SECTION 316329 - DRILLED CONCRETE PIERS AND SHAFTS

This Section covers dry-installed and slurry-displacement-installed drilled piers.

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:

Dry-installed drilled piers.

Slurry displacement-installed drilled piers.

Dry-installed or slurry displacement-installed drilled piers at Contractor's choice.

* + - 1. 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**].

Retain subparagraph below if additional requirements are necessary; include information about conference.

Review methods and procedures related to drilled piers including, but not limited to, the following:

Review geotechnical report.

Discuss existing utilities and subsurface conditions.

Review coordination with temporary controls and protections.

Review measurement and payment of unit prices.

* + - 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 concrete 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.

Retain "Shop Drawings" Paragraph below if drilled piers are reinforced.

* + - * 1. Shop Drawings: For concrete reinforcement, detailing fabricating, bending, supporting, and placing.
				2. Qualification Data: For Installer [**land surveyor**] [**professional engineer**] [**and**] [**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: From manufacturer, for the following:

Cementitious materials.

Admixtures.

Steel reinforcement and accessories.

Retain "Material Test Reports" Paragraph below for material test reports that are Contractor's responsibility.

* + - * 1. Material Test Reports: For each material below, by a qualified testing agency:

Retain option in "Aggregates" Subparagraph below if retaining service record data with "Normal-Weight Aggregate" Paragraph in "Concrete Materials" Article.

Aggregates:[**Include service record data indicating absence of deleterious expansion of concrete due to alkali aggregate reactivity.**]

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. QUALITY ASSURANCE
				1. Installer Qualifications: An experienced installer that has specialized in drilled-pier work.
				2. Testing Agency Qualifications: Qualified according to ASTM C1077, ASTM D3740, and ASTM E329 for testing indicated.

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. TRIAL DRILLED PIER

Retain trial drilled pier if verification of Contractor's methods and equipment is required. Testing a trial drilled pier is an expensive procedure. Coordinate "Trial Drilled Pier" Paragraph below with Drawings for size and location. Insert requirements for preconstruction static-load testing, dynamic-load testing, integrity testing, or rock core testing if required.

* + - * 1. Trial Drilled Pier: Construct trial drilled pier of diameter and depth and at location indicated or, if not indicated, of same diameter and depth as largest drilled piers, located at least three diameters clear of permanent drilled piers, to demonstrate Installer's construction methods, equipment, standards of workmanship, and tolerances.

Revise subparagraphs below to suit Project.

Install reinforcement, fill with concrete, remove temporary casings, and terminate trial drilled pier [**24**] inches below subgrade and leave in place.

Install permanent casings, excavate bell, excavate rock socket, and place slurry, as required for permanent drilled piers.

If Director’s Representative determines that trial drilled pier does not comply with requirements, excavate for and cast another until it is accepted.

* + - 1. FIELD CONDITIONS
				1. Existing Utilities: Locate existing underground utilities before excavating drilled piers. If utilities are to remain in place, provide protection from damage during drilled-pier operations.

Should uncharted or incorrectly charted piping or other utilities be encountered during excavation, adapt drilling procedure if necessary to prevent damage to utilities. Cooperate with Director’s Representative and utility companies in keeping services and facilities in operation without interruption. Repair damaged utilities to satisfaction of utility owner.

Retain "Interruption of Existing Utilities" Paragraph below if interruption of existing utility service is required.

* + - * 1. Interruption of Existing Utilities: Do not interrupt any utility to facilities occupied by Director’s Representative or others unless permitted under the following conditions and then only after arranging to provide temporary utility according to requirements indicated:

Notify [**Director’s Representative**] no fewer than [**two**] days in advance of proposed interruption of utility.

Do not proceed with interruption of utility without [**Director’s Representative’**] written permission.

If office practice differs from “Project-Site Information” Paragraph below, revise below to suit Project or delete.

* + - * 1. Project-Site Information: A geotechnical report has been prepared for this Project and is available for information only. The opinions expressed in this report are those of geotechnical engineer and represent interpretations of subsurface soil conditions, tests, and results of analyses conducted by geotechnical engineer. Director’s Representative is not responsible for interpretations or conclusions drawn from this data.

Make additional test borings and conduct other exploratory operations necessary for drilled piers.

The geotechnical report is [**included**] [**referenced**] elsewhere in the Project Manual.

* + - * 1. Survey Work: Engage a qualified land surveyor or professional engineer, licensed in the State of New York, to perform surveys, layouts, and measurements for drilled piers. Before excavating, lay out each drilled pier to lines and levels required. Record actual measurements of each drilled pier's location, shaft diameter, bottom and top elevations, deviations from specified tolerances, and other specified data.

Record and maintain information pertinent to each drilled pier 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
				1. Drilled-Pier Standard: Comply with ACI 336.1 except as modified in this Section.
			2. STEEL REINFORCEMENT

Retain this article if reinforced-concrete drilled piers are used. Retain type and grade of reinforcement required or revise to suit Project. See the Evaluations in Section 033000 "Cast-in-Place Concrete" for discussion of steel reinforcement.

* + - * 1. Reinforcing Bars: ASTM A615, Grade 60, deformed.

Retain "Low-Alloy-Steel Reinforcing Bars" Paragraph below for reinforcement that is welded or if added ductility is sought.

* + - * 1. Low-Alloy-Steel Reinforcing Bars: ASTM A706, deformed.

Retain "Galvanized Reinforcing Bars" Paragraph below for galvanized-steel reinforcement. Retain type of reinforcement from first set of options; retain zinc coating class from second set. Class I has at least 50 percent more zinc weight than Class II.

* + - * 1. Galvanized Reinforcing Bars: [**ASTM A615, Grade 60**] [**ASTM A706**], deformed bars, ASTM A767, [**Class I**] [**Class II**] zinc coated after fabrication and bending.

Retain "Epoxy-Coated Reinforcing Bars" Paragraph below for epoxy-coated steel reinforcement. Retain type of reinforcement from first set of options; retain epoxy-coated product from second set. ASTM A775 bars are usually epoxy coated before fabrication; ASTM A934 bars are epoxy coated after fabrication and should not be field bent or rebent.

* + - * 1. Epoxy-Coated Reinforcing Bars: [**ASTM A615, Grade 60**] [**ASTM A706**], deformed bars, [**ASTM A775**] [**or**] [**ASTM A934**], epoxy coated, with less than 2 percent damaged coating in each [**12**]-inch bar length.
				2. Plain-Steel Wire: ASTM A82, [**as drawn**] [**galvanized**].
				3. Deformed-Steel Wire: ASTM A496.
				4. Epoxy-Coated Wire: ASTM A884, Class A, Type 1 coated, [**as-drawn, plain**] [**deformed**]-steel wire, with less than 2 percent damaged coating in each [**12**]-inch wire length.

Insert other products for dowels or dowel sleeves if required. See Section 033000 "Cast-in-Place Concrete."

* + - * 1. Joint Dowel Bars: ASTM A615, Grade 60, plain. Cut bars true to length with ends square and free of burrs.
			1. CONCRETE MATERIALS

See the Evaluations in Section 033000 "Cast-in-Place Concrete" for discussion of concrete materials.

* + - * 1. Cementitious Material: Use the following cementitious materials, of same type, brand, and source, throughout Project:

Retain type of portland cement from options in "Portland Cement" Subparagraph below. ACI 336.1 limits portland cement to Type I or II.

Portland Cement: ASTM C150, [**Type I**] [**Type II**] [**Type I/II**] [**Type III**] [**Type V**].[**Supplement with the following:**]

Retain supplementary cementing materials from "Fly Ash" and "Ground Granulated Blast-Furnace Slage" subparagraphs below if permitted. Ready-mix concrete manufacturer blends these materials with portland cement. Fly ash, slag, or pozzolanic materials may slow rate of concrete strengthening. Availability of Class F fly ash predominates over Class C fly ash.

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

Ground Granulated Blast-Furnace Slag: ASTM C989, Grade 100 or 120.

Retain "Blended Hydraulic Cement" Subparagraph below if factory-blended hydraulic cement is permitted; verify availability of options before specifying. Fly ash, slag, or pozzolanic materials in the nonportland cement part of blended hydraulic cement may slow rate of concrete strengthening.

Blended Hydraulic Cement: ASTM C595, [**Type IS, portland blast-furnace slag**] [**Type IP, portland-pozzolan**] [**Type I (PM), pozzolan-modified portland**] [**Type I (SM), slag-modified portland**] cement.

Insert aggregate class from ASTM C33 or aggregate gradation in "Normal-Weight Aggregate" Paragraph below if required. Retain last option below if damage caused by concrete expansion from alkali silica or alkali carbonate reactions is anticipated.

* + - * 1. Normal-Weight Aggregate: ASTM C33, graded, [**3/4-inch-**] nominal maximum coarse-aggregate size. Provide aggregate from a single source[**with documented service record data of at least 10 years' satisfactory service in similar applications and service conditions using similar aggregates and cementitious materials**].

Retain "Fine Aggregate" Subparagraph below if optional restriction for fine aggregate in ASTM C33 is required.

Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

* + - * 1. Water: ASTM C94[**and potable**].
				2. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and that do not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.

Retain one or more chemical admixtures from first four subparagraphs below.

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.

<**Insert admixture**>.

Compressive strength of grout mix in "Sand-Cement Grout" Paragraph below is based on the "Optional Requirements Checklist" accompanying ACI 336.1. Grout is used to fill any visible voids and the annular space between permanent casing and shaft wall or between permanent liner and oversized temporary casing.

* + - * 1. Sand-Cement Grout: Portland cement, ASTM C150, Type II; clean natural sand, ASTM C404; and water to result in grout with a minimum 28-day compressive strength of 1000 psi, of consistency required for application.
			1. STEEL CASINGS

Retain this article if permanent steel casings are required. Retain type of casing from "Steel Pipe Casings" and "Corrugated-Steel Pipe Casings" paragraphs below.

* + - * 1. Steel Pipe Casings: ASTM A283, Grade C, or ASTM A36, carbon-steel plate, with joints full-penetration welded according to AWS D1.1.
				2. Corrugated-Steel Pipe Casings: ASTM A929, steel sheet, zinc coated.

Retain "Liners" Paragraph below if liners are required to suit Project.

* + - * 1. Liners: Comply with ACI 336.1.
			1. SLURRY

Retain this article if slurry displacement-installation method is proposed or is Contractor's choice.

* + - * 1. Slurry: [**Pulverized bentonite**] [**pulverized attapulgite**] [**or**] [**polymers**] mixed with water to form stable colloidal suspension; complying with ACI 336.1 for density, viscosity, sand content, and pH.
			1. CONCRETE MIXTURES
				1. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301.
				2. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement according to ACI 301 limits as if concrete were exposed to deicing chemicals.

Retain first option in first paragraph below if drilled piers are exposed to chlorides in service; retain second option for situations that are not dry or protected from moisture in service. Percentages are from ACI 301 .

* + - * 1. Limit water-soluble, chloride-ion content in hardened concrete to [**0.15**] [**0.30**] percent by weight of cement.

If different concrete mixtures are required, copy paragraph below and re-edit to suit Project; indicate locations of each concrete mixture here or on Drawings.

* + - * 1. Proportion normal-weight concrete mixture as follows:

Retain strength from six options in "Compressive Strength (28 Days)" Subparagraph below. Coordinate compressive strength with water-cementitious materials ratio if concrete is subject to special exposure conditions or sulfate exposure.

Compressive Strength (28 Days): [**6000 psi**] [**5000 psi**] [**4500 psi**] [**4000 psi**] [**3500 psi**] [**3000 psi**].

Retain water-cementitious materials ratio from three options in "Maximum Water-Cementitious Materials Ratio" Subparagraph below or revise to suit Project; delete if in-service durability conditions are benign and limits on water-cementitious materials ratio are not required. Coordinate water-cementitious materials ratio with compressive strength.

Maximum Water-Cementitious Materials Ratio: [**0.50**] [**0.45**] [**0.40**] <**Insert ratio**>.

Minimum Slump: Capable of maintaining the following slump until completion of placement:

Minimum slump in first three subparagraphs below is based on ACI 336.1. Retain applicable subparagraphs for drilling methods permitted. Revise to insert slump limit if applicable; ACI 336.1 sets no upper slump limit.

4 inches for dry, uncased, or permanent-cased drilling method.

6 inches for temporary-casing drilling method.

7 inches for slurry displacement method.

Air Content: Do not air entrain concrete.

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

When air temperature is between [**85**] and [**90**] deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above [**90**] deg F, reduce mixing and delivery time to 60 minutes.

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

Retain "Unclassified Excavation" or "Classified Excavation" Paragraph below. "Unclassified Excavation" Paragraph might be preferred if extensive site investigation reduces risk of facing unanticipated soil conditions. Retain "Classified Excavation" Paragraph if excavation is classified and adjustments in the Contract Sum and, if applicable, in the Contract Time are authorized for excavation for obstructions. Coordinate with unit prices and trial drilled pier in Part 1.

* + - * 1. Unclassified Excavation: Excavate to bearing elevations regardless of character of surface and subsurface conditions encountered. Unclassified excavated materials may include rock, soil materials, and obstructions.

Retain one of two "Obstructions" subparagraphs below. Retain first subparagraph to require excavation to bearing elevations regardless of conditions encountered. Retain second to set guidelines for defining additional cost items.

Obstructions: Unclassified excavation may include removal of unanticipated boulders, concrete, masonry, or other subsurface obstructions. No changes in the Contract Sum or the Contract Time are authorized for removal of obstructions.

Obstructions: Unclassified excavated materials may include removal of unanticipated boulders, concrete, masonry, or other subsurface obstructions. Payment for removing obstructions that cannot be removed by conventional augers fitted with soil or rock teeth, drilling buckets, or underreaming tools attached to drilling equipment of size, power, torque, and downthrust necessary for the Work is according to Contract provisions for changes in the Work.

* + - * 1. Classified Excavation: Excavation is classified as standard excavation, special excavation, and obstruction removal and includes excavation to bearing elevations as follows:

Regional practices described in first two subparagraphs below may vary. Revise to establish more detailed criteria for Project.

In first subparagraph below, insert geotechnical engineer's recommended minimum values for power, torque, and downthrust of drilling equipment if required.

Standard excavation includes excavation accomplished with conventional augers fitted with soil or rock teeth, drilling buckets, or underreaming tools attached to drilling equipment of size, power, torque, and downthrust necessary for the Work.

Rock properties in first subparagraph below could be defined by specifying a maximum rate of penetration to define refusal.

Special excavation includes excavation that requires special equipment or procedures where drilled-pier excavation equipment used in standard excavation, operating at maximum power, torque, and downthrust, cannot advance the shaft.

Special excavation requires use of special rock augers, core barrels, air tools, blasting, or other methods of hand excavation.

Earth seams, rock fragments, and voids included in rock excavation area are considered rock for full volume of shaft from initial contact with rock.

Obstructions: Payment for removing unanticipated boulders, concrete, masonry, or other subsurface obstructions that cannot be removed by conventional augers fitted with soil or rock teeth, drilling buckets, or underreaming tools attached to drilling equipment of size, power, torque, and downthrust necessary for the Work is according to Contract provisions for changes in the Work.

* + - * 1. Prevent surface water from entering excavated shafts. Conduct water to site drainage facilities.
				2. Excavate shafts for drilled piers to indicated elevations. Remove loose material from bottom of excavation.

Retain applicable subparagraphs below.

Excavate bottom of drilled piers to level plane within 1:12 tolerance.

Remove water from excavated shafts before concreting.

Retain first subparagraph below if socketing drilled pier into rock.

Excavate rock sockets of dimensions indicated.

Retain subparagraph below if grooving lower portions of shaft to develop side resistance.

Cut series of grooves about perimeter of shaft to height from bottom of shaft, vertical spacing, and dimensions indicated.

Insert new paragraph here if anticipating that some drilled piers might reach suitable bearing at depths above elevations indicated. Insert criteria that define suitable bearing strength of strata, such as minimum compressive strength, penetrometer, or shear strength tests.

* + - * 1. Notify and allow testing and inspecting agency to test and inspect bottom of excavation. If unsuitable bearing stratum is encountered, make adjustments to drilled piers as determined by Director’s Representative.

Do not excavate shafts deeper than elevations indicated unless approved by Director’s Representative.

Payment for additional authorized excavation is according to Contract provisions for changes in the Work.

Retain first "End-Bearing Drilled Piers" Paragraph below if further exploration below bearing elevation is required for end-bearing piers or if soft soils are suspected. Use of auger probe varies regionally. Delete or revise depth of probe if water-bearing strata may be encountered.

* + - * 1. End-Bearing Drilled Piers: Probe with auger to a depth below bearing elevation, equal to diameter of the bearing area of drilled pier. Determine whether voids, clay seams, or solution channels exist.

Revise frequency of tests in first subparagraph below to suit Project.

Test first three drilled piers and one of every six drilled piers thereafter.

Fill augur-probe holes with grout.

Retain "End-Bearing Drilled Piers" Paragraph below if drilled piers bear on clay or hardpan.

* + - * 1. End-Bearing Drilled Piers: Probe with auger to a depth of 96 inches below bottom elevation of shaft, and visually inspect and classify soil. Verify continuity and thickness of strata.

Revise frequency of tests in subparagraph below to suit Project.

Test first three drilled piers and one of every six drilled piers thereafter.

If retaining first paragraph below, revise to state minimum spacing determined by geotechnical engineer.

* + - * 1. Excavate shafts for closely spaced drilled piers and for drilled piers occurring in fragile or sand strata only after adjacent drilled piers are filled with concrete and allowed to set.

Retain "Slurry Displacement Method" Paragraph below if slurry is required or permitted.

* + - * 1. Slurry Displacement Method: Stabilize excavation with slurry maintained a minimum of 60 inches above ground-water level and above unstable soil strata to prevent caving or sloughing of shaft. Maintain slurry properties before concreting.

Excavate and complete concreting of drilled pier on same day, or redrill, clean, and test slurry in excavation before concreting.

Retain "Temporary Casings" Paragraph below if permanent casings are not required. Temporary casings may not be required if permanent casings are not used.

* + - * 1. Temporary Casings: Install watertight steel casings of sufficient length and thickness to prevent water seepage into shaft; to withstand compressive, displacement, and withdrawal stresses; and to maintain stability of shaft walls.

Remove temporary casings, maintained in plumb position, during concrete placement and before initial set of concrete[**, or leave temporary casings in place**].

Retain "Bells" Paragraph below if bells are required. Examine soil stability and constructability before designing drilled piers with bells.

* + - * 1. Bells: Excavate bells for drilled piers to shape, base thickness, and slope angle indicated. Excavate bottom of bells to level plane and remove loose material before placing concrete.

Retain subparagraph below if shoring of bells is necessary or practical.

Shore bells in unstable soil conditions to prevent cave-in during excavation, inspection, and concreting.

Review ACI 336.1 tolerances and revise "Tolerances" Paragraph below to insert exceptions if applicable.

* + - * 1. Tolerances: Construct drilled piers to remain within ACI 336.1 tolerances.

Subparagraph below is based on ACI 336.1 requirements. Revise scope, design responsibility, or corrective procedure if required.

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. PERMANENT STEEL CASING INSTALLATION

Retain this article if installing permanent casings by dry method.

* + - * 1. Install permanent steel casings of minimum wall thickness indicated and of diameter not less than diameter of drilled pier.

Install casings as excavation proceeds, to maintain sidewall stability.

Retain first subparagraph below if casing is seated into rock stratum. Delete if corrugated-steel casing is selected.

Fabricate bottom edge of lowest casing section with cutting shoe capable of penetrating rock and achieving water seal.

Connect casing sections by continuous penetration welds to form watertight, continuous casing.

Remove and replace or repair casings that have been damaged during installation and that could impair strength or efficiency of drilled pier.

Revise subparagraph below if high-slump concrete is permitted.

Fill annular void between casing and shaft wall with grout.

Delete "Corrugated-Steel Casings" Paragraph below if steel pipe casings are used; corrugated-steel casings may not be watertight installations.

* + - * 1. Corrugated-Steel Casings: Provide corrugated-steel casings formed from zinc-coated steel sheet.

Corrugated casings may be delivered in sections or panels of convenient length and field connected according to manufacturer's written instructions.

* + - 1. STEEL REINFORCEMENT INSTALLATION

Retain this article if reinforcement is required.

* + - * 1. Comply with recommendations in CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.
				2. Clean reinforcement of loose rust and mill scale, earth, and other materials that reduce or destroy bond with concrete.
				3. Fabricate and install reinforcing cages symmetrically about axis of shafts in a single unit.
				4. Accurately position, support, and secure reinforcement against displacement during concreting. Maintain minimum cover over reinforcement.
				5. Use templates to set anchor bolts, leveling plates, and other accessories furnished in work of other Sections. Provide blocking and holding devices to maintain required position during final concrete placement.
				6. Protect exposed ends of extended reinforcement, dowels, or anchor bolts from mechanical damage and exposure to weather.
			1. CONCRETE PLACEMENT
				1. Place concrete in continuous operation and without segregation immediately after inspection and approval of shaft by a qualified [**Special Inspector**] [**testing agency**].

Retain subparagraph below if construction joints are approved. If permitted, include limits on locations and details of construction joints on Drawings. Delete option below if amount of steel reinforcement is sufficient.

Construct a construction joint if concrete placement is delayed more than one hour. Level top surface of concrete[**and insert joint dowel bars**]. Before placing remainder of concrete, clean surface laitance, roughen, and slush concrete with commercial bonding agent or with sand-cement grout mixed at ratio of 1:1.

Revise methods or restrictions in "Dry Method" Paragraph below to suit Project. ACI 336.1 permits free-fall concreting, but in its "Optional Requirements Checklist" it cautions against permitting free-fall concreting for pier diameters less than 30 inches. Insert any special requirements for tremie placement or pumping concrete if free-fall concrete is unacceptable.

* + - * 1. Dry Method: Place concrete to fall vertically down the center of drilled pier without striking sides of shaft or steel reinforcement.

Where concrete cannot be directed down shaft without striking reinforcement, place concrete with chutes, tremies, or pumps.

Vibrate top 60 inches of concrete.

Revise or expand slurry displacement methods of concreting in "Slurry Displacement Method" Paragraph below if required.

* + - * 1. Slurry Displacement Method: Place concrete in slurry-filled shafts by tremie methods or pumping. Control placement operations to ensure that tremie or pump pipe is embedded no less than [**60**] inches into concrete and that flow of concrete is continuous from bottom to top of drilled pier.
				2. Coordinate withdrawal of temporary casings with concrete placement to maintain at least a [**60**]-inch head of concrete above bottom of casing.

Vibrate top [**60**] inches of concrete after withdrawal of temporary casing.

* + - * 1. Screed concrete at cutoff elevation level and apply scoured, rough finish. Where cutoff elevation is above the ground elevation, form top section above grade and extend shaft to required elevation.
				2. Protect concrete work, according to ACI 301, from frost, freezing, or low temperatures that could cause physical damage or reduced strength.

Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.

Do not use calcium chloride, salt, or other mineral-containing antifreeze agents or chemical accelerators.

* + - * 1. If hot-weather conditions exist that would seriously impair quality and strength of concrete, place concrete according to ACI 301 to maintain delivered temperature of concrete at no more than 90 deg F.

Retain subparagraph below if significant exposure of portions of drilled piers is expected.

Place concrete immediately on delivery. Keep exposed concrete surfaces and formed shaft extensions moist by fog sprays, wet burlap, or other effective means for a minimum of seven days.

* + - 1. FIELD QUALITY CONTROL
				1. Inspection:

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

Notify Director’s Representative and testing and inspection agencies 24 hours prior to commencement of pile installation 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 Agency: [**Director’s Representative**] will engage a qualified testing agency to perform tests and inspections.

Retain "Drilled-Pier Tests and Inspections" Paragraph below to describe tests and inspections to be performed.

* + - * 1. Drilled-Pier Tests and Inspections: For each drilled pier, before concrete placement.

Soil Testing: Bottom elevations, bearing capacities, and lengths of drilled piers indicated have been estimated from available soil data. Actual elevations and drilled-pier lengths and bearing capacities are determined by testing and inspecting agency. Final evaluations and approval of data are determined by Director’s Representative.

Consider revising "Bearing Stratum Tests" Subparagraph below to suit Project or to include specific tests if Contractor engages testing agency.

Bearing Stratum Tests: Testing agency takes undisturbed [**hardpan**] [**rock**] core samples from drilled-pier bottoms; tests each sample for compression, moisture content, and density; and reports results and evaluations.

* + - * 1. Concrete Tests and Inspections: ASTM C172 except modified for slump to comply with ASTM C94.

Slump: ASTM C143; one test at point of placement for each compressive-strength test but no fewer than one test for each concrete load.

Concrete Temperature: ASTM C1064; one test hourly when air temperature is 40 deg F and below and 80 deg F and above, and one test for each set of compressive-strength specimens.

Compression Test Specimens: ASTM C31; one set of four standard cylinders for each compressive-strength test unless otherwise indicated. Mold and store cylinders for laboratory-cured test specimens unless field-cured test specimens are required.

Revise number of test cylinders in "Compression Test Specimens" Subparagraph above and number of tests in "Compressive-Strength Tests" Subparagraph below if required.

Compressive-Strength Tests: ASTM C39; one set for each drilled pier but not more than one set for each truck load. Test one specimen at seven days, test two specimens at 28 days, and retain one specimen in reserve for later testing if required.

If frequency of testing provides fewer than five strength tests for a given class of concrete, conduct tests from at least five randomly selected batches or from each batch if fewer than five are used.

If strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, Contractor shall evaluate operations and provide corrective procedures for protecting and curing in-place concrete.

Strength of each concrete 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, concrete manufacturer, and Contractor within 48 hours of testing. List Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests in reports of compressive-strength tests.

Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Director’s Representative but not be used as sole basis for approval or rejection of concrete.

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

Retain first subparagraph below if full-depth coring is anticipated.

Continuous coring of drilled piers may be required, at Contractor's expense, if temporary casings have not been withdrawn within specified time limits or if observations of placement operations indicate deficient concrete quality, presence of voids, segregation, or other possible defects.

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. An excavation, concrete, or a drilled pier will be considered defective if it does not pass tests and inspections.
				2. Prepare test and inspection reports for each drilled pier as follows:

Revise list below to suit Project.

Actual top and bottom elevations.

Actual drilled-pier diameter at top, bottom, and bell.

Top of rock elevation.

Description of soil materials.

Description, location, and dimensions of obstructions.

Final top centerline location and deviations from requirements.

Variation of shaft from plumb.

Shaft excavating method.

Design and tested bearing capacity of bottom.

Depth of rock socket.

Levelness of bottom and adequacy of cleanout.

Properties of slurry and slurry test results at time of slurry placement and at time of concrete placement.

Ground-water conditions and water-infiltration rate, depth, and pumping.

Description, purpose, length, wall thickness, diameter, tip, and top and bottom elevations of temporary or permanent casings. Include anchorage and sealing methods used and condition and weather tightness of splices if any.

Description of soil or water movement, sidewall stability, loss of ground, and means of control.

Bell dimensions and variations from original design.

Date and time of starting and completing excavation.

Inspection report.

Condition of reinforcing steel and splices.

Position of reinforcing steel.

Concrete placing method, including elevation of consolidation and delays.

Elevation of concrete during removal of casings.

Locations of construction joints.

Concrete volume.

Concrete testing results.

Remarks, unusual conditions encountered, and deviations from requirements.

<**Insert requirement**>.

* + - 1. 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 316329