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USACE / NAVFAC / AFCEC / NASA **UFGS-31 63 29 (November 2019)**

Preparing Activity: USACE **Superseding**
UFGS-31 63 29 (November 2014)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in Agreement with UMRL dated July 2023

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SECTION 31 63 29

DRILLED CONCRETE PIERS AND SHAFTS
11/19

NOTE: This guide specification covers the requirements for the procurement, installation, and testing of drilled concrete piers and shafts.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

PART 1 GENERAL

NOTE: Use the following specifications in conjunction with this section:

Section 01 35 26 GOVERNMENTAL SAFETY REQUIREMENTS

On the drawings, show:

1. Subsurface-soil-data logs.

2. Top and bottom elevation of each drilled pier and/or shaft.

3. Size (diameter in mm inches), bearing capacity, and total number of each size of drilled pier and/or

shaft.

4. Dimensions of the bell, if required.

5. Dimensions of the casing.

6. Reinforcing steel details, if required.

7. Location of drilled piers and/or shafts to be penetration tested, if required.

8. Location of drilled piers and/or shafts to be proof tested, if required.

9. Locations, size, and installation sequence of load testing drilled pier and/or shaft, if required.

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[1.1 UNIT PRICES

a. Requirements for price breakdown of drilled concrete piers or shafts are specified in Section 01 20 00 PRICE AND PAYMENT PROCEDURES. Requirements for construction scheduling related to drilled concrete piers or shaft work are specified in Section 01 32 17.00 20 NETWORK ANALYSIS SCHEDULES (NAS).

b. Requirements for price breakdown of drilled concrete piers or shaft work are specified in Section 01 20 00 PRICE AND PAYMENT PROCEDURES.

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NOTE: This paragraph anticipates bids on a lump sum price for an entire project including drilled concrete piers or shaft work with directed changes being in accordance with the CONTRACT CLAUSES or in accordance with unit prices as defined in paragraph SEPARATE UNIT PRICES.

Delete "in accordance with the CONTRACT CLAUSES" or paragraphs "TESTS" and "SEPARATE UNIT PRICES" for lump sum projects.

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[1.1.1 Basis of Bids

Base the bid on the number and total length of drilled concrete [piers] [and] [shafts], established by top and bottom elevations and diameters, as indicated and specified. Adjustment of the contract will be made [in accordance with the CONTRACT CLAUSES], if the total length of drilled concrete [piers] [or] [shafts] installed and approved is greater or less than the total length shown. The Contractor will not receive payment for rejected concrete [piers] [or] [shafts] or for those not conforming to specifications.

][1.1.2 Tests

1.1.2.1 Load Test

The Contract includes [_____] load tests rated at [_____] metric tons kips per drilled concrete [pier] [or] [shaft]. The Contracting Officer reserves the right to increase or decrease the number of load tests.

Adjustments in the contract price will be made for each such increase or decrease by the amount bid for "Additional Drilled Concrete [Pier] [or] [Shaft] Test" or "Omitted Drilled Concrete [Pier] [or] [Shaft] Load Test".

1.1.2.2 Penetration Test

The Contract includes [_____] penetration tests. The Contracting Officer reserves the right to increase or decrease the number of penetration tests. Adjustments in the contract price will be made for each such increase or decrease by the amount bid for "Additional Penetration Test" or "Omitted Penetration Test".

1.1.2.3 Proof Test Hole

The Contract includes [_____] proof test holes. The Contracting Officer reserves the right to increase or decrease the number of proof test holes. Adjustments in the contract price will be made for each such increase or decrease by the amount bid for "Additional Proof Test Hole" or "Omitted Proof Test Hole".

][1.1.3 Separate Unit Prices

1.1.3.1 Additional Concrete [Pier][or][Shaft] Lengths

Additional [pier] [shaft] lengths will be paid for at the contract unit price for "Additional [Pier] [Shaft] Length" for each diameter of [pier] [shaft] installed as approved.

1.1.3.2 Omitted [Pier] [and] [Shaft] Lengths

The contract price will be reduced by the amount bid for "Omitted [Pier] [Shaft] Length" for each diameter of [pier] [shaft] omitted as directed.

1.1.3.3 Casings Permanently Left in Place

Steel casings permanently left in place due to contract conditions:

a. Total pounds of steel beyond casings indicated will be paid for at the contract unit price per pound for "Additional Steel Casing."

b. Omitted Casing Steel: The contract price will be reduced by the amount bid for "Omitted Casing Steel" omitted as directed.

1.1.3.4 Reinforcing Steel for Additional [Piers] [Shafts]

Reinforcing steel for additional [pier] [shaft] lengths will be paid for at the contract unit price for "Additional [Pier] [Shaft] Reinforcing Steel" installed as approved.

1.1.3.5 Reinforcing Steel for [Piers] [Shafts] Omitted

The contract price will be reduced by the amount bid for "Omitted [Pier] [Shaft] Reinforcing Steel" omitted as directed.

1.1.3.6 Removal of Rock

Removal of rock within the limit of [piers] [shafts] will be paid for at the contract unit price for "Removal of Rock" per linear meter foot, for each diameter of [pier] [shaft] installed. Rock excavation is defined as

any hard dense material that cannot be removed with [pier] [shaft] drilling equipment having the specified capacity and could only be removed by hand, air tools, blasting, or other specialized methods.

1.1.3.7 Removal of Obstructions Other Than Rock

Removal of obstructions other than rock within the limits of the [piers] [shafts] which cannot be removed using standard drilling equipment with the specified capacity will be paid for at the contract unit price per linear meter foot for "Removal of Obstructions" for each diameter of [pier] [shaft] installed.

][1.1.4 Basis of Payment

1.1.4.1 Unit Price

The Contracting Officer has the right to increase or decrease the total length linear footage of drilled [piers] [shafts] to be furnished and installed by changing the [pier] [shaft] elevations, by requiring the installation of additional [piers] [shafts], or omission of [piers] [shafts] 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 meter foot (including drilled pier and/or shaft) multiplied by the total linear meters feet of acceptable [piers] [shafts] actually installed provided, however, that in the event the Contracting Officer requires an increase or decrease in the total lengthlinear footage of [piers] [shafts] furnished and installed, the contract unit price will be adjusted in accordance with the CONTRACT CLAUSES.

1.1.4.2 Full Compensation

Payment in accordance with the above paragraph Unit Price constitutes full compensation for furnishing, delivering, handling, and/or installing (as applicable) all material, labor and equipment necessary to meet contract requirements applicable to the [piers] [shafts]. The Contractor will not be allowed payment for rejected [piers] [shafts].

1.1.4.3 Load Tests

The Contract includes [_____] [_____] -metric tonskips [pier] [shaft] load tests. The Contracting Officer reserves the right to increase or decrease the number of load tests. Adjustments in the contract price will be made for such increases or decreases by the amounts bid for "Additional [Pier] [Shaft] Load Test" or "Omitted [Pier] [Shaft] Load Test."

1.1.4.4 Penetration Tests

The Contract includes [_____] penetration tests. The Contracting Officer reserves the right to increase or decrease the number of penetration tests. Adjustments in the contract price will be made for such increases or decreases by the amounts bid for "Additional Penetration Test" or "Omitted Penetration Test."

1.1.4.5 Proof Test Holes

The Contract includes [_____] proof test holes. The Contracting Officer reserves the right to increase or decrease the number of proof test holes. Adjustments in the contract price will be made for such increases or decreases by the amounts bid for "Additional Proof Test Hole" or

"Omitted Proof Test Hole."

]]1.2 REFERENCES

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NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.
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The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 117	(2010; Errata 2011) Specifications for Tolerances for Concrete Construction and Materials and Commentary
ACI 301	(2016) Specifications for Structural Concrete
ACI 304R	(2000; R 2009) Guide for Measuring, Mixing, Transporting, and Placing Concrete
ACI 305R	(2020) Guide to Hot Weather Concreting
ACI 306.1	(1990; R 2002) Standard Specification for Cold Weather Concreting
ACI 318	(2014; Errata 1-2 2014; Errata 3-5 2015; Errata 6 2016; Errata 7-9 2017) Building Code Requirements for Structural Concrete (ACI 318-14) and Commentary (ACI 318R-14)
ACI 336.1	(2001) Specification for the Construction of Drilled Piers
ACI SP-66	(2004) ACI Detailing Manual

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE 7-16	(2017; Errata 2018; Supp 1 2018) Minimum

	Design Loads and Associated Criteria for Buildings and Other Structures

AMERICAN WELDING SOCIETY (AWS)

AWS A5.1/A5.1M	(2012) Specification for Carbon Steel Electrodes for Shielded Metal Arc Welding
AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel
AWS D1.4/D1.4M	(2011) Structural Welding Code - Reinforcing Steel

ASTM INTERNATIONAL (ASTM)

ASTM A615/A615M	(2022) Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM A1064/A1064M	(2022) Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
ASTM C31/C31M	(2022) Standard Practice for Making and Curing Concrete Test Specimens in the Field
ASTM C39/C39M	(2021) Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C94/C94M	(2022a) Standard Specification for Ready-Mixed Concrete
ASTM C143/C143M	(2020) Standard Test Method for Slump of Hydraulic-Cement Concrete
ASTM C150/C150M	(2022) Standard Specification for Portland Cement
ASTM C172	(2010) Standard Practice for Sampling Freshly Mixed Concrete

CONCRETE REINFORCING STEEL INSTITUTE (CRSI)

CRSI 10MSP	(2018) Manual of Standard Practice

U.S. FEDERAL HIGHWAY ADMINISTRATION (FHWA)

FHWA NHI-10-016	(2010) Drilled Shafts: Construction Procedures and LRFD Design Methods

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1926.651	Specific Excavation Requirements

1.3 SUBMITTALS

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NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy, Air Force, and NASA projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

Choose the first bracketed item for Navy, Air Force and NASA projects, or choose the second bracketed item for Army projects.

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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or “S” classification are [for Contractor Quality Control approval.][for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government.] Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Installation Plan

SD-02 Shop Drawings

Drilled Shaft Diameters[; G[, [____]]]

Depth of Test Holes[; G[, [____]]]

Top and Bottom of Shaft Elevations[; G[, [____]]]

Steel Reinforcement[; G[, [____]]]

Anchor Bolt Locations[; G[, [____]]]

Accessories[; G[, [____]]]

SD-05 Design Data

Drilled Shaft Foundation Design Analysis[; G[, [____]]]

Mix Design Data[; G[, [____]]]

SD-06 Test Reports

Soils Report[; G[, [____]]]

Ground Water Conditions

Load Test[; G[, [____]]]

Penetration Test[; G[, [____]]]

Slump

Concrete[; G[, [____]]]

Compressive Strength[; G[, [____]]]

SD-07 Certificates

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NOTE: Specify load tests when needed to confirm design capacities. At least one pier or shaft location should be load tested in each area of substantially different subsoil conditions. Indicate number, size, and location of test pier or shaft and sequence.
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Bill of Lading for Ready-Mix Concrete Deliveries

Steel Reinforcement[; G[, [____]]]

Welding Certificates[; G[, [____]]]

Excavation and Drilling Equipment

Qualifications of Excavator[; G[, [____]]]

Qualifications of Engineer[; G[, [____]]]

1.4 QUALITY CONTROL

1.4.1 General

Install drilled shaft foundations in accordance with applicable requirements as described by ACI 336.1, and FHWA NHI-10-016.

1.4.2 Sequencing and Scheduling

Submit a detailed installation plan describing the schedule for drilling and/or excavation, installation of steel reinforcement and concrete placement with anticipated site conditions so that each excavated shaft is poured the same day that the drilling is performed.

1.4.3 Inspection Criteria

Design inspection activities to minimize delays while insuring the intent of the Industry Standard Specifications.

1.4.4 Qualification of Excavation Contractor

An experienced excavator with five (5) years experience and licensed in the State of [_____], specialized in excavating and installing work similar in material, design, and extent to that indicated for this Project. Submit certificates substantiating the Qualifications of Excavator.

1.4.5 Qualification of Professional Engineer

Provide engineering services by an authorized engineer currently licensed in the State of [_____]; having a minimum of four (4) years experience as an engineer knowledgeable in drilled shaft foundation design analysis, protocols and procedures for the ACI 336.1, FHWA NHI-10-016, ASCE 7-16, and the [_____] Building Code. Submit certificates substantiating the Qualifications of Engineer.

1.4.6 Welding Qualifications

Provide and maintain qualified procedures and personnel according to AWS D1.1/D1.1M, AWS D1.4/D1.4M, and AWS A5.1/A5.1M. Submit Welding Certificates to the Contracting Officer.

1.4.7 Pre-Construction Conference

After submittals are received and approved but before drilled shaft excavation and foundation work, including associated work, is performed, the Contracting Officer will hold a pre-construction conference to review the following:

a. The drawings, specifications and the geotechnical report.

b. Finalize construction schedule and verify availability of materials, Excavator's personnel, equipment, and facilities needed to make progress and avoid delays.

c. Methods and procedures related to drilled shaft foundation installation, including engineer's written instructions.

d. Support conditions for compliance with requirements, including alignment between foundation system and erection of structural members.

e. Governing regulations and requirements for, certificates, insurance, tests and inspections if applicable.

f. Temporary protection requirements for foundation assembly during and after installation.

1.5 PROJECT CONDITIONS

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NOTE: Require proof testing if the soundness of rock below the pier or shaft bearing level is unknown. Indicate location of each pier or shaft to be proof tested.

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1.5.1 Existing Conditions

Locate existing underground utilities before excavating drilled shaft foundations. If existing utilities are to remain in place, provide protection during drilled shaft operations.

1.5.2 Interruption of Existing Utilities

Do not interrupt any utility to occupied facilities unless directed in writing by the Contracting Officer.

1.5.3 Weather Limitations

Proceed with installation preparation only when existing and forecasted weather conditions permit work to proceed without water entering into the area of excavation.

PART 2 PRODUCTS

2.1 DESIGN REQUIREMENTS

Submit design data for the following:

a. Drilled shaft foundation design analysis to include, but not limited to the following:

   (1) Applicable Building code criteria for the excavation's geographic area

   (2) Dead and Live Loads

   (3) Compressive and Lateral Loads

   (4) Collateral Loads

   (5) Foundation Loads

   (6) Bearing strata

   (7) Casing description

b. Mix design data in accordance with paragraph READY-MIX CONCRETE accompanied by the Bill of Lading for Ready Mix Concrete deliveries.

2.1.1 Assembly

Installation drawings are to include, but not limited to, the following items indicating a completely dimensioned layout and location of drilled shafts and concrete placement for foundation system. Submit detailed shop

drawings for the following:

a. Drilled shaft diameters

b. Depth of test holes

c. Top and bottom of shaft elevations

d. Steel reinforcement

e. Anchor bolt locations

f. Accessories

2.2 EQUIPMENT

2.2.1 Drilling and Excavation Equipment

Provide drilling and excavation equipment having adequate capacity, including but not limited to, power, torque and down thrust to excavate a hole of diameter and depth indicated. Also provide excavation and over-reaming tools of adequate design, size and strength to perform the work indicated.

Provide special drilling equipment including, but not limited to, rock core barrels, rock tools, air tools and other equipment as necessary to construct the shaft excavation to the size and depth indicated when materials encountered can not be drilled using earth augers and/or over-reaming tools.

Submit certificates substantiating appropriate selection of excavation and drilling equipment.

2.3 MATERIALS

2.3.1 Steel Reinforcement

2.3.1.1 Deformed Steel Bars

Steel bars conforming to ASTM A615/A615M, Grade 60 ksi and ACI 318.

2.3.1.2 Plain Steel Wire

Steel wire conforming to ASTM A1064/A1064M.

2.3.2 Ready-Mix Concrete

Ready-Mix concrete and mix design conforming to ACI 117, ACI 301, and ACI 304R, minimum compressive strength 5,500 psi at 28 days. Slump results between 5 to 6 inches, according to ASTM C143/C143M.

Portland cements conforming to ASTM C150/C150M, Type II. Provide one brand and type of cement for formed concrete having exposed-to-view finished surfaces.

Potable water conforming to ASTM C94/C94M.

Measure, batch, mix and deliver concrete according to ASTM C94/C94M and furnish batch ticket information.

PART 3 EXECUTION

3.1 PREPARATION

Protect existing structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, vibration, and other hazards created by drilled shaft foundation operations.

Provide Fall Protection as required by Section 01 35 26 GOVERNMENTAL SAFETY REQUIREMENTS and 29 CFR 1926.651.

3.2 INSTALLATION

3.2.1 Construction Criteria

Provide equipment for checking the dimensions and alignment of each shaft excavation. Determine dimensions and alignment jointly with the contractor and engineer. Measure final shaft depths with appropriate weighted tape measure or other approved method after cleaning.

Provide and install monolithically cast-in-place concrete drilled shaft foundation to the sizes indicated.

Provide and install straight cylindrical shaft foundation of the type indicated.

Tolerances:

a. Maximum variation of the center of any shaft foundation from the required location: 7.62 cm 3 inches, measured at the ground surface.

b. Bottom Diameter: Minus zero, plus 15.24 cm 6 inches, measured in any direction.

c. Maximum variation from plumb: 1:40.

d. Maximum bottom level: Plus or minus 5.08 cm 2 inches.

3.2.2 Excavation

Accomplish excavation of shaft foundations by standard excavation methods including, but not limited to, conventional augers fitted with soil and/or rock teeth, or under-reaming tools attached to drilling equipment of adequate size, power, torque and down thrust necessary for the work.

Perform excavation through whatever materials that are encountered to the dimensions, depths and applicable ACI 336.1 tolerances.

Protect excavated walls with temporary watertight steel casings of sufficient length to prevent water intrusion, cave-ins, displacement of surrounding earth, and injury to personnel and damage to construction operations.

Excavate shafts for drilled foundations to indicated elevations. Remove loose debris, materials and/or muck to make bottom surfaces level within ACI 336.1 tolerances.

Remove water from excavated shaft prior to concrete placement.

3.2.3 Steel Reinforcement

Comply with recommendations in the CRSI "Manual of Standard Practice" CRSI 10MSP for fabricating, placing and supporting reinforcement. Shop fabricate steel reinforcement in accordance with ACI SP-66.

When practicable, deliver the reinforcement cage assembly to the jobsite as a complete unit ready for installation. Should it be necessary to make any additional connections and/or splices, provide as indicated on the approved shop drawings, at-grade level prior to lowering the complete assembly into the hole.

Clean reinforcement of loose rust, mill scale, earth and other foreign materials. Do not tack weld crossing reinforcing bars. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.

Lower reinforcement steel into the hole in such a manner as to prevent damage to the walls of the excavation. Place, tie and/or clip cage symmetrically about the axis of the shaft. Use centering devices securely attached to the cage to clear the shaft walls and maintain the cage in place throughout the concrete placement operations.

Cooperate with other trades in setting of anchor bolts, inserts, and other embedded items. Where conflicts occur between reinforcing and embedded items, notify the Contracting Officer in order to reconcile conflicts before concrete placement. Position and support anchors and embedded items with appropriate accessories.

Use templates to set anchor bolts, leveling plates and other accessories required for structure erection. Provide blocking and/or holding devices to maintain required anchoring positions during final concrete placement.

3.2.4 Concrete Placement

Keep all equipment, including but not limited to, mixers, pumps, hoses, tools and screeds clean and free of set concrete throughout the placement operation.

Convey concrete from the mixer to place of deposit by best industry methods that prevents segregation and loss of material. Size and design the equipment for conveying concrete to ensure uniform, continuous placement of concrete.

Place concrete in accordance with ACI 318.

Place concrete in a continuous operation and without segregation into dry excavations whenever possible after inspection and written approval by the Contracting Officer. Use all practicable means to obtain a dry excavation before and during concrete placement.

Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. When hot weather conditions exist that would impair quality and strength of placed concrete, comply with ACI 305R. Comply with ACI 306.1 for cold-weather protection.

A minimum of 50 percent of the base for each shaft is to be less than 1.27 cm 1/2 inch of sediment at the time of concrete placement. Maximum depth of sediment or debris at any place on the base of the shaft is not to

exceed 3.81 cm 1-1/2 inches. Shaft cleanliness is to be determined by the engineer by visual inspection.

3.3 FIELD QUALITY CONTROL

3.3.1 Test Reports

As a minimum, submit the following test reports and data.

a. Soils Report

b. Ground Water conditions

c. Load Test

d. Penetration Test

e. Slump

f. Concrete

g. Compressive Strength

Sample and test concrete for quality control during placement.[Quality control testing is provided by the contract.]

Sample freshly placed concrete for testing in accordance with ASTM C172.

Make concrete test specimens for compressive strength at 7 and 28 days for each design mix conforming to ASTM C31/C31M. Compression test concrete in accordance with ASTM C39/C39M.

Test Slump at plant for each design mix in accordance with ASTM C143/C143M.

-- End of Section --