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PART 1 – GENERAL

1.1 REFERENCES

(Issue (date) of references included in project specifications need not be more current than provided by the latest change (Notice) to this guide specification. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.)

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

- ASTM C 31/C 31M (1998) Making and Curing Concrete Test Specimens in the Field
- ASTM C 33 (1999) Concrete Aggregates
- ASTM C 39 (1996) Compressive Strength of Cylindrical Concrete Specimens
- ASTM C 109/C 109M (1999) Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or (50-mm) Cube Specimens)
- ASTM C 150 (1998) Portland Cement
- ASTM C 618 (1998) Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete
- ASTM C 937 (1980; R 1997) Grout Fluidifier for Preplaced-Aggregate Concrete
- ASTM C 939 (1997) Flow of Grout for Preplaced-Aggregate Concrete (Flow Cone Method)
- ASTM D 1143 (1981; R 1994e1) Piles Under Static Axial Compressive Load

1.2 LUMP SUM BASIS FOR BIDS AND PAYMENT

Where the basis for bidding is based on lump sum price, use the following paragraphs

The pile diameter specified shall be the diameter of the auger, which should be 50 mm (2 inches) larger in diameter than that used to calculate the structural capacity of the pile. The structural capacity of the pile should be based on an allowable design stress no greater than 20 percent of

the 28-day grout strength. The number of augered test piles shall depend on the degree of variations in subsoil conditions as revealed by test borings. In general, a minimum of 3 augering tests should be made; more where subsurface conditions are questionable. One test pile shall be load tested in each area of substantially different subsoil conditions, but not less than one pile load test for the project. The total test load should be twice the working load on the pile, which should not exceed 36 metric tons (40 tons) per pile. Withdrawal of the auger and examination of the soil to verify the soil profile should be required for all test piles and for 10 percent of the remaining piles to supplement the soil boring information. The contract price for piling shall be a principal sum based on [] inch diameter piles, (including [] test piles), having a total aggregate length of [] linear feet and shall include [] pile load tests having a capacity of [] ton and [] auger withdrawals.

1.2.1 Variations in Pile Quantities

The Contracting Officer/Owner will determine and record for the Contractor "calculated" pile tip elevations for all the piles from the results of laboratory tests on soil samples and data obtained as a result of placing and loading the test piles specified herein. The Contracting Officer/Owner reserves the right to increase or decrease the total length of piles to be furnished and installed by changing the pile locations or elevations, requiring the installation of additional piles, or directing the omission of piles from the requirements shown and specified. Should the total pile length installed vary from that specified as the basis for bidding because of added or omitted piles or variations in the pile lengths, the principal sum shall be adjusted by the amount bid per linear foot for "Additional Pile Length" or "Omitted Pile Length".

1.2.2 Variations in Pile Load Test Quantities

The Contracting Officer/Owner reserves the right to increase or decrease the number of pile load tests from that specified for the basis of bidding. For changes in the number of load tests required, the contract principal sum price shall be adjusted by the amount bid for "Each Additional Pile Load Test" or "Each Omitted Pile Load Test."

1.2.3 Variations in Auger Withdrawal Quantities

Should the number of auger withdrawals be increased above the specified contracted number, at the direction of the Contracting Officer/Owner, the contract principal sum shall be adjusted by the amount bid for "Each Additional Auger Withdrawal".

1.2.4 Lump Sum Basis of Payment

The Contractor's furnished price shall include all necessary equipment, tools, material, labor, and supervision required for installing and cutting off the piles (including test piles); for conducting the load tests; and for auger withdrawals, in order to meet the applicable contract requirements. Payment for piles will be on the basis of the lengths of the piles measured from cut-off elevations to final tip elevations. No additional payment will be made for withdrawn, damaged, or rejected piles; for any portion of a pile remaining above the cut-off elevation; for cutting off piles; nor for any cut off lengths of piles. Payment for load tests will be made for each load test satisfactorily performed. Payment for auger withdrawal will be made for each auger withdrawal made at the direction of the Contracting Officer/Owner.

1.3 UNIT PRICE BASIS FOR BIDS AND PAYMENTS

Where the basis for bidding is based on unit price, use the following paragraphs

1.3.1 Piles

The lump sum contract price does not include foundation piles, test piles, or the placement thereof. Payment for which will be made in accordance with paragraph Unit Price Basis of Payment.

1.3.2 Unit Price Basis of Payment

The Contracting Officer/Owner reserves the right to increase or decrease the length of piles to be furnished and installed, to change the foundation pile locations or elevations, to require the installation of additional piles, or to require omission of piles from the requirements shown and specified. Whether or not such changes are made, the Contractor will be paid at the contract unit price per linear foot (including test piles), multiplied by the total linear feet of acceptable piles actually installed; provided however, that in the event the Contracting Officer/Owner requires an increase or decrease in the total length of piles furnished and installed, the contract unit price will be adjusted in accordance with SPECIAL CONTRACT REQUIREMENTS.

1.3.3 Full Compensation

Payment in accordance with paragraph Unit Price Basis of Payment shall constitute full compensation for furnishing, delivering, handling, and/or installing (as applicable) all material, labor and equipment necessary to meet contract requirements applicable to the foundation piles. The Contractor will not be allowed payment for withdrawn, broken, or rejected piles, nor (except for control test piles) for a portion of any pile remaining above the cut-off point.

1.3.4 Load Tests

The contract includes [] pile load tests. The Contracting Officer/Owner reserves the right to increase or decrease the number of pile load tests. Adjustments in the contract price will be made for such increases or decreases in the amount bid for "Each Additional Pile Load Test" or "Each Omitted Pile Load Test."

1.4 SUBMITTALS

Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required. Indicate submittal classification by using "G" or "O" when the submittal requires Government or Owner approval. Submittals not classified as "G" or "O" will show on the submittal register as For Information Only "FIO". When used, a designation following the "G" or "O" identifies the department that will review the submittal.

The following shall be submitted in accordance with Section SUBMITTAL PROCEDURES:

SD-02 Shop Drawings: Auger-placed Grout Piles; [], [] Drawings to demonstrate compliance of augering, mixing, and pumping equipment, and installation and installed piles with contract documents. Drawings shall include detail and erection details and reinforcement as specified. Test Piles; [], [] A complete and accurate record of all auger-placed grout piles (both test and production piles). The record shall indicate the pile location, diameter, length, elevation of tip and top of pile, and the quantity and strength of grout material actually pumped in each pile hole. Any unusual conditions encountered during pile installation shall be reported immediately to the Contracting Officer/Owner.

SD-03 Product Data: Grout Pump; [], [] Materials; [], [] Grout Specimens for Laboratory Tests; [], [] Grout specimens for Contractor Tests; [], [] A description of the materials to be used and the proposed methods of operations.

SD-07 Certificates: Auger-placed Grout Piles; [], [] Evidence to the Contracting Officer/Owner that the Contractor has been engaged in the successful installation of auger-placed grout piles for at least [] years.

1.5 DESCRIPTION

Auger-placed grout piles are not recommended in low strength soils such as peat or soils

containing layers or fields of boulders or cobbles. Working load on the pile should be limited to 36 metric tons (40 tons) per pile. Assuming subsurface conditions are adequate, the working load on the pile should be limited to about 36 metric tons (40 tons) per pile for 300 mm (12 inch) piles up to about 73 metric tons (80 tons) per pile for 450 mm (18 inch) piles.

Auger-placed grout piles are formed by the rotation of a continuous flight hollow-shaft auger into the ground to the tip elevation established by the requirements specified elsewhere in this section. Grout is then injected through the auger shaft as the auger is being withdrawn in such a way as to exert removing pressure on the withdrawing earth-filled auger as well as lateral pressure on the soil surrounding the grout-filled pile hole.

1.6 REQUIREMENTS

The ground surface at each pile location at the time of augering and grouting, shall be at least 300 mm (12 inches) higher than the required pile cut-off elevation and the augered hole shall be completely filled with grout. All materials shall be fed to the mixer accurately measured by weight, except water that may be measured by volume. The order of placing the materials shall be water, fluidifier, and other solids in order of increasing particle size. Time of mixing shall not be less than 1 minute.

Each pile hole shall be drilled and filled with grout in an uninterrupted operation, except where the auger withdrawal is required or directed by the Contracting Officer/Owner. When the auger is withdrawn to check the soil profile, it shall be reinserted in the pile hole to the required tip elevation and the pile hole filled with grout, without interruption.

The minimum inside diameter of the hollow shaft of the auger flight shall be 1-1/4 inches. Grout injection equipment shall be provided with a grout pressure gauge in clear view of the equipment operator. Rate of grout injection and rate of auger withdrawal from the soil shall be coordinated to maintain, at all times, a positive pressure on this gauge which will, in turn, indicate the existence of a "removing pressure" on the bottom of the auger flight. The magnitude of this pressure and performance of other augering and grouting procedures, such as rate of augering, rate of grout injection, and control of grout return around the auger flight are dependent on soil conditions and equipment capability and shall be at the option of the Contractor, subject to review by the Contracting Officer/Owner. The auger hoisting equipment shall be capable of withdrawing the auger smoothly and at a constant rate. If the auger jumps upward during withdrawal, it shall be reinserted to the original tip elevation and the rate of withdrawal decreased to prevent further jumping.

Material excavated by augering shall be disposed of by the Contractor outside the limits of the right-of-way, unless otherwise directed. No pile shall be left partially completed overnight but must be completely grouted and protected at the termination of each day's operation.

1.7 SUBSURFACE DATA

(This paragraph is to be used by the Government/Owner to show the subsurface soil data logs. The subsoil investigation report and samples of the materials may be examined in the [____].)

1.8 GROUT PUMP

The grout pump shall be a positive displacement pump of an approved design. The pump discharge capacity shall be calibrated in strokes per cubic foot, or revolutions per cubic foot, by a method approved by the Contracting Officer/Owner. Oil or other rust inhibitors shall be removed from the mixing drums and pressure grout pumps prior to mixing and pumping.

PART 2 – PRODUCTS

2.1 MATERIALS

2.1.1 Grout

(Insert the ultimate compressive strength required by the design (3,000 psi) minimum). Grout shall consist of a mixture of portland cement, a pozzolanic material (when approved) fluidifier, sand, and water. This mixture will be proportioned and mixed to produce a grout capable of being pumped with an ultimate compressive strength of [] psi at 28 days. Other admixtures shall not be used.

2.1.1.1 Portland Cement

Cement Portland cement shall conform to ASTM C 150.

2.1.1.2 Pozzolan

Pozzolan shall be a fly ash or other approved pozzolanic material conforming to ASTM C 618.

2.1.1.3 Grout Fluidifier

Grout fluidifier shall conform to ASTM C 937, except that expansion shall not exceed 4 percent. The fluidifier shall be a compound possessing characteristics that will increase the flowability of the mixture, assist in the dispersal of cement grains, and neutralize the setting shrinkage of the high-strength cement mortar.

2.1.1.4 Water

Water shall be fresh, clean, and free from sewage, oil, acid, alkali, salts, or organic matter.

2.1.1.5 Fine Aggregate

(To be used as alternate requirement.) Fine aggregate shall meet the requirements of ASTM C 33. The sand shall consist of hard, dense, durable, uncoated rock particles and be free from injurious amounts of silt, loam, lumps, soft or flaky particles, shale, alkali, organic matter, mica, and other deleterious substances. If washed, a washing method shall be used that will not remove desirable fines, and the sand shall subsequently be permitted to drain until the residual-free moisture is reasonably uniform and stable. The sand shall be well-graded from fine to coarse, with fineness modulus between 1.30 and 3.40. [The fineness modulus is defined as the total divided by 100 of the cumulative percentages retained on U.S. Standard Sieve Numbers 16, 30, 50, and 100.]

2.1.1.6 Aggregate

Aggregate shall meet the requirements of ASTM C 33, for fine aggregate, except as to grading. The sand shall consist of hard, dense, durable, uncoated rock fragments and shall be free from injurious amounts of silt, lumps, loam, soft, or flaky particles, shale, alkali, organic matter, mica, and other deleterious substances. If washed, the method shall not remove other desirable fines and the sand shall be permitted to drain until the residual free moisture is reasonably uniform and stable. Sand grading shall be reasonably consistent and shall conform to the following requirements as delivered to the grout mixer:

U.S. Standard Sieve Number	Cumulative Percent by Weight Passing	Cumulative Percent by Weight Retained
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8	100	0
16	95-100	0-5
30	55-80	20-45
50	30-55	45-70
100	10-30	70-90
200	0-10	90-100

The sand shall have a fineness modulus of not less than 1.30 and not more than 2.10. Sand grading shown above may be modified with the approval of the Contracting Officer/Owner. Mortar test specimens made with the modified sand shall exhibit compressive strength equal to, or greater than, that exhibited by similar specimens made with sand meeting grading and other requirements shown above.

2.1.2 Reinforcement

Materials, assembly, and placement of reinforcement shall conform to the requirements of Section 03300 CAST-IN-PLACE STRUCTURAL CONCRETE.

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PART 3 – EXECUTION

3.1 GROUT VOLUME

The volume of grout per linear foot of pile shall be not less than the volume of grout per foot of test piles. All volume measurements shall be made in the presence of the Contracting Officer/Owner.

3.2 CASINGS

The Contractor may use steel cylinder casings as a soil retention liner as soil warrants. Casings shall be approved by the Contracting Officer/Owner and shall be left in place and filled with grout. Casings shall be of sufficient strength and rigidity to withstand all installation stresses, to prevent distortion caused by placing adjacent piles, and to prevent collapse due to soil or hydrostatic pressure. The casing shall be rotated by the auger drive unit (weighted or jetted) to the required depth. After the casing is in place, the casing and hole shall be cleared of water, sediment, and debris prior to pouring the grout.

3.3 FLOW CONE TEST

The quantity of water used shall produce a grout having a consistency of not less than 21 seconds, when tested with a flow cone in accordance with ASTM C 939.

3.4 GROUT SPECIMENS FOR LABORATORY TESTS

(To be used as alternate requirement.) Grout tests shall be conducted in accordance with ASTM C 109/C 109M in a laboratory, approved by the Contracting Officer/Owner. Test specimens shall be prepared by pouring grout into 2 x 2 x 2 inch cube molds. Not less than 9 cubes shall be cast during each 8-hour shift. Three cubes shall be tested at 7 days; 3 at 28 days; and 3 at 90 days

3.5 GROUT SPECIMENS FOR CONTRACTOR TESTS

(The requirement of this paragraph may be waived.) (Insert the total number of pile holes requiring withdrawal of auger before inserting the mortar.) Withdrawal and examination of the auger to verify the soil profile should be required at all test pile locations and at 10 percent of the remaining pile locations to supplement the soil boring information. Grout tests shall be conducted by the Contractor in accordance with ASTM C 31/C 31M and ASTM C 39. Test specimens of grout shall be prepared by pouring grout into 6 x 12 inch cylinder molds. Molds shall be provided with a top cover plate designed to restrain grout expansion and to permit escape of air and water. Not less than 1 set of cylinders shall be collected during the placing of each group of 15 piles or fraction thereof. One set shall consist of 6 cylinders of which three cylinders shall be tested in 7 days and three cylinders at 28 days. Any set in cylinders of which one or more cylinders test at 10 percent or more below the required strength shall be cause for rejection of the pile group.

3.6 TEST PILES

3.6.1 Placement

)Insert the grout strength required at the time the test load is applied, which could be the specified 28-day strength if Type III (high-early strength) cement is used or 75 percent of the specified 28-day strength if regular cement is used.) Test piles shall be of the type, and shall be placed in the manner, specified elsewhere in this section. The Government/Owner will use test pile and load test data in addition to test reports on soil samples to determine "calculated" pile tip elevations. Piles immediately adjacent to the test pile shall be placed after placing test pile and prior to load testing. Test piles that are located within the tolerances indicated for all piles and provide a safe design capacity as determined by the results of a satisfactory load test may be used in the finished work. Test loads shall not be applied to the piles until the grout has obtained a minimum strength of [_____]psi.

3.6.2 Depth

For all test piles, the auger shall be withdrawn after reaching the "calculated" tip elevation and before grout is pumped. The Contracting Officer/Owner will be present to check the soil conditions and shall have the right to increase the test pile length, if soil conditions warrant. In such cases, the Contracting Officer/Owner may require additional auger withdrawals after drilling to the lower tip elevation. Such additional auger withdrawals shall be included in the total number of auger withdrawals made. The pile hole shall not be filled with grout until the Contracting Officer/Owner has approved the final tip elevation.

3.6.3 Loading Test

ASTM D 1143 contains several requirements, which would not be considered applicable to routine pile load testing. It may be advisable to qualify the requirement that load tests be performed in accordance with ASTM D 1143 as follows:

1. Delete the requirement for pretest information;
2. Permit a recent calibration of the test jack, pressure gauge, etc., instead of requiring such calibration to be made immediately prior to the test;
3. Permit the use of test jacks, which are not equipped with spherical bearings;
4. Permit the wedges and not the loads to be adjusted so they remain loose as settlement occurs;
5. Permit the supports for beams to which dial gauges are attached to be a minimum distance of 1.5 m (5 feet) from the center of the test pile;
6. Specifically delete the optional requirement for incremental strain measurement;
7. Delete the requirement that the test load is to be removed upon reaching loads of 50 and 100 percent of the anticipated working load;
8. Delete the requirement that the load is to be reapplied to 200 percent of the

- working load after removal of the test loads;
9. Delete the requirement that the pile is to be tested to 300 percent of the anticipated working load.
 10. The requirement of performing the load tests under the direct supervision of a registered professional engineer may be waived by the Contracting Officer/Owner

The load tests at locations shown or directed shall be made on test piles placed to the tip elevation used for establishing lengths of piles for bidding, except as otherwise directed by the Contracting Officer/Owner. Loading, testing, and recording of data shall be under the supervision of a registered professional engineer. The analysis of the load test data shall be performed by the registered professional engineer. The registered professional engineer shall be provided and paid by the Government/Owner. The installation of contract piles shall not proceed within each area of substantially different subsoil conditions until a satisfactory load test has been performed in that area.

3.6.4 Acceptance

(Insert twice the pile design working load.) Test piles shall be loaded to twice the design working load of [] tons, unless failure occurs first. The safe design capacity of a test pile, as determined from the results of load tests, shall be the lesser of the two values computed according to the following:

- a. One-half the load that causes a net settlement after rebound of not more than 0.01 inch per ton of total test load.
- b. One-half the load that causes a gross settlement of not more than 1 inch, provided that the load settlement curve shows no sign of failure.

3.6.5 Tolerances

Piles shall be located as shown on drawings or as otherwise directed by the Contracting Officer/Owner. Piles shall be installed from the ground surface existing after general excavation work has been completed. The maximum variation of the center of any pile from the required location shall be 2 inches at the ground surface, and no pile shall be out-of-plumb by more than 2 percent. Piles damaged, mislocated, or out of alignment beyond the maximum tolerance shall be abandoned and additional piles shall be placed as directed.

3.7 TEST PILES WITHDRAWALS

In addition to the test pile holes, the auger shall be withdrawn from the ground at [] pile holes. Before pumping grout, the soil profile at the "calculated" pile tip elevation will be checked by the Contracting Officer/Owner.

3.8 PROTECTION OF PILES

The sequence of pile installation shall be such that adjacent piles show no evidence of disturbance. This evidence would appear as a drop in the grout surface. The load applied to the soil by the drilling equipment shall be far enough away from the pile being drilled to avoid compressing or shearing the soil, which may in turn, displace or squeeze-off the grout column. No piles shall be placed within 5 feet of adjacent piles until the grout in the existing piles has set for 3 days, unless otherwise directed by the Contracting Officer/Owner.

3.9 SPECIAL INSPECTION AND TESTING FOR SEISMIC -RESISTING SYSTEMS

(Include this paragraph only when special inspection and testing for seismic-resisting systems is

required by paragraph 3.2 of FEMA 302, NEHRP RECOMMENDED PROVISIONS FOR SEISMIC REGULATIONS FOR NEW BUILDINGS AND OTHER STRUCTURES.)

This paragraph will be applicable to both new buildings designed according to TI 809-04, SEISMIC DESIGN FOR BUILDINGS, and to existing building seismic rehabilitation designs done according to TI 809-05, SEISMIC EVALUATION AND REHABILITATION FOR BUILDINGS. The designer must indicate on the drawings all locations and all features for which special inspection and testing is required in accordance with Chapter 3 of FEMA 302. This includes indicating the locations of structural components and connections requiring inspection. (Add any additional requirements as necessary.)

Special inspections and testing for seismic-resisting systems and components shall be done in accordance with Section SPECIAL INSPECTION FOR SEISMIC-RESISTING SYSTEMS.