SECTION 316316 - AUGER CAST GROUT PILES

This Section covers piles excavated by auger drilling and filled with grout.

Revise this Section by deleting and inserting text to meet Project-specific requirements.

The Unit Prices Article has been deleted from this section on direction from the Director of Division of Design. Continue to state quantities of work on the drawings. Any variance in the quantity of work will be negotiated by a field order or change order to the contract.

1. GENERAL
	* + 1. RELATED DOCUMENTS
				1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
			2. SUMMARY
				1. Section includes auger cast grout piles.
			3. PREINSTALLATION MEETINGS

Retain "Preinstallation Conference" Paragraph below if Work of this Section is extensive or complex enough to justify a conference.

* + - * 1. Preinstallation Conference: Conduct conference at [**Project site**].
			1. REFERENCE STANDARDS
				1. American Concrete Institute

ACI 305.1 - Specification for Hot Weather Concreting

ACI 306.1 - Standard Specification for Cold Weather Concreting

* + - * 1. ASTM International

ASTM A615 - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement

ASTM A772 - Standard Test Method for AC Magnetic Permeability of Materials Using Sinusoidal Current

ASTM C33 - Standard Specification for Concrete Aggregates

ASTM D94 - Standard Test Methods for Saponification Number of Petroleum Products

ASTM C109 - Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. Cube Specimens)

ASTM C150 - Standard Specification for Portland Cement

ASTM C172 - Standard Practice for Sampling Freshly Mixed Concrete

ASTM C494 - Standard Specification for Chemical Admixtures for Concrete

ASTM C618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete

ASTM C937 - Standard Specification for Grout Fluidifier for Preplaced-Aggregate Concrete

ASTM C939 - Standard Test Method for Flow of Grout for Preplaced-Aggregate Concrete (Flow Cone Method)

ASTM C942 - Standard Test Method for Compressive Strength of Grouts for Preplaced-Aggregate Concrete in the Laboratory

ASTM C1017 - Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete

ASTM C1077 - Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation

ASTM D1143 - Standard Test Methods for Deep Foundations Under Static Axial Compressive Load

ASTM D3689 - Standard Test Methods for Deep Foundations Under Static Axial Tensile Load

ASTM D3740 - Standard Practice for Minimum Requirements for Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction

ASTM D3966 - Standard Test Methods for Deep Foundations Under Lateral Load

ASTM D5882 - Standard Test Method for Low Strain Impact Integrity Testing of Deep Foundations

ASTM E329 - Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection

* + - * 1. American Welding Society

AWS D1.1 - Structural Welding Code-steel

AWS D1.4 - Structural Welding Code-reinforcing steel

* + - * 1. International Organization of Standards

ISO/IEC 17025 - General requirements for the competence of testing and calibration laboratories

* + - 1. SUBMITTALS
				1. Submittals for this Section are subject to the re-evaluation fee identified in Article 4 of the General Conditions.
				2. Manufacturer’s installation instructions shall be provided along with product data.
				3. Submittals shall be provided in the order in which they are specified and tabbed (for combined submittals).
				4. Product Data: For each type of product.

USE PARAGRAPH BELOW WITH EPD REQUIREMENT WHEN PROJECT ESTIMATE IS $1M OR MORE.

* + - * 1. Submit an Environmental Product Declaration (EPD) from the manufacturer for each concrete mix and steel reinforcement bar within this specification section, if available. A statement of the contractor’s good faith effort to obtain the EPD shall be provided if not available.

Manufacturer-provided EPDs must be Product Specific Type III (Third-Party Reviewed), in adherence with ISO 14025 *Environmental labels and declarations*, ISO 14044 *Environmental management – Life cycle assessment*, and ISO 21930 *Core rules for environmental product declarations of construction products and services.*

* + - * 1. Design Mixtures: For each grout mixture. Submit alternative design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

Indicate amounts of mixing water to be withheld for later addition at Project site.

* + - * 1. Shop Drawings: For auger cast grout piles, prepared by or under the supervision of a qualified Professional Engineer, licensed in the State of New York.

Identify each pile and indicate pile dimensions, cross sections, locations, sizes, and numbering plan.

Indicate types and configurations of reinforcement and detail fabricating.

Detail connections to pile caps.

Include method of centralizing reinforcement, type and size of centralizing devices, and locations on reinforcing bars.

Retain "Static Pile Tests" Subparagraph below if specifying these tests.

Static Pile Tests: Include arrangement of static test pile reaction frame, test and anchor piles, equipment, and instrumentation. Submit structural analysis data signed and sealed by the qualified Professional Engineer, licensed in the State of New York, responsible for their preparation.

* + - * 1. Qualification Data: For testing agency.

Retain "Welding certificates" Paragraph below if retaining "Welding Qualifications" Paragraph in "Quality Assurance" Article.

* + - * 1. Welding certificates.

Retain "Material Certificates" Paragraph below to require submittal of material certificates from manufacturers.

* + - * 1. Material Certificates: For the following:

Cementitious materials.

Concrete admixtures.

Steel reinforcing.

* + - * 1. Equipment Data: Description of drilling and grout-pumping equipment including the following:

Type and make of drilling rig, rated capacity, and boom lengths.

Torque of drilling machine and horsepower of hydraulic power unit.

Pressure and discharge capacity of grout pump.

Automated monitoring equipment to be used.

* + - * 1. Static Pile Test Reports: Submit within three days of completing each test.
				2. Pile Inspection Reports: Submit not later than the morning of the next working day after placing each pile.
				3. Certified Piles Survey: Submit within [**seven**] days of completion.

Retain "Field quality-control reports" Paragraph below if Contractor is responsible for field quality-control testing and inspecting.

* + - * 1. Field quality-control reports.
				2. Preinstallation Survey Report: Submit existing conditions survey conducted by licensed NYS Land Surveyor of area in vicinity of proposed pile installation including adjacent buildings and utilities. Additionally, provide photographic/video documentation of existing conditions identifying existing irregularities.
			1. CLOSEOUT SUBMITTALS
				1. Record Drawings.
				2. Certified Pile Survey: Submit within seven days of pile installation completion.
			2. QUALITY ASSURANCE

Retain "Testing Agency Qualifications" Paragraph below if Contractor selects testing agency or if Contractor is required to provide services of a qualified testing agency in "Field Quality Control" Article.

* + - * 1. Testing Agency Qualifications: Qualified according to ASTM C1077, ASTM D3740, and ASTM E329 for testing indicated[**and accredited by IAS or ILAC Mutual Recognition Arrangement as complying with ISO/IEC 17025**].
				2. Mix Designs: For each type of grout. Include description of type and proportions of ingredients.

Retain "Welding Qualifications" Paragraph below if shop or field welding is required. If retaining, also retain "Welding certificates" Paragraph in "Informational Submittals" Article.

* + - * 1. Welding Qualifications: Qualify procedures and personnel according to the following:

AWS D1.1, "Structural Welding Code - Steel."

AWS D1.4, "Structural Welding Code - Reinforcing Steel."

* + - 1. PRECONSTRUCTION TESTING

Retain this article if load testing is required to verify design assumptions during pile installation. Load testing is usually performed before permanent pile installation.

* + - * 1. Test Piles: Construct of diameter, depth, and at locations indicated on Drawings or, if not indicated, of same diameter and depth as largest production piles and at locations selected by Director’s Representative, to confirm allowable load of piles and demonstrate Installer's construction methods, equipment, standards of workmanship, and tolerances.

If Director’s Representative determines that test pile does not comply with requirements, install for and cast another until it is accepted.

Tests: Arrange and perform the following pile tests:

Retain appropriate tests in subparagraphs below. Insert optional loading apparatus and loading procedures if required.

Axial Compressive Static Load Test: ASTM D1143, Procedure A, Quick Test[**and the following Procedures:**]

Delete, revise, or add other Procedures in first three subparagraphs below to suit Project. Retain first option in "Axial Compressive Static Load Test" Subparagraph above if retaining below.

Procedure B, Maintained Test.

Procedure C, Loading in Excess of Maintained Test.

Procedure G, Cyclic Loading Test.

Axial Tension Static Load Test: ASTM D3689.

Lateral Load Test: ASTM D3966.

Retain first subparagraph below or revise for other displacement indicators if required.

Equip each test pile with two telltale rods, according to ASTM D1143, for measuring deformation during load test.

Provide pile reaction frame, anchor piles, equipment, and instrumentation with enough reaction capacity to perform tests. Notify Director’s Representative at least 48 hours in advance of performing tests. On completion of testing, remove testing structure, anchor piles, equipment, and instrumentation.

Allow a minimum of [**seven**] days to elapse after installing test piles before starting pile testing.

Revise "Number of Test Piles" Subparagraph below to suit Project.

Number of Test Piles: [**One pile**] [**As indicated**].

Revise "Approval Criteria" Subparagraph below to suit Project. Criteria are examples only.

Approval Criteria: Allowable load shall be the load acting on the test pile when[**the lesser of**] the following criteria are met, divided by a factor of safety of [**2**]:

Retain one or more of first three subparagraphs below or insert other criteria to suit Project.

Net settlement of not more than 0.01 inch/ton of test load.

Total settlement of 1 inch provided the load settlement curve shows no sign of failure.

A plunging failure or sharp break in the load settlement curve.

Test Pile Records: Prepare records for each test pile[**, compiled and attested to by a qualified professional engineer, licensed in the State of New York**]. Include same data as required for permanent piles.

Test piles that comply with requirements, including location tolerances, may be used on Project.

* + - 1. FIELD CONDITIONS
				1. Protect structures, underground utilities, and other construction from damage caused by pile excavation.

Revise "Site Information" Paragraph below to suit Project and office practice.

* + - * 1. Site Information: A geotechnical report has been prepared for this Project and is [**included**] [**referenced**] elsewhere in the Project Manual for information only.
				2. Survey Work: Engage a qualified land surveyor or professional engineer, licensed in the State of New York, to perform surveys, layouts, and measurements for auger cast grout piles. Before excavating, lay out each pile to lines and levels required. Record actual measurements of each pile's location, shaft diameter, bottom and top elevations, deviations from specified tolerances, and other specified data.

Record and maintain information pertinent to each pile and indicate on record Drawings. Cooperate with Director’s Representative testing and inspecting agency to provide data for required reports.

1. PRODUCTS
	* + 1. PERFORMANCE REQUIREMENTS

Retain "Delegated Design" Paragraph below if Contractor is required to assume responsibility for design.

* + - * 1. Delegated Design: Engage a qualified professional engineer, licensed in the State of New York, to design piles, including comprehensive engineering analysis, using performance requirements and design criteria indicated.

Consult a structural engineer experienced in engineering auger cast grout piles to quantify design loads applicable to Project. Retain "Design Loads" Sub2 paragraph below if design loads are not indicated on Drawings.

Design Loads: [**As indicated on Drawings**].

* + - 1. STEEL REINFORCEMENT

Revise this article to suit steel reinforcement requirements; delete if not required.

* + - * 1. Reinforcing Bars: ASTM A615, Grade 60, deformed.
				2. Single Bar Reinforcing: ASTM A722, high strength, threaded.

Mechanical Couplings: Screw-on type, capable of supporting the minimum ultimate tensile strength of the coupled bars.

* + - * 1. Centralizers: Devices to center steel reinforcement in excavation; spaced not less than 20 feet o.c. for vertical piles[**and 10 feet o.c. for battered piles**].
			1. CONCRETE MATERIALS
				1. Portland Cement: ASTM C150, [**Type I**] [**Type II**] [**Type I/II**] [**Type III**] [**Type V**].[**Supplement with the following:**]

Retain "Fly Ash" Subparagraph below if permitted. Availability of Class F fly ash predominates over Class C fly ash. Silica flume and blast furnace slag may also be inserted if permitted.

Fly Ash: ASTM C618, [**Class C**] [**Class F**].

* + - * 1. Fine Aggregate: ASTM C33 with 100 percent passing a No. 8 sieve, free of materials with deleterious reactivity to alkali in cement. Provide aggregate from single source.
				2. Water: ASTM C94 and potable.
				3. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures. Do not use calcium chloride or admixtures containing calcium chloride.

Retain one or more chemical admixtures from four subparagraphs below or insert others to suit Project.

Water-Reducing Admixture: ASTM C494, Type A.

Water-Reducing and Retarding Admixture: ASTM C494, Type D.

High-Range, Water-Reducing and Retarding Admixture: ASTM C494, Type G.

Plasticizing and Retarding Admixture: ASTM C1017, Type II.

* + - * 1. Fluidifier: ASTM C937, with expansion of less than 4 percent.
			1. RELATED MATERIALS

Retain "Pile-Top Forms" Paragraph below if required for piles with cutoff elevations above grade.

* + - * 1. Pile-Top Forms: Metal, glass-fiber-reinforced plastic, paper, or fiber tubes. Provide units with enough wall thickness to resist plastic concrete loads without detrimental deformation. Diameter same as pile diameter.
			1. GROUT MIXTURES
				1. Prepare design mixtures for each type and strength of grout, proportioned on the basis of laboratory trial mixture, field test data, or both.

Use a qualified independent testing agency for preparing and reporting proposed mixture designs based on laboratory trial mixtures.

* + - * 1. Proportion grout mixture as follows:

Options in "Minimum Compressive Strength" Subparagraph below are examples only; revise to suit Project.

Minimum Compressive Strength: [**5000 psi**] [**4500 psi**] [**4000 psi** ] at 28 days; ASTM C109 with cube specimens restrained from expansion according to ASTM C942.

Options in "Maximum Water-Cementitious Materials Ratio" Subparagraph below are examples only; revise to suit Project.

Maximum Water-Cementitious Materials Ratio: [**0.43**] [**0.38**].

Grout Flow: [**10 to 25 seconds**]; ASTM C939 and ASTM C109 using a flow cone with 0.75-inch opening.

* + - 1. FABRICATING REINFORCEMENT
				1. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."
			2. GROUT MIXING
				1. Ready-Mixed Grout: Measure, batch, mix, and deliver according to ASTM C94, and furnish batch ticket information.

Temperature Limits: Comply with ACI 305.1 for hot weather and ACI 306.1 for cold weather.

1. EXECUTION
	* + 1. PREPARATION
				1. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, and other hazards created by drilling operations.
				2. Perform Preinstallation Survey and document existing conditions using photographs and videos.

Delete paragraph below if pile-top casings are used to extend pile tops above adjacent ground elevation.

* + - * 1. Rough grade ground elevation at pile locations to a minimum of [**12**] inches above required cutoff elevation.
			1. DRILLING AND PUMPING EQUIPMENT
				1. Drilling Rig: Capable of advancing hollow-stem, continuous-flight augers of design diameters to depths 20 percent greater than design depths; with stabilizing arm at bottom of leads to prevent rotation, and middle guide for augers greater than 40 feet in length.

Mark leads at maximum 60-inch intervals to facilitate measurement of penetration.

* + - * 1. Hollow-Stem Auger: Continuous auger flighting without gaps or breaks, of diameter no more than 3 percent less than pile diameter; with grout pumping hole at bottom of auger head below cutting teeth. Seal grout-pumping hole with temporary tip plug to be fully opened by grout pressure or reinforcing bar during grout installation.

Hollow Shaft Diameter: Minimum [**1-1/4-inch**] clear ID.

* + - * 1. Grout Pump: Positive-displacement pump with a known volume per stroke. Minimum displacement pressure at pump of [**350**] lbf/sq. in..
				2. Automated Monitoring Equipment: Capable of measuring auger depth, penetration rate, and grout volume pumped per unit depth increment and of printing results.
			1. INSTALLATION
				1. Prevent surface water from entering excavated shafts. Conduct water to site drainage facilities.
				2. Advance auger at a continuous rate during insertion that prevents removal of excess soil.
				3. Install piles to [**elevations indicated**] [**auger refusal**] [**elevations indicated or auger refusal**]. Establish and maintain axial alignment of leads and shaft before and during driving.

Retain "Auger Refusal" Subparagraph below if retaining second or third option in last paragraph above. Revise auger refusal rate to suit Project.

Auger Refusal: Rate of less than [**1 fpm**].

* + - * 1. Drilling Tolerances:

Location: Pile centers maximum [**3**] inches from locations indicated.

Plumb: Within [**2**] percent from vertical.

Batter Angle: Within [**4**] percent from required angle.

* + - 1. INSTALLATION
				1. Maintain positive (clockwise) rotation of auger during withdrawal. Promptly remove excavated spoils to prevent accumulation.
				2. Grout Placement: Place grout in continuous operation.

Lift auger [**6**] to [**12**] inches at start of grout pumping to facilitate tip plug removal, then return to previously established tip elevation.

Develop an initial grout head of [**60 inches**] before start of auger withdrawal and maintain during extraction.

Monitor pumped grout volumes using automated monitoring equipment.

Volume of placed grout is at least [**115**] percent of theoretical volume. If less than required volume is placed for any given [**60**]-inch segment, lower auger a minimum of [**60**] inches, or to bottom of pile if less than [**60**] inches available, and restart withdrawal.

If grout pumping is interrupted during placement, lower auger a minimum of [**60**] inches, or to bottom of pile if less than [**60**] inches available, and restart withdrawal.

* + - * 1. Steel Reinforcement Installation, General: Comply with recommendations in CRSI's "Manual of Standard Practice."

Clean reinforcement of loose rust and mill scale, earth, and other materials that reduce or destroy bond with grout.

Screen pile top to remove spoils immediately after auger withdrawal and before placing reinforcement.

* + - * 1. Single Bar Reinforcing: Install through center of hollow-stem auger before grout placement.
				2. Reinforcing Cages: Install immediately after grout placement and support at ground surface until initial set. Allow cages to fall into shaft freely under their own weight; do not force by vibrating or pushing with mechanical equipment.
				3. Adjacent Piles: Do not install piles within [**6 pile diameters**] of piles grouted within the previous [**12**] hours.
				4. Pile Completion:

Where cutoff elevation is above the ground elevation, form top section above grade and extend shaft to required elevation with pile-top form.

Where cutoff elevation is below the ground elevation, cut off top of piles at elevations indicated by removing fresh grout from the top of pile or cutting off hardened pile top after initial set.

* + - * 1. If location or out-of-plumb tolerances are exceeded, provide corrective construction. Submit corrective construction proposals to Director’s Representative for review before proceeding.
			1. FIELD QUALITY CONTROL
				1. Inspection:

Directors Representative will engage an inspector to monitor pile driving operations and perform final inspection of completed work.

Notify Director’s Representative and testing and inspection agencies 24 hours prior to commencement of pile driving operations.

Additional inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.

* + - * 1. Testing:

Directors Representative will engage a testing agency to perform required tests.

Test Piles: Required test piles are indicated on the Drawings. Test piles shall be the first piles installed in the group. Keep the Director’s Representative informed of the schedule for installing test piles. Install test piles with the same equipment to be used for the remainder of the group.

Test piles, if properly located and successfully tested, will be accepted as permanent piles and may be left in place.

Verify with the soils designer that the contractor is to compile the driving records. Modify paragraph below if state personnel will compile the records.

* + - * 1. Grout Tests: Testing of samples of fresh grout obtained according to ASTM C172 shall be performed according to the following requirements:

Flow Rate: ASTM C939 and ASTM C109 using a flow cone with 0.75-inch opening.

Compressive Strength: ASTM C109 with cube specimens restrained from expansion according to ASTM C942.

First option in "Testing Frequency" Subparagraph below is recommended by DFI; increase the number of samples taken if additional intermediate testing is required to facilitate Project schedule. Revise if cylinders are required rather than cubes.

Testing Frequency: Obtain [**six**] 2-inch cubes for each 50 cu. yd. or fraction thereof of grout placed, but not less than one set for each day's pour. Obtain an additional set of cubes from each truck during test pile placement.

Revise first subparagraph below if additional intermediate testing is required.

Test two cubes at 7 days, two cubes at 28 days, and hold two cubes in reserve.

Strength of each grout mixture is satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than [**500 psi**].

Report test results in writing to Director’s Representative, grout manufacturer, and Contractor within 48 hours of testing. List Project identification name and number, date of placement, name of testing and inspecting agency, location of grout batch in Work, design compressive strength at 28 days, grout mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests in reports of compressive-strength tests.

Additional Tests: Testing and inspecting agency to make additional tests of grout if test results indicate that compressive strengths or other requirements have not been met, as directed by Director’s Representative.

Perform additional testing and inspecting, at Contractor's expense, to determine compliance of replaced or additional work with specified requirements.

Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.

* + - * 1. Low-Strain Integrity Testing: Performed and reported according to ASTM D5882 on [**five single**] [**3 percent of**] piles and reported for each pile.
				2. Pile Inspection Reports: Prepare inspection reports for each auger cast grout pile as follows:

Revise list below to suit Project.

Pile location.

Pile diameter.

Actual top and bottom elevations.

Final top centerline location and deviations from requirements.

Variation from plumb.

Date and time of starting and completing.

Position and condition of reinforcing steel and splices or mechanical couplings.

Automatic monitoring equipment record including grout volume actually pumped.

Grout testing results.

Remarks, unusual conditions encountered, and deviations from requirements.

If retaining "Certified Piles Survey" Paragraph below, retain "Certified Piles Survey" Paragraph in "Closeout Submittals" Article.

* + - * 1. Certified Piles Survey: Prepared by a qualified land surveyor or professional engineer, licensed in the State of New York, showing final location of piles in relation to the property survey and existing benchmarks.

Notify Director’s Representative when deviations from locations exceed allowable tolerances.

* + - * 1. Prepare test and inspection reports.
				2. Driving Records: Obtain and record the data (required under Quality Control Submittals) on the Driving Records.
				3. Equipment Acceptance:

Unacceptable Piles: Piles that fail tests, are placed out of position, are below cutoff elevations, or are damaged.

Provide additional piles or replace piles to meet specified requirements.

* + - 1. ADJUSTING
				1. Remove improperly located piles and piles found defective after driving. In lieu of removing a pile, at the option of the Director, additional pile(s) may be driven adjacent to the deficient pile providing that this can be done without injury to the structure. Such additional piles shall be at the expense of the Contractor.
			2. DISPOSAL OF SURPLUS AND WASTE MATERIALS
				1. Disposal: Remove surplus satisfactory soil and waste material, including unsatisfactory soil, trash, and debris, and legally dispose of it off State property.

END OF SECTION 316316