss and soil relaxation. Should non-drillable material be encountered preventing placement to the depth required, immediately advise the Engineer and proceed with the work as directed by the Engineer. Refusal is defined as the depth where the penetration of the standard auger equipment is less than 12 inches per minute.

9. Plug the hole in the bottom of the auger prior to advancing into the ground.

10. Pump the grout with sufficient pressure as the auger is withdrawn to completely fill the auger hole, preventing hole collapse and to cause the lateral penetration of the grout into soft or porous zones of the surrounding soil or rock. Prior to commencing withdrawal of the auger, establish a head of at least 5 feet of grout by pumping a volume of grout equivalent to 5 feet of pile volume. Do not include the volume or strokes required to prime the grout pumping system in the volume required to build this initial head. Maintain this head of at least 5 feet of grout above the injection point around the perimeter of the auger to displace and remove any loose material from the hole. Maintain positive rotation of the auger at least until placement of the grout.

11. Once the grout head has been established, greatly reduce the speed of rotation of the auger and commence extraction at a rate consistent with the pump discharge. Maintain extraction at a steady rate to prevent a locked-in auger, necking of the pile, or a substantially reduced pile section. Ensure grout starts flowing out from the hole when the cutting head is at least 5 feet below the ground surface. Place a minimum volume of grout in the hole of at least 115% of the column of the auger hole from a depth of 5 feet to the tip. Place a minimum volume of grout in the hole of at least 100% of the column of the auger hole from the ground surface to a depth of 5 feet. Do not include any grout needed to create surplus grout head in the volume of grout placed into the hole. If the grout does not flow out from the hole when the cutting head is at least 5 feet below the ground surface, redrill the pile under the direction of the Engineer. If grouting is interrupted for any reason, reinsert the auger by drilling at least 5 feet below the tip of the auger when the interruption occurred, and then regrout.

Use this method of placement at all times. Do not depend on the stability of the hole without the earth filled auger.

12. Assume responsibility for the grout volume placed. If less than 115% of the theoretical volume of grout is placed in any 5 foot increment (100% in the top 5 foot increment),

reinstall the pile by advancing the auger 10 feet or to the bottom of the pile if that is less, followed by controlled removal and grout injection.

13. Furnish and install the reinforcing steel and anchoring bolts as shown in the Contract Documents. For ACP for miscellaneous structures and low clearance post options for noise walls, u~~U~~se wheels or other approved noncorrosive spacing devices within 3 feet of the bottom, within 3 feet of the top, and intervals not exceeding 10 feet along the pile to ensure concentric spacing for the entire length of the cage. Do not use block or wire type spacers. Use a minimum of one spacer per 30 inches of circumference or perimeter of cage with a minimum of three at each level. For noise wall ACP in which the full reinforcement is attached to the post, spacing devices within 3 ft of the top of the pile are not required.

14. Use reinforcement that is without kinks or nonspecified bends, free of mud, oil or other coatings that could adversely affect the bond. Make splices in reinforcement as shown on the Contract Documents, unless otherwise approved by the Engineer. Place the required steel reinforcement while the grout is still fluid, and immediately after finishing grouting and clearing it from any contaminating material. Install the steel cage into the grout by its own weight or manually. Do not use a mechanical equipment or tool to impact the steel cage or to force it into the grout. If the steel cage cannot be placed completely following this procedure, redrill and regrout the pile.

15. Leave any temporary supports of/for items placed into a grouted pile (reinforcement template, anchor bolt template, precast column supports, etc.) in place for a minimum of 12 hours after completion of the pile. Do not place wall panels or other loads, before piles are accepted and the grout has set a minimum of seven days or reached the 28 day strength.

STRUCTURES FOUNDATIONS
(REV 7-8-21)

SUBARTICLE 455-5.1 is deleted and the following substituted:

455-5 General Requirements.

455-5.1 Predrilling of Pile Holes: Predrilled pile holes are either starter holes to the depth described in this Subarticle or holes drilled through embankment/fill material down to the natural ground surface at no additional cost to the Department. When using low displacement steel piling such as structural shapes, drive them through the compacted fill without the necessity of drilling holes through the fill except when the requirements for predrilling are shown in the Plans. When using concrete or other high displacement piles, drill pile holes through fill, new or existing, to at least the elevation of the natural ground surface. Use the range of drill diameters listed below for square concrete piles.

12 inch square piles	15 to 17 inches
14 inch square piles	18 to 20 inches
18 inch square piles	22 to 26 inches
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24 inch square piles	30 to 34 inches
30 inch square piles	36 to 43 inches

For other pile sizes, use the diameter of the drills shown in the Plans or approved by the Engineer. Accurately drill the pile holes with the hole centered over the Plan location of the piling. Maintain the location and vertical alignment within the tolerances allowed for the piling.

For predrilled holes required through rock or other hard (i.e. debris, obstructions, etc.) materials that may damage the pile during installation, predrill hole diameters approximately 2 inches larger than the largest dimension across the pile cross-section. Fill the annular space around the piles as described in 455-5. 10.1 with clean A-3 sand or sand meeting the requirements of 902-3.3.

In the setting of permanent and test piling, the Contractor may initially predrill holes to a depth up to 20% of the test pile length whichever is greater, unless required otherwise by the Engineer or the Plans. Predrill holes for production piles in the same manner as the test piles. Where installing piles in compacted fill, predrill the holes to the elevation of the natural ground surface. With prior written authorization from the Engineer, the Contractor may predrill holes to greater depths to minimize the effects of vibrations on existing structures adjacent to the work and/or for other reasons the Contractor proposes.

SUBARTICLE 455-5.12.2 is deleted and the following substituted:

455-5.12.2 Wave Equation:

1. Use Wave Equation Analysis for Piles (WEAP) programs to evaluate the suitability of the proposed driving system (including the hammer, follower, capblock and pile

cushions) as well as to estimate the driving resistance, in blows per 12 inches or blows per inch, to achieve the pile bearing requirements and to evaluate pile driving stresses.

Use Wave Equation Analyses to show the hammer meets the requirements described in 455-5.3 and maximum allowed pile stresses are not exceeded.

2. Required Equipment for Driving: Hammer approval is based on satisfactory field performance including dynamic load test results. In the event piles require different hammer sizes, the Contractor may elect to drive with more than one size hammer or with a variable energy hammer, provided the hammer is properly sized and cushioned, will not damage the pile, and will develop the required resistance.

3. Maximum Allowed Pile Stresses:

a. General: The maximum allowed driving stresses for concrete, steel, and timber piles are given below. In the event dynamic load tests show that the hammer will overstress the pile, modify the driving system or method of operation as required to prevent overstressing the pile. In such cases provide additional cushioning, reduce the stroke, or make other appropriate agreed upon changes.

b. Prestressed Concrete Piles: Use the following equations to determine the maximum allowed pile stresses:

$$s_{apc} = 0.7\, f'_c - 0.75\, f_{cpe} \qquad (1)$$

$$s_{apt} = 6.5\,(f'_c)^{0.5} + 1.05\, f_{cpe} \qquad \text{(2a) for piles less than 50 feet long}$$

$$s_{apt} = 3.25\,(f'_c)^{0.5} + 1.05\, f_{cpe} \qquad \text{(2b) for piles 50 feet long and greater}$$

$$s_{apt} = 500 \qquad \text{(2c) within 20 feet of a mechanical splice}$$

where:

s_{apc} = maximum allowed pile compressive stress, psi

s_{apt} = maximum allowed pile tensile stress, psi

f'_c = specified minimum compressive strength of concrete, psi

f_{cpe} = effective prestress (after all losses) at the time of driving, psi, taken as 0.8 times the initial prestress force divided by the minimum net concrete cross-sectional area of the pile (f_{cpe} = 0 for dowel spliced piles).

c. Steel Piles: Ensure the maximum pile compression and tensile stresses measured during driving are no greater than 0.9 times the yield strength (0.9 f_y) of the steel.

d. Timber Piles: Ensure the maximum pile compression and tensile stresses measured during driving are no greater than 3.6 ksi for Southern Pine and Pacific Coast Douglas Fir and 0.9 of the ultimate parallel to the grain strength for piles of other wood.

ARTICLE 455-11 is deleted and the following substituted:

455-11 Method of Measurement (All Piling).

455-11.1 General:

No adjustments in the length, in feet, of piling will be made if cut-offs are required after the pile has been driven to satisfactory bearing.

455-11.2 Prestressed Concrete Piling:

455-11.2.1 Length: The length of precast concrete piles will be considered as the overall length from head to tip. Final pay length will be based on the casting length as authorized in accordance with 455-5.15.3 subject to provisions of 455-11.2.3, 455-11.2.4, 455-11.8, 455-11.9, 455-11.12 and 455-11.13.

455-11.2.2 Driving of Unplanned Epoxy-Bonded Dowel Splice: If a pile is driven below cut-off and satisfactory bearing is not obtained, and additional driving is required after construction of a satisfactory splice, an additional 10 feet of piling will be paid for the additional driving. This compensation for driving of splice, however, will not be allowed for test piles that are spliced and redriven.

455-11.2.3 Extracting Piles: In the event that a pile is driven below cut-off without obtaining the required bearing, and the Engineer elects to have the pile extracted and a longer pile substituted, the pile extraction will be paid for as Unforeseeable Work. In the event a pile is damaged or mislocated, and the damage or mislocation is determined to be the Department's responsibility, and the Engineer elects to have the pile extracted, the pile extraction will be paid for as Unforeseeable Work. If a replacement pile is required, compensation will be made under the item for piling, for both the original pile and replacement pile. Redriving of an extracted and undamaged pile will be paid for at 30% of the Contract unit price for piling.

The Contractor may substitute a longer pile in lieu of splicing and building-up a pile. In this event, the Contractor will be paid for the original authorized length of the pile, plus any additional length furnished by the Contractor up to the authorized length of the build-up, as piling. The Contractor will be paid 30 feet of piling as full compensation for extracting the original pile.

455-11.2.4 Underwater Driving: When the Contractor selects one of the optional underwater driving methods, payment will be made by selecting the applicable method from the following:

1. Using a pile longer than the authorized length: Measurement for piling will be made only for the authorized length at that location unless the length of pile from cut-off elevation to the final tip elevation is greater than the authorized length, in which case payment for piling will be made from cut-off elevation to final tip elevation. No payment will be made for pile splice, when this option is selected, unless the pile is physically spliced and the splice is driven below cut-off elevation to achieve bearing.

2. Using an underwater hammer or a pile follower: Measurement will be in accordance with 455-11.2.1.

455-11.3 Steel Piling:

455-11.3.1 Length: The length of steel piles will be considered as the overall length from head to tip. Final pay length will subject to provisions of 455-11.8, 455-11.9, 455-11.10, 455-11.12, and 455-11.13.

455-11.3.2 Point Protectors: The quantity to be paid for will be each for the total of point protectors authorized, furnished, and properly installed.

455-11.4 Test Piles: The quantity to be paid for of test piles of various types, will be the length, in feet, of test piling furnished, driven and accepted, according to the authorized length list, and any extensions thereof as approved by the Engineer.

Test piles left in place as permanent piles will be paid for only as test piling. Any extensions necessary to continue driving the pile for test purposes, as authorized by the Engineer, will be paid for as test piles. Other extensions of piles, additional length paid for splicing and build-ups will be included in the quantities of regular piling and will not be paid for as test piling.

455-11.5 Dynamic Load Tests: Payment will be based on the number of dynamic load tests shown in the Plans, authorized by the Engineer, or required in 455-5.12.7, completed and accepted in accordance with the Contract Documents. No separate payment will be made for dynamic load tests used to evaluate changes in the Contractor's driving equipment. No payment will be made for dynamic load tests used to evaluate the integrity of a pre-planned epoxy-bonded dowel splice. Include all costs associated with dynamically testing production piles with epoxy-bonded dowel splices under Pay Item No. 455-34. No payment will be made for dynamic load tests on test piles.

For structures with 100% dynamic testing, the cost of supplying and installing embedded gauges or attaching external gauges to each pile for dynamic load tests is included in the cost of the pile and no separate payment will be made.

For structures without 100% dynamic testing, the cost of supplying and installing embedded gauges or attaching external gauges to each production pile for dynamic load testing prior to initial driving, authorized by the Engineer, will be 20 feet of additional pile. No payment will be made for attaching dynamic testing equipment for set-checks or redrives. No payment will be made for dynamic load testing performed when driving using followers. No payment will be made for any dynamic load testing performed on temporary piles.

455-11.6 Steel Sheet Piling: The quantity to be paid for will be the plan quantity area, in square feet, measured from top of pile elevation to the bottom of pile elevation and beginning and end wall limits as shown in the Plans with no allowance for variable depth surface profiles. Approved alternate support structures would be paid for as plan quantity computed for sheet pile. Sheet piling used in cofferdams and to incorporate the Contractor's specific means and methods, and not ordered by the Engineer, will be paid for as required in Section 125.

455-11.7 Concrete Sheet Piling: The quantity to be paid for will be the product of the number of such piles satisfactorily completed, in place, times their lengths in feet as shown in the Plans or authorized by the Engineer. This quantity will be based upon piles 2-1/2 feet wide.

When the Engineer approves, the Contractor may furnish the concrete sheet piling in widths wider than shown in the Plans; then the number of piles shall be the actual number of units completed times the width used divided by the width in the Plans.

455-11.8 Pile Splices: The quantity to be paid for authorized drivable splices and build-ups greater than 5 feet in length in concrete piling, and test piling, which are made for the purpose of obtaining authorized pile lengths longer than shown as the maximum length in the Standard Plans Indexes, for obtaining greater lengths than originally authorized by the Engineer, to incorporate test piling in the finished structure, for further driving of test piling, or for splices shown in the Plans, will be 30 feet of additional prestressed concrete piling under Pay Item No. 455-34.

For concrete piles and test piles, where the build-up is 5 feet or less in length, the quantity to be paid for will be 9 feet of prestressed concrete piling under Pay Item No. 455-34 as

compensation for drilling and grouting the dowels and all other costs for which provision has not otherwise been made.

The quantity to be paid for authorized splices in steel piling and test piling, for the purpose of obtaining lengths longer than the lengths originally authorized by the Engineer, will be 20 feet of additional steel piling under Pay Item No. 455-35.

455-11.9 Set-Checks and Redrives:

455-11.9.1 Set Checks/Test Piles: There will be no separate payment for the initial four set-checks performed the day of and the working day following initial driving. For each additional set-check ordered by the Engineer and performed within the following working day of initial driving, an additional quantity of 10 feet of piling will be paid.

455-11.9.2 Set Checks/Production Piles: There will be no separate payment for the initial two set-checks performed the day of and the working day following initial driving. For each additional set-check ordered by the Engineer and performed within the following working day of initial driving, an additional quantity of 10 feet of piling will be paid.

455-11.9.3 Redrives: The quantity to be paid for will be the number of redrives, each, authorized by the Engineer. Payment for any pile redrive (test pile or production pile) ordered by the Engineer will consist of 20 feet of additional piling.

455-11.10 Pile Extraction: Piles authorized to be extracted by the Engineer and successfully extracted as provided in 455-11.2.3 will be paid for as described in 455-11.2.3. No payment for extraction will be made for piles shown in the Plans to be extracted or piling damaged or mislocated by the Contractor that are ordered to be extracted by the Engineer.

455-11.11 Static Load Tests: The quantity to be paid for will be the number of static load tests of the designated tonnages, each, as shown in the Plans or authorized by the Engineer, actually applied to piles, completed and accepted in accordance with the Plans and these Specifications.

455-11.12 Preformed Pile Holes: The quantity added to the payment for piling will be 30% of the length of completed preformed pile holes from existing ground or the bottom of any required excavation, whichever is lower, to the bottom of preformed hole acceptably provided, complete for the installation of the bearing piles, regardless of the type of pile (test pile or production pile) installed therein. Only those holes authorized to be paid for, as provided in 455-5.10.3, will be included in the measurement for payment. The Engineer will authorize payment for preformed pile holes only when the pile has been placed in proper position and has achieved the required penetration.

455-11.13 Grouted Preformed Pile Holes: The quantity added to the payment for piling will be 70% of the length of grouted preformed pile holes from the bottom of preformed hole acceptably provided to the required top of grouting, regardless of the type of pile (test pile or production pile) installed therein. Only those holes required to be grouted, will be included in the measurement for payment.

SUBARTICLE 455-16.3 is deleted and the following substituted:

455-16.3 Support, Alignment, and Tolerance: Tie and support the reinforcing steel in the shaft so that the reinforcing steel will remain within allowable tolerances as specified in 455-20 and Section 415.

Ensure concentric spacing for the entire length of the cage. As a minimum, use centering devices consisting of wheels or other approved noncorrosive spacing devices within

3 feet of the bottom, within 6 feet of the top, and intervals not exceeding 10 feet along the cage length. When a casing with an inside diameter (I.D.) larger than the required shaft diameter is used, provide, within the portion of the oversized casing, centering devices specially dimensioned or other means to ensure the casing and the cage are concentric. Do not use block or wire type spacers. Ensure no permanent metallic elements will be within the concrete cover space. Use a minimum of one spacer per 30 inches of circumference of cage with a minimum of four at each level. Provide spacers at the bottom of the drilled shaft reinforcing cage as required to maintain the proper position of the cage.

Check the elevation of the top of the steel cage before and after placing the concrete. If the cage is not within the specified tolerances, correct, and submit a revised DSIP to the Engineer for approval. Do not construct additional shafts until receiving approval from the Engineer.

SUBARTICLE 455-17.6.1.3 is deleted and the following substituted:

455-17.6.1.3 Required TITDS Reports: Submit the TITDS data and analysis results to the Engineer in a signed and sealed report, together with all electronic data, within 48 hours of testing. The report shall include as minimum the following items:

1. Graphs displaying all temperature measurements and average temperature versus depth.
2. Indication of unusual temperatures, including cooler local deviations from the average at any depth from the overall average over the entire length.
3. A graph displaying the average temperature and theoretical temperature versus depth.
4. Variations in temperature between access tubes which may indicate variations in cage alignment.
5. The calculated radius of the shaft throughout the entire depth.
6. Calculated concrete cover throughout the entire depth.
7. Shaft Details, Probe Details, Environmental Details, Tube Run Selection and Shaft Adjustment Data that show the measurements, inputs and adjustments to the data. Screen captures of these pages from the TIP Reporter software will be acceptable.
8. A conclusion stating whether the tested shaft is free from integrity defects, meets the minimum concrete cover and diameter requirements by the specifications and the cage is properly aligned. When anomalies are detected, include in the report a three-dimensional rendering of the shape of the shaft.

SUBARTICLE 455-17.6.2 is deleted and the following substituted:

455-17.6.2 Cross Sonic Logging (CSL) and Tomography: When required by the Engineer, perform CSL testing in accordance with ASTM D6760. Engage a qualified Specialty Engineer to perform the CSL testing. The qualified CSL Specialty Engineer must be a Professional Engineer in the State of Florida and have a minimum six months experience of CSL testing, supervising the collection of CSL data and interpretation of CSL results. The individual performing the CLS testing in the field must work for the Specialty Engineer firm and have a

minimum of six months experience of CSL testing. The Contractor shall provide all necessary access and assistance to the CSL Specialty Engineer to satisfactorily perform the testing.

When a shaft contains four tubes, test every possible tube combination. For shafts with five or more tubes, test all pairs of adjacent tubes around the perimeter, and one-half of the remaining number of tube combinations, as chosen by the Engineer. Pull the probes simultaneously, starting from the bottoms of the tubes, over an electronic depth measuring device. Perform the CSL tests with the source and receiver probes in the same horizontal plane. Continuously record CSL signals at depth intervals of 2-1/2 inches or less from the bottom of the tubes to the top of each shaft. Remove all slack from the cables prior to pulling to provide accurate depth measurements in the CSL records. When the measurements indicate a 30% or greater reduction in velocity between one or more pairs, take one or two concrete cores to allow further evaluation and repair, or replace the shaft as directed by the Engineer. Determine the location of the concrete cores by performing 3D tomographic analysis using the CSL measurements. The core depths shall be at least 5 feet deeper than the bottom of the anomaly determined by the 3D tomography analysis or full depth if the anomaly is within 5 feet of the bottom of the shaft. The Engineer may accept a drilled shaft without rock cores if an EAR demonstrates that the anomaly does not affect the structural and the geotechnical axial capacity, the structural and geotechnical lateral stability, the settlement behavior of the shaft, and that the anomaly will not impact the durability of the foundation.

When repairs are done, perform CSL measurements in all tube pair combinations with the source and receiver running at the same horizonal plane and at the vertical offsets of 45 degrees above and below. Perform all measurements including the offset measurements from the point where the higher probe is at least 5 feet below the lower limit of the repaired zone to the point where the lower probe is at least 5 feet above the upper limit of the repaired zone. Offset measurements must be as follows: plus 45 degrees (source below receiver) and minus 45 degrees (source above receiver). Use the measurements of these two offsets in combination with the horizontal measurements to perform the 3D tomography. Provide the CSL measurements, CSL logs and 3D tomographic analysis at no additional cost to the Department.

After acceptance of production shafts by the Engineer, fill the tubes or core holes with a structural non-shrink grout in accordance with 455-17.6.1.

If the Contractor determines at any time during the non-destructive testing and evaluation of the drilled shaft that the drilled shaft should be replaced, no further testing or evaluation of that shaft is required.

ARTICLE 455-20 is deleted and the following substituted:

455-20 Construction Tolerances.

Meet the following construction tolerances for drilled shafts:

1. Ensure that the top of the drilled shaft is no more than 3 inches laterally in the X or Y coordinate from the position indicated in the Plans.

2. Ensure that the vertical alignment of the shaft excavation does not vary from the alignment shown in the Plans by more than 1/4 inches per foot of depth.

3. After placing all the concrete, ensure that the top of the reinforcing steel cage is no more than 6 inches above and no more than 3 inches below plan position.

4. Ensure that the reinforcing cage is concentric with the shaft within a tolerance of 1-1/2 inches. Ensure that concrete cover is a minimum of 4-1/2 inches unless shown otherwise in the Plans.

5. Ensure that the minimum diameter of the drilled shaft is not smaller than the specified shaft diameter minus 1 inch. All casing diameters shown in the Plans refer to I.D. (inside diameter) dimensions. However, the Contractor may use casing with an outside diameter equal to the specified shaft diameter if the extra length described in 455-15.7 is provided. In this case, ensure that the I.D. of the casing is not smaller than the specified shaft diameter minus 1 inch. When approved, the Contractor may elect to provide a casing larger in diameter than shown in the Plans to facilitate meeting this requirement. When conditions are such that a series of telescoping casings are used, provide the casing sized to maintain the minimum shaft diameters listed above.

6. Except when abutting or encroaching within a sidewalk, ensure that the top elevation of the drilled shaft concrete has a tolerance of plus 1 inch and minus 3 inches from the top of shaft elevation shown in the Plans.

7. When abutting or encroaching within a sidewalk, ensure that the top elevation of the drilled shaft is flush with the sidewalk surface.

8. The dimensions of casings are subject to American Petroleum Institute tolerances applicable to regular steel pipe.

9. Use excavation equipment and methods designed so that the completed shaft excavation will have a flat bottom. Ensure that the cutting edges of excavation equipment are normal to the vertical axis of the equipment within a tolerance of plus or minus 3/8 inches per foot of diameter.

ARTICLE 455-44 is deleted and the following substituted:

455-44 Pile Installation.

Meet the following requirements:

1. Locate the piles as shown on the drawings.

2. Should soft, compressible muck, organics, clay or other unsuitable materials (non A-1, A-3, A-2-4 or limestone materials) be encountered, remove the unsuitable material to a maximum depth of 5 feet and a radial distance around the pile centerline of two pile diameters, unless otherwise indicated in the Plans. Backfill with clean granular backfill materials (A-1, A-3, A-2-4), placed and compacted in maximum 12 inch lifts to at least 95% of maximum dry density as determined by FM 1-T180. Complete this work to the Engineer’s satisfaction prior to ACP construction. Should more than 5 feet depth or excessive quantities of unsuitable material be encountered, immediately advise the Engineer and proceed with the work as directed by the Engineer.

3. Provide continuous auger flighting from the bottom of the pile to the top of ground at the time of drilling with no gaps or other breaks, except for connections. Ensure the auger flights are uniform in diameter throughout its length, and of the diameter specified for the piles less a maximum of 3%. Provide augers with a distance between flights of approximately half the diameter of the auger.

4. Use augers with the grout injection hole located at the bottom of the auger head below the bar containing the cutting teeth, and with pile auger leads containing a bottom guide.

5. Construct piles of the length and diameter shown on the Plans.

6. Clearly mark the auger leads to facilitate monitoring of the incremental drilling and grout placement. Provide individual foot marks with 5 foot increments highlighted and clearly visible. Provide a clear reference mark on the moving auger assembly to facilitate accurately monitoring the vertical movement of the auger.

7. Place piles by rotating a continuous flight hollow shaft auger into the ground at a continuous rate that prevents removal of excess soil. Stop advancement after reaching the predetermined depth.

8. Should auger penetration to the required depth prove difficult due to hard materials/refusal, the pile location may be predrilled, upon approval of the Engineer, through the obstruction using appropriate drilling equipment, to a diameter no larger than one-half the prescribed finish diameter of the ACP. Commence grouting immediately upon reaching the required tip elevation to minimize ground loss and soil relaxation. Should non-drillable material be encountered preventing placement to the depth required, immediately advise the Engineer and proceed with the work as directed by the Engineer. Refusal is defined as the depth where the penetration of the standard auger equipment is less than 12 inches per minute.

9. Plug the hole in the bottom of the auger prior to advancing into the ground.

10. Pump the grout with sufficient pressure as the auger is withdrawn to completely fill the auger hole, preventing hole collapse and to cause the lateral penetration of the grout into soft or porous zones of the surrounding soil or rock. Prior to commencing withdrawal of the auger, establish a head of at least 5 feet of grout by pumping a volume of grout equivalent to 5 feet of pile volume. Do not include the volume or strokes required to prime the grout pumping system in the volume required to build this initial head. Maintain this head of at least 5 feet of grout above the injection point around the perimeter of the auger to displace and remove any loose material from the hole. Maintain positive rotation of the auger at least until placement of the grout.

11. Once the grout head has been established, greatly reduce the speed of rotation of the auger and commence extraction at a rate consistent with the pump discharge. Maintain extraction at a steady rate to prevent a locked-in auger, necking of the pile, or a substantially reduced pile section. Ensure grout starts flowing out from the hole when the cutting head is at least 5 feet below the ground surface. Place a minimum volume of grout in the hole of at least 115% of the column of the auger hole from a depth of 5 feet to the tip. Place a minimum volume of grout in the hole of at least 100% of the column of the auger hole from the ground surface to a depth of 5 feet. Do not include any grout needed to create surplus grout head in the volume of grout placed into the hole. If the grout does not flow out from the hole when the cutting head is at least 5 feet below the ground surface, redrill the pile under the direction of the Engineer. If grouting is interrupted for any reason, reinsert the auger by drilling at least 5 feet below the tip of the auger when the interruption occurred, and then regrout.

Use this method of placement at all times. Do not depend on the stability of the hole without the earth filled auger.

12. Assume responsibility for the grout volume placed. If less than 115% of the theoretical volume of grout is placed in any 5 foot increment (100% in the top 5 foot increment), reinstall the pile by advancing the auger 10 feet or to the bottom of the pile if that is less, followed by controlled removal and grout injection.

13. Furnish and install the reinforcing steel and anchoring bolts as shown in the Contract Documents. For ACP for miscellaneous structures and low clearance post options for noise walls, use wheels or other approved noncorrosive spacing devices within 3 feet of the

bottom, within 3 feet of the top, and intervals not exceeding 10 feet along the pile to ensure concentric spacing for the entire length of the cage. Do not use block or wire type spacers. Use a minimum of one spacer per 30 inches of circumference or perimeter of cage with a minimum of three at each level. For noise wall ACP in which the full reinforcement is attached to the post, spacing devices within 3 ft of the top of the pile are not required.

14. Use reinforcement that is without kinks or nonspecified bends, free of mud, oil or other coatings that could adversely affect the bond. Make splices in reinforcement as shown on the Contract Documents, unless otherwise approved by the Engineer. Place the required steel reinforcement while the grout is still fluid, and immediately after finishing grouting and clearing it from any contaminating material. Install the steel cage into the grout by its own weight or manually. Do not use a mechanical equipment or tool to impact the steel cage or to force it into the grout. If the steel cage cannot be placed completely following this procedure, redrill and regrout the pile.

15. Leave any temporary supports of/for items placed into a grouted pile (reinforcement template, anchor bolt template, precast column supports, etc.) in place for a minimum of 12 hours after completion of the pile. Do not place wall panels or other loads, before piles are accepted and the grout has set a minimum of seven days or reached the 28 day strength.