

# Modifications/Changes in this update

Department of Veterans Affairs



Office of Construction & Facilities  
Management

**DATE SUBMITTED:** 10/01/12

**DESCRIPTION OF DOCUMENT:** (previous section title, number and date)  
31 63 26 Drilled Caissons (10-06M)

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**CAHNGES MADE:**

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Modifications include: Updating references and the following:

Added requirements for tolerances for cross-section area and battered caissons

Added requirements for contractor qualifications

Added requirements for pile load testing, in-place survey, and record drawings

Added requirements for quality control.

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**SECTION 31 63 26  
DRILLED CAISSONS**

SPEC WRITER NOTE: Delete between //----//  
if not applicable to project. Also  
delete any other item or paragraph not  
applicable in the section and renumber  
the paragraphs.

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

This section specifies excavation and concrete required for construction of foundation caissons.

SPEC WRITER NOTE: Obtain from Structural  
Engineer bearing material name which  
shall be same nomenclature as appears in  
SUB-SURFACE EXPLORATION REPORT. Insert  
name in following paragraph.

**1.2 DEFINITIONS**

Satisfactory Bearing Material: \_\_\_\_\_ and is assumed to occur at bottom of caisson elevations shown.

**1.3 RELATED WORK**

- A. Materials testing and inspection during construction: Section 01 45 29, TESTING LABORATORY SERVICES.
- B. Safety requirements and blasting operations: Section 00 72 00, GENERAL CONDITIONS, Article, ACCIDENT PREVENTION.
- C. Subsurface Investigation: Section 01 00 00, GENERAL REQUIREMENTS, Article, PHYSICAL DATA
- D. Earth excavation: Section 31 20 00, EARTH MOVING.
- E. Concrete, including materials and mixes: Section 03 30 00, CAST-IN-PLACE CONCRETE.

**1.4 CONTRACT BASIS**

- A. Contract price for caissons will be based upon total length for each type of caisson shown and number of caisson load tests indicated in the Contract Documents. Length of caissons will be measured from bottom elevation to top elevation of the caisson. The diameter of the caisson is defined as the minimum diameter of the shaft.
  - 1. Adjustment of contract price shall be based upon total length of each type of caisson placed and not on the length of individual caissons. When the total length of each type of completed caisson is greater or less than the length shown due to unsuitable soils or design modifications by the Resident Engineer, contract price

adjustment will be made in accordance with Articles, DIFFERING SITE CONDITIONS, CHANGES and CHANGES-SUPPLEMENT of the GENERAL CONDITIONS as applicable.

2. Contract price and time will be adjusted in accordance with Articles, DIFFERING SITE CONDITIONS, CHANGES and CHANGES-SUPPLEMENT of the GENERAL CONDITIONS as applicable, when artificial materials that are not shown are encountered.

### 1.5 CLASSIFICATION OF EXCAVATION

#### A. Soil/Weathered Rock Excavation:

SPEC WRITER NOTE: The requirements for track mounted power excavators may vary. Discuss with soils consultant and modify as necessary.

Soil or weathered rock that can be reasonably excavated with the rock auger, i.e. rock auger advancement greater than 150 mm (6 inches) per 15 minutes (see rock auger refusal, 1.5.C-2, below)

#### B. Sloping Weathered Rock Excavation:

Excavation of soil/weathered rock that can typically be excavated with the rock auger, except when the steeply sloping orientation of the stratum causes the rock auger to run askew.

#### C. Rock Excavation:

1. Excavation of material that meets the rock auger refusal criteria and requires the rock core barrel or other hard rock excavation techniques for removal.
2. Rock auger refusal is defined as a penetration rate of less than 150 mm (6 inches) in 15 minutes, while operating a caisson drilling rig, rated with a torque capacity of at least 110 kN-meters (1,000,000 inch-pounds), applying a continuous down pressure of at least 220 kN (50,000 pounds), equipped with a rock auger that contains conical carbide-tipped ("Kennemetal") teeth.

#### D. Nominal Soil or Weathered Rock Seams:

Nominal soil or weathered rock seams below rock auger refusal will be excavated and considered as rock for rock excavation quantities. A nominal soil or weathered rock seam is one which is less than 600 mm (2 feet) thick. Where soil or weathered rock seams or voids of 600 mm (2 feet) or greater are excavated within a mixed rock/soil or rock/weathered rock profile, excavation is classified as soil/weathered rock excavation until rock auger refusal is again established.

**1.6 MEASUREMENT AND PAYMENT FOR ROCK EXCAVATION**

- A. Measurement: Excavation type in units of length shall be considered to change at the upper contact with a different excavation type as defined by section 1.5.
- B. Payment: Contract unit rates per length of each type of caisson shall be provided for each excavation condition type noted above in Section 1.5. Contract price and time will be adjusted for overruns or underruns in accordance with Articles, DIFFERING SITE CONDITIONS, CHANGES and CHANGES-SUPPLEMENT of the GENERAL CONDITIONS as applicable.
- C. Payment for Differing Site Conditions: No payment will be made for any rock excavation beyond caisson limits unless additional excavation is directed by the Resident Engineer. When rock excavation, as classified, is encountered, contract price and time will be adjusted in accordance with Articles, DIFFERING SITE CONDITIONS, CHANGES and CHANGES-SUPPLEMENT of the GENERAL CONDITIONS as applicable.

SPEC WRITER NOTE: Obtain following allowable tolerances from Structural Engineer.

**1.7 TOLERANCES**

Install caissons with not more than the lesser of 1/24th of caisson shaft diameter or 75 mm (3 inches) from design center location. Caissons shall not be out of plumb more than 25 mm (1 inch) in 3000 mm (10 feet) for the full depth. Cross sections of shafts and bells shall not be less than design dimensions. Batter caissons shall be installed a maximum of 2 percent of length from specified inclination.

**1.8 SUBMITTALS**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Before beginning work, submit a detailed location plan and description of the proposed method of caisson installation, all of which shall be subject to the review and approval of the Resident Engineer.
- C. Shop Drawings shall comply with ACI 315 "Manual of Standard Practice for Detailing Reinforced Concrete Structures". Furnish shop drawings prepared by a Professional Engineer licensed in the State of the project for the detailing, fabricating, bending, and placing of concrete reinforcement.

- D. //Submit a detailed plan showing load test arrangement, location, and Contractor's qualifications and results for review and approval by the Resident Engineer.//
- E. Reports:
1. Caisson record: Data as specified.
  2. Rock excavation: Data as specified.
  3. Soil Testing Agency Reports shall be issued showing material type and allowable bearing capacity at bottom of shaft within 24 hours after testing//observing each caisson.
  4. Certified, "Caisson Field Record" for each caisson recording actual elevation of bottom, elevation of rock (if applicable), final centerline location of top, variation of shaft from plumb, bell dimension (if applicable), result of all tests and observations performed, material type and actual allowable bearing capacity of bottom, depth of socket into rock, levelness of bottom, seepage of water, still water level (if allowed to flood), elevation (top and bottom) of lining left in place, variation of shaft diameter (from those shown), and evidence of seams, voids or channels below bottom.
- F. Certificates: Contractor's qualifications as specified: Experienced specialty piling subcontractor having a minimum of 5 years successful experience installing Work of the same type required for this project. Employ only skilled tradesmen who are thoroughly experienced with the materials and equipment to be used in the Work.
- G. Pile Load Testing:
1. A schedule and sequencing plan for pile testing and installation.
  2. Pile Load Test Work Plan:
    - a. At least two weeks before commencing pile load testing work, the Contractor shall submit a pile load test work plan describing the equipment, apparatus, procedures, and schedule for testing ACP's in accordance with ASTM D1143// ASTM D3689 // ASTM D3966 and as specified herein, to verify the design pile capacity. The work plan shall also include the proposed instrumentation of the test pile indicating depth, location, and details of the pile.
    - b. As part of the Pile Load Test Work Plan, submit shop drawings and other information describing the loading and test monitoring arrangement for pile load tests, including the following:
      - 1) Structural design of the test load support/reaction frame.

- 2) Details of equipment and apparatus to be used for the monitoring load and pile movements.
  - 3) Data on testing and measuring equipment including required jack, load cell and/or gauge calibrations.
  - 4) Sample field data recording sheets or examples of automated data acquisition records proposed for recording load test data.
- H. Independent Testing and Inspection Agency: The Contractor shall retain an Independent Testing and Inspection Agency (Agency) to document, monitor, and observe load test, probe pile, test pile, and production pile work. This Agency shall submit field reports and test results required for pile load tests, pile installations, and grout testing and inspection. They shall submit a pile installation report for each pile no later than three days after the installation is complete.
- I. Qualification Data: For Installer, Land Surveyor, and Testing and Inspection Agency.
- J. Upon completion of caisson installations, the Contractor shall submit five copies of drawings indicating actual in-place pile locations. The Contractor shall pay for all surveying costs. Drawings must be submitted prior to beginning any pile cap or mat installation. One electronic copy of the drawings shall be submitted in AutoCAD DWG format on CD-ROM.
- K. Record drawings at Project closeout according to Division 01 Section "Closeout Procedures."

#### **1.9 QUALITY CONTROL**

- A. Contractor's Quality Control Responsibilities: Contractor is solely responsible for quality control of the Work.
- B. A Quality Control Program shall be submitted by the Contractor at least two weeks prior to the commencement of work. The implementation of a Contractor Quality Control Program does not relieve the Contractor from the responsibility to provide work in accordance with the Contract Documents, applicable codes, regulations, and Governing Authorities.
- C. Contractor's Independent Testing and Inspection Agency (Agency): The Contractor shall retain at his own expense, the services of a qualified Independent Testing and Inspection Agency, licensed in the state of the project, to provide testing and inspection services during the installation of all foundation piling involved in this Work. This firm shall also provide consultation services to the Contractor if problems

are encountered during the execution of the Work. The Agency shall be primarily concerned with the testing and construction methods which will result in finished foundation piling of the required quality and strength. The Agency shall also be concerned with preventing settlement and/or damage to surrounding structures, roads, utilities, embankments, etc., both within the property lines and on adjoining properties during the construction.

- D. The Agency shall be experienced in the testing and installation of caisson foundations. It shall have been involved in at least 8 different caisson projects in the last 5 years, and shall have experience in recommending, testing, and specifying caissons for similar subsurface conditions.
- E. Survey Work: The Contractor shall engage a qualified land surveyor or professional engineer to perform surveys, layouts, and measurements for caissons. The surveyor shall record actual measurements of each caisson's location, shaft diameter, bottom and top elevations, deviations from specified tolerances, and other specified data.
- F. Contractor's Grout Mix Designer: The Contractor shall employ, at his own expense, a testing laboratory to design grout mixes, conduct tests and submit reports for the design mixes. The Grout Mix Designer shall be qualified according to ASTM C1077 and ASTM E329 to perform material evaluation tests and to design concrete mixes, as documented according to ASTM E548.
- G. Welding Standards: Qualify procedures and personnel according to the following:
  - 1. AWS D1.1
  - 2. AWS D1.4
- H. Regulatory Requirements: Comply with applicable requirements of the laws, codes, ordinances and regulations of Federal, State and Municipal authorities having jurisdiction. Obtain necessary approvals from all such authorities.

#### **1.10 QUALITY ASSURANCE**

- A. The Owner shall retain the services of a Geotechnical Consultant (Consultant) to provide general observation of all pile operations and to provide technical advice to the Owner with regard to pile operations and performance.
- B. The Consultant shall have been involved in at least 8 different caisson installation projects in the last 5 years, and shall have experience in

recommending, testing, and specifying caissons for similar subsurface conditions.

#### 1.11 APPLICABLE PUBLICATIONS

- A. Publications listed below form a part of this specification to extent referenced. Publications are referenced in text by basic designation only.
- B. American Society for Testing and Materials (ASTM):
- A36/A36M-08 ..... Standard Specification for Carbon Structural Steel
- A283/A283M-03(2007) .... Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates
- A615/A615M-09b ..... Standard Specification for Deformed and Plain Carbon Steel Bars for Concrete Reinforcement
- A929/A929M-01(2007) .... Standard Specification for Steel Sheet, Metallic Coated by the Hot Dip Process for Corrugated Steel Pipe
- A996/A996M-09b ..... Standard Specification for Rail Steel and Axle Steel Deformed and Bars for Concrete Reinforcement
- C33-11a ..... Standard Specification for Concrete Aggregates
- C94/C94M-12 ..... Standard Specification for Ready Mixed Concrete
- C150-C50M-11 ..... Standard Specification for Portland Cement
- C494/C494M-11 ..... Standard Specification for Chemical Admixtures for Concrete
- C618-12 ..... Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
- C989-C989M-11 ..... Standard Specification for Slag Cement for Use in Concrete and Mortars
- C1017/C1017M-07 ..... Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete
- D1143-81(1994)e1 ..... Standard Test Method for Piles Under Static Axial Compressive Load
- D3689-90(1995) ..... Standard Test Method for Individual Piles Under Static Axial Tensile Load
- D3966-90(1995) ..... Standard Test Method for Piles Under Lateral Loads
- C. American Concrete Institute (ACI):

- 211.1-91 (2009) ..... Standard Practice for Selecting Proportions for Normal, Heavyweight and Mass Concrete
- 301-10 ..... Specifications for Structural Concrete
- 315-99 ..... Details and Detailing of Concrete Reinforcement
- D. American Welding Society (AWS):
  - D1.1/D1.DM (2010) ..... Structural Welding Code - Steel
  - D1.4 (1998) ..... Structural Welding Code - Reinforcing Steel

**PART 2 - PRODUCTS**

SPEC WRITER NOTE: Make material requirements agree with applicable requirements specified in the referenced Applicable Publications. Update and specify only that which applies to the project.

**2.1 MATERIALS**

SPEC WRITER NOTE: Delete this Article if unreinforced-concrete drilled piers are used.

- A. Steel Reinforcement: ASTM A615/A615M, or 996, Grade 60, deformed.
- B. Portland Cement: ASTM C150, Type I or II.

SPEC WRITER NOTE: Select mineral or cementitious admixtures from two subparagraphs below if permitted. Ready-mix plant blends fly ash or slag with portland cement.

- C. Fly Ash/Slag:
  - 1. Fly Ash Admixture: ASTM C618, Class C or F.
  - 2. Ground Granulated Blast-Furnace Slag: ASTM C989, Grade 100 or 120.
- D. Normal-Weight Aggregate: ASTM C33, uniformly graded, 19 mm (3/4-inch) maximum aggregate size.
- E. Water: Potable, complying with ASTM C94/C94M requirements.
- F. Admixtures: Certified by manufacturer to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material and to be compatible with other admixtures and cementitious materials. Do not use admixtures containing calcium chloride.

SPEC WRITER NOTE: If desired, select admixtures from subparagraphs below.

- 1. Water-Reducing Admixture: ASTM C494, Type A.
- 2. Water-Reducing and Retarding Admixture: ASTM C494, Type D.
- 3. High-Range, Water-Reducing Admixture: ASTM C494, Type G.

4. Plasticizing and Retarding Admixture: ASTM C1017, Type II.
- G. Steel Casings: All casing shall meet ASTM A283, Grade C; or ASTM A36, carbon-steel plate, with joints full-penetration welded according to AWS D1.1, or ASTM A929/A929M, steel sheet, zinc coated corrugated steel. The Contractor shall design shells to withstand drilling forces and earth pressures and reinforce the bottom cutting edge as required for proper drilling and sealing of the shells into the rock. The cutting edge shall be capable of coring through at least 3000 mm (10 ft) of broken or solid rock. A minimum of 2% out of roundness of the diameter shall be considered in the design of the shell. All seams shall be welded and watertight
- H. Concrete Mix: Prepare design mixes according to ACI 211.1 and ACI 301 for each type and strength of concrete determined by either laboratory trial mix or field test data bases. Use a qualified testing agency for preparing and reporting proposed mix designs for laboratory trial mix basis. Proportion mixes according to ACI 211.1 and ACI 301 to provide normal-weight concrete with the following properties:
1. Compressive Strength (28 Days): 34.5 MPa (5000 psi).
  2. Minimum Slump: Capable of maintaining a slump of 125 mm (5 inches) plus or minus 25 mm (1 inch).
  3. Do not air entrain concrete for caissons
  4. Limit water-soluble, chloride-ion content in hardened concrete to 0.15//0.3 percent by weight of cement.
  5. Concrete-mix design adjustments may be considered if characteristics of materials, project conditions, weather, test results, or other circumstances warrant. Resubmission and approval of proposed changes to concrete-mix proportions is the responsibility of the Contractor.
- I. Concrete Mixing: Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M, and furnish batch ticket information. Do not add water to concrete mix after mixing, unless a procedure per ACI 301 is submitted to and approved by the Resident Engineer. Maintain concrete temperature less than 32 degree Celsius (90 degree Fahrenheit).

### **PART 3 - EXECUTION**

#### **3.1 GENERAL**

- A. Size: Minimum sizes and types of caissons are shown. Proposal to use caissons of sizes and types different from those shown may be accepted

if submitted in writing to Resident Engineer for approval and provided the following conditions are met:

1. Least dimension of caisson is equal to or greater than least dimension shown.
2. Enlargement at base of caisson is in bell-form with dimensions equal to or greater than minimum shown.

SPEC WRITER NOTE: Consult Structural Engineer for bearing value required in following paragraph (3).

3. If volume of caisson as constructed is greater than that shown, bearing area at base is increased so that additional weight is distributed to bearing material at no more than \_\_\_\_ kPa ( \_\_\_\_ ksf).
  4. Entire caisson receives full lateral support from surrounding material.
- B. Changes: Requests for change in size or type of caisson from those shown shall be accompanied by calculations and other documentation necessary to show that proposed changes will meet load requirements. Do not proceed with changes before receiving written approval from Resident Engineer.
- C. Temporary Steel Casings: Install casings for protection of workers and inspection personnel, for prevention of cave-ins or displacement of earth walls, and for retention of ground water.
- D. Defective Casings: Do not install buckled, distorted or otherwise damaged casings. Replace casings damaged or disturbed during construction, casings that are not mud-tight or otherwise not in accordance with drawings or specifications, at no additional cost to the Government.
- E. Survey: Registered Professional Land Surveyor or Registered Civil Engineer, specified in Section 01 00 00, GENERAL REQUIREMENTS, shall establish lines and levels and stake caisson locations.

### 3.2 EXCAVATION

- A. Excavation and construction methods shall result in minimum disturbance of surrounding material and full lateral support of caissons by surrounding material.
- B. Remove boulders and rock in caissons such as rock seams underlain with soil seams, sloping rock or rock otherwise unsatisfactory for bearing.

- C. If materials with satisfactory bearing strength occur at elevations higher or lower than those shown, place bottom of caissons at higher or lower elevations, subject to approval of Resident Engineer.

SPEC WRITER NOTE: Delete following paragraph if not required.

- D. Test Drilling: Percussion drill one test hole, 50 mm (2 inches) in diameter to depth equal to twice caisson diameter, but not less than 1800 mm (6 feet) deep, in bottom of each caisson which has been excavated to rock to determine if rock seams are underlain by soil seams or voids.
- E. Excavate caissons to dimensions and required bearing strata or elevations shown on contract drawings. Maintain sidewall stability during drilling. Excavate holes for closely spaced caissons, and those occurring in fragile strata, only after adjacent holes are filled with concrete and allowed to set. The excavation shall be accomplished by hand or machine excavation as required. Caisson drilling equipment shall have the minimum torque capacity and downward force capacity for the contract site conditions. Bottoms of caissons shall be cleaned of loose or soft materials and leveled. If bottoms are sloping rock, excavate to a level plane or step with maximum step height less than 1/4 the width or diameter of the bearing area. All material removed from the caisson holes shall be removed from the ground around the casing before concrete placement is started and shall be disposed of by the Contractor off site in areas submitted to and approved by the Engineer.
- F. Excavations for utilities, support of excavations, or other purposes shall be kept a minimum distance of two shaft diameters away from the outer edge of the caisson.

### **3.3 PLACING CONCRETE**

- A. Before placing concrete, the tip of the caisson shall be observed and approved by a qualified testing agency registered and licensed in the state. The testing agency shall be retained by the Contractor and approved by the Resident Engineer. The shaft shall be inspected, cleared of mud, water, loose material and debris.
- B. Place concrete using a down pipe to direct flow of concrete. Except in presence of water, concrete may fall freely up to a maximum height of 9.14 meters (30 feet) provided the concrete does not hit the sides of

the caisson. Use tremie pipe or pump if distance is greater than 9.14 meters (30 feet).

- C. Withdraw casings, as concrete is deposited, maintaining top surface of concrete constantly at least 1800 mm (6 feet) above lower end of casings. Place concrete to form a monolithic cylindrical shaft having full lateral support from surrounding undisturbed materials. Strike finished top surface of concrete to true plane at required elevation.
- D. Concrete placement in each caisson shall be one continuous operation. If placing operation has to be stopped, leave surface approximately level. If concrete has hardened, clean surface and slush with a 1 to 1 cement-sand grout before placing operation is resumed. Concrete pours shall not begin within one hour of darkness. In the event that this type of continuous sequential operation cannot be performed, the Contractor shall submit for approval by the Resident Engineer a method of securing the open excavation. The Contractor shall not leave excavations open overnight without receiving prior written approval from the Resident Engineer.
- E. When water is present, control water level to within 50 mm (2 inches) of bottom of the caisson by pumping. If impossible or impractical to control water, secure written permission from Resident Engineer to place concrete through water by means of a watertight tremie.
  - 1. When placing concrete under water, discharge end of tremie shall be submerged in fresh concrete and shaft of tremie maintained full of concrete to point above water level.
  - 2. Increase cement content of concrete required to be placed in water by one sack per cubic yard of concrete.

#### **3.4 CAISSON RECORD**

- A. For each caisson placed and before superstructure framing is placed, submit to Resident Engineer for approval a certified report recording following information prepared by Registered Professional Land Surveyor or Registered Civil Engineer.
- B. Caisson number, length, and bearing material.
- C. Location.
- D. Concrete and steel reinforcement properties.
- E. Plumbness.
- F. Dates:
  - 1. Excavation completed.
  - 2. Concrete placed.

G. Diameters:

1. Top of shaft.
2. Bottom of shaft.
3. Bell.

H. Elevations:

1. Top of ground.
2. Top of concrete.
3. Top of rock.
4. Bottom of caisson.

**3.5 CLEAN UP:**

- A. All debris from excavation of objectionable material, removal of obstructions, and any material not to remain as part of the construction are to be removed and disposed of by the Contractor in a legal manner at no additional cost to the Owner.
- B. The site shall be cleaned at frequent intervals and no material shall be stored on the site in a manner, which would obstruct the easy access of equipment and personnel.

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