# SECTION 31 63 29

# DRILLED CONCRETE PIERS

## PART 1 - GENERAL

### 1.1. SCOPE

A. Section Includes:

1. Dry-installed or slurry displacement-installed drilled piers.

### 1.2. RELATED SECTIONS

Section 03 20 00 – Concrete Reinforcing.

### 1.3. REFERENCED CODES AND STANDARDS

A. Standards and References listed below apply where designation is cited in this Section. Where applicable year of adoption or revision is not listed below, the latest edition applies.

B. San Francisco Building Code (SFBC) 2019.

C. American Concrete Institute (ACI) Standards

1. 301-16 – Specifications for Structural Concrete.
2. 318-14 – Building Code Requirements for Structural Concrete.
3. 336.1-01 – Specification for the Construction of Drilled Piers.

D. American Society for Testing and Materials (ASTM) Standards

1. A36-14 – Standard Specification for Carbon Structural Steel
2. A283-13 – Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates
3. A615-16 – Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
4. A706-16 – Standard Specification for Low Alloy Steel Deformed and Plain Bars for Concrete Reinforcement
5. A929-17 – Standard Specification for Steel Sheet, Metallic-Coated by the Hot-Dip Process for Corrugated Steel Pipe
6. C31-12 – Standard Practice for Making and Curing Concrete Test Specimens in the Field
7. C33-16e1 – Standard Specification for Concrete Aggregates
8. C39-17b – Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
9. C94-17a – Standard Specification for Ready-Mixed Concrete
10. C143-15a – Standard Test Method for Slump of Hydraulic-Cement Concrete
11. C150-17 – Standard Specification for Portland Cement
12. C172-14a – Standard Practice for Sampling Freshly Mixed Concrete

13. C404-11 – Standard Specification for Aggregates for Masonry Grout
14. C494-17 – Standard Specification for Chemical Admixtures for Concrete
15. C618-15 – Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
16. C989-16e1 – Standard Specification for Slag Cement for Use in Concrete and Mortars
17. C1017-13e1 – Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete
18. C1064-12 – Standard Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete

D. American Welding Society (AWS)

1. D1.1 – Structural Welding Code – Steel, Latest Edition
2. D1.4 – Structural Welding Code – Reinforcing Steel, Latest Edition

E. Concrete Reinforcing Steel Institute (CRSI)

1. CRSI MSP-2-01 – Manual of Standard Practice, 27th Edition

1.4. SUBMITTALS

A. Product Data: For each type of product.

B. Design Mixtures: For each concrete mixture. Submit alternative design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

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

C. Shop Drawings: For concrete reinforcement, detailing fabricating, bending, supporting, and placing.

D. Qualification Data: For Installer.

E. Material Certificates: From manufacturer, for the following:

1. Cementitious materials.
2. Admixtures.
3. Steel reinforcement and accessories.

F. Material Test Reports: For each material below, by a qualified testing agency:

1. Aggregates

G. Record drawings.

1.5. QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer that has specialized in drilled-pier work.

1.6. FIELD CONDITIONS

A. 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.

1. 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 Owner and utility companies in keeping services and facilities in operation without interruption. Repair damaged utilities to satisfaction of utility owner.

B. Project-Site Information: A geotechnical report or memo has been prepared for this Project and is available for information only. The opinions expressed in this report or memo are those of geotechnical engineer and represent interpretations of subsoil conditions, tests, and results of analyses conducted by geotechnical engineer. Owner is not responsible for interpretations or conclusions drawn from this data.

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

2. The geotechnical memo or report is referenced elsewhere in the Project Manual.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

A. Drilled-Pier Standard: Comply with ACI 336.1 except as modified in this Section.

### 2.2 STEEL REINFORCEMENT

A. Reinforcing Bars: ASTM A 615, Grade 60, deformed, or ASTM A 706, Grade 60, deformed.

### 2.3 CONCRETE MATERIALS

A. Cementitious Material: Use the following cementitious materials, of same type, brand, and source, throughout Project:

1. Portland Cement: ASTM C 150, Type II. Supplement with the following:

a) Fly Ash: ASTM C 618, Class F.

b) Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.

B. Normal-Weight Aggregate: ASTM C 33, graded, 1-inch- nominal maximum coarse-aggregate size. Provide aggregate from a single source.

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

C. Water: ASTM C 94.

D. 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.

1. Water-Reducing Admixture: ASTM C 494, Type A.

2. Water-Reducing and Retarding Admixture: ASTM C 494, Type D.

3. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494, Type G.

4. Plasticizing and Retarding Admixture: ASTM C 1017, Type II.

E. Sand-Cement Grout: Portland cement, ASTM C 150, Type II; clean natural sand, ASTM C 404; and water to result in grout with a minimum 28-day compressive strength of 1000 psi, of consistency required for application.

## 2.4 STEEL CASINGS

A. Steel Pipe Casings: ASTM A 283, Grade C, or ASTM A 36, carbon-steel plate, with joints full-penetration welded according to AWS D1.1.

1. Corrugated-Steel Pipe Casings: ASTM A 929, steel sheet, zinc coated.

2. Liners: Comply with ACI 336.1.

## 2.5 SLURRY

A. 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.

## 2.6 CONCRETE MIXTURES

A. 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.

1. 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.

2. Limit water-soluble, chloride-ion content in hardened concrete to 0.30 percent by weight of cement.

B. Proportion normal-weight concrete mixture as follows:

1. Compressive Strength (28 Days): 4000 psi.

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

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

b) 6 inches for temporary-casing drilling method.

c) 7 inches for slurry displacement method.

3. Air Content: Do not air entrain concrete.

## 2.7 REINFORCEMENT FABRICATION

A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

## 2.8 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94, and furnish batch ticket information.

1. 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.

## PART 3 - EXECUTION

### 3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, vibration, and other hazards created by drilled-pier operations.

### 3.2 EXCAVATION

A. 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.

1. 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 under-reaming tools attached to drilling equipment of size, power, torque, and down-thrust necessary for the Work is according to Contract provisions for changes in the Work.

B. Prevent surface water from entering excavated shafts. Conduct water to site drainage facilities.

C. Excavate shafts for drilled piers to indicated elevations. Remove loose material from bottom of excavation.

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

2. Remove water from excavated shafts before concreting.

D. 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 Geotechnical Engineer.

1. Do not excavate shafts deeper than elevations indicated unless approved by the Geotechnical Engineer.

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

E. 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.

F. 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.

1. Excavate and complete concreting of drilled pier on same day, or re-drill, clean, and test slurry in excavation before concreting.

G. 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.

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

2. Fiber foaming tube (ex. sonotube) used for forming the top two feet of light pole foundation and shall be removed after installation. Fiber foaming tube shall not be used as temporary casing. For proper contact between light pole foundation and surrounding soil, all temporary casing shall be removed except corrugated steel metal casing.

H. Tolerances: Construct drilled piers to remain within ACI 336.1 tolerances.

1. If location or out-of-plumb tolerances are exceeded, provide corrective construction. Submit corrective construction proposals to Geotechnical Engineer for review before proceeding.

## 3.3 STEEL REINFORCEMENT INSTALLATION

A. Comply with recommendations in CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.

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

C. Fabricate and install reinforcing cages symmetrically about axis of shafts in a single unit.

D. Accurately position, support, and secure reinforcement against displacement during concreting. Maintain minimum cover over reinforcement.

E. Protect exposed ends of extended reinforcement or dowels from mechanical damage and exposure to weather.

## 3.4 CONCRETE PLACEMENT

A. Place concrete in continuous operation and without segregation immediately after inspection and approval of shaft by a qualified Special Inspector.

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

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

2. Do not allow concrete to free-fall into the drilled shaft (dry or wet) for more than 5 feet.

3. Vibrate top 60 inches of concrete.

C. 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.

D. Coordinate withdrawal of temporary casings with concrete placement to maintain at least a 60-inch head of concrete above bottom of casing.

1. Vibrate top 60 inches of concrete after withdrawal of temporary casing.

2. Fill void space between permanent casing and shaft excavation or between

permanent liner and temporary casing with an accepted fluid grout or other accepted material.

E. 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.

F. Protect concrete work, according to ACI 301, from frost, freezing, or low temperatures that could cause physical damage or reduced strength.

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

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

G. 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.

1. 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.

## 3.5 FIELD QUALITY CONTROL

A. Special Inspections: The Contractor will engage a qualified special inspector to perform the following special inspections/testing:

1. Drilled piers.

2. Excavation.

3. Concrete.

4. Placement of steel reinforcing.

B. Testing Agency: The Contractor will engage a qualified testing agency to perform tests and inspections.

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

1. Soil Testing: Bottom elevations and lengths of drilled piers indicated have been estimated from available soil data. Actual elevations and drilled-pier lengths are determined by testing and inspecting agency. Final evaluations and approval of data are determined by Geotechnical Engineer.

D. Concrete Tests and Inspections: ASTM C 172 except modified for slump to comply with ASTM C 94.

1. Slump: ASTM C 143; one test at point of placement for each compressive-strength test but no fewer than one test for each concrete load.

2. Concrete Temperature: ASTM C 1064; 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.

3. Compression Test Specimens: ASTM C 31; 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.

4. Compressive-Strength Tests: ASTM C 39; 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.

5. 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.

6. 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.

7. 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.

8. Report test results in writing to Engineer, 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.

9. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by the Engineer but not be used as sole basis for approval or rejection of concrete.

10. 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 Engineer.

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

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

E. An excavation, concrete, or a drilled pier will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports for each drilled pier as follows:

1. Actual drilled-pier elevations and diameter at top and bottom.

2. Description of soil materials.

3. Description, location, and dimensions of obstructions.

4. Final top centerline location and deviations from requirements.

5. Variation of shaft from plumb.

6. Shaft excavating method.

7. Levelness of bottom and adequacy of cleanout.

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

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

10. 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.

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

12. Date and time of starting and completing excavation.

13. Inspection report.

14. Condition of reinforcing steel and splices.

15. Position of reinforcing steel.

16. Concrete placing method, including elevation of consolidation and delays.

17. Elevation of concrete during removal of casings.

18. Concrete volume.

19. Concrete testing results.

20. Remarks, unusual conditions encountered, and deviations from requirements.

## 3.6 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Disposal: Remove surplus satisfactory soil and waste material, including unsatisfactory soil, trash, and debris, and legally dispose of it off Owner's property.

END OF SECTION