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USACE / NAVFAC / AFCEA / NASA            UFGS-31 63 26.16 20 (April 2006)  
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Preparing Activity: NAVFAC                Replacing without change  
   UFGS-02468N (September 1999)

## UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated 19 March 2007

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### SECTION 31 63 26.16 20

#### DRILLED FOUNDATION CAISSONS

04/06

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NOTE: This guide specification covers the requirements for the procurement, installation, and testing of drilled foundation caissons.

Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable items(s) or insert appropriate information.

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

Comments and suggestions on this guide specification are welcome and should be directed to the technical proponent of the specification. A listing of technical proponents, including their organization designation and telephone number, is on the Internet.

Recommended changes to a UFGS should be submitted as a Criteria Change Request (CCR).

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NOTE: On the drawings, show:

1. Subsurface-soil-data logs.
2. Top and bottom elevation of each caisson.
3. Size (diameter in **mm inches**, bearing capacity, and total number of each size of caissons.
4. Dimensions of the bell, if required.
5. Dimensions of the casing.
6. Reinforcing steel details, if required.
7. Location of caissons to be penetration tested, if required.

8. Location of caisson to be proof tested, if required.

9. Locations, size, bell dimensions, and installation sequence of load testing caisson, if required.

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## PART 1 GENERAL

### 1.1 REFERENCES

\*\*\*\*\*

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 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.

\*\*\*\*\*

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 WELDING SOCIETY (AWS)

AWS D1.1/D1.1M (2006; Errata 2006) Structural Welding Code - Steel

AWS D1.4/D1.4M (2005; E 2005) Structural Welding Code - Reinforcing Steel

#### ASTM INTERNATIONAL (ASTM)

ASTM A 123/A 123M (2002) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

ASTM A 36/A 36M (2005) Standard Specification for Carbon Structural Steel

ASTM A 615/A 615M (2006a) Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement

ASTM A 966/A 966M

(2006) Standard Test Method for Magnetic Particle Examination of Steel Forgings Using Alternating Current

ASTM D 1143

(1981; R 1994e1) Piles Under Static Axial Compressive Load

ASTM D 1586

(1999) Penetration Test and Split-Barrel Sampling of Soils

## 1.2 SUBMITTALS

\*\*\*\*\*

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list to reflect only the submittals required for the project. Submittals should be kept to the minimum required for adequate quality control.

A "G" following a submittal item indicates that the submittal requires Government approval. Some submittals are already marked with a "G". Only delete an existing "G" if the submittal item is not complex and can be reviewed through the Contractor's Quality Control system. Only add a "G" if the submittal is sufficiently important or complex in context of the project.

For submittals requiring Government approval on Army projects, a code of up to three characters within the submittal tags may be used following the "G" designation 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.

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" designation; submittals not having a "G" designation are [for Contractor Quality Control approval.] [for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government.] The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Survey of caisson locations

SD-04 Samples

Test caissons

SD-06 Test Reports

Penetration test records

Proof test holes reports

Load test reports

SD-07 Certificates

\*\*\*\*\*  
NOTE: Specify load tests when needed to confirm  
design capacities. At least one caisson location  
should be load tested in each area of substantially  
different subsoil conditions. Indicate number,  
size, and location of test caisson and sequence.  
\*\*\*\*\*

Caisson load tests procedure

SD-11 Closeout Submittals

Caisson records

Submit detailed records for each caisson as specified in  
paragraph entitled "Records."

1.3 DELIVERY AND STORAGE

\*\*\*\*\*  
NOTE: Insert the appropriate Section number and  
title in the blank below using proper format per UFC  
1-300-02.  
\*\*\*\*\*

Deliver casings and appurtenant equipment to the job site in an undamaged  
and ready to place condition. Delivery of concrete shall be in accordance  
with requirements of [\_\_\_\_\_].

1.4 QUALITY ASSURANCE

1.4.1 Survey of Caisson Locations

Submit a certified survey meeting the requirements specified herein.

1.4.2 Penetration Test Records

\*\*\*\*\*  
NOTE: The requirement for performing penetration  
tests would be based on the availability of current  
information on bearing conditions at caisson  
locations. At least one caisson location should  
require a penetration test in each area of  
substantially different subsoil conditions.  
\*\*\*\*\*

Submit [four] [\_\_\_\_\_] copies of penetration test records before concrete

filling of caissons in accordance with ASTM D 1586.

#### 1.4.3 Proof Test Holes Reports

\*\*\*\*\*  
NOTE: Require proof testing if the soundness of  
rock below the caisson bearing level is unknown.  
Indicate location of each caisson to be proof tested.  
\*\*\*\*\*

Submit [four] [\_\_\_\_\_] copies of proof test holes reports before concrete  
filling of caissons.

#### 1.4.4 Load Test Reports

\*\*\*\*\*  
NOTE: Specify load tests when needed to confirm  
design capacities. At least one caisson location  
should be load tested in each area of substantially  
different subsoil conditions. Indicate number,  
size, and location of test caisson and sequence.  
\*\*\*\*\*

Submit [four] [\_\_\_\_\_] copies of load test reports before installing  
caissons.

#### 1.4.5 Test Caissons

Test caissons shall be constructed where directed and, if approved,  
retained as part of the work.

### PART 2 PRODUCTS

#### 2.1 MATERIALS

##### 2.1.1 Concrete Work

\*\*\*\*\*  
NOTE: Insert the correlated section number and  
title or include concrete specification in this  
section, in the blank below using the proper format  
per UFC 1-300-02.  
\*\*\*\*\*

[\_\_\_\_\_] , as modified herein:

##### 2.1.1.1 Strength

\*\*\*\*\*  
NOTE: Compressive strength (28 day strength or f'c)  
of concrete shall be 25 MPa 3000 psi or higher.  
When loads are high and drilling conditions  
difficult, it may be more economical to use 30 MPa  
4000 psi or 35 MPa 5000 psi concrete and larger  
shafts rather than a smaller shaft with reinforcing  
or permanent casing. If there is a reinforcing  
cage, or if there is a large bell, the ability of  
the concrete to flow between reinforcing bars, or to  
completely fill the bell, is a matter of prime

importance. For these piers, the concrete should have a slump of about 152 mm 6 inches. Slump may vary, depending on the mix, between 102 mm 4 inches and 152 mm 6 inches. A maximum size of 19 mm 3/4 inch is appropriate under these circumstances.

\*\*\*\*\*

Concrete strength shall be [ ] MPa [ ] psi at 28 days. Slump shall be from [ ] to [ ] mm [ ] to [ ] inches.

#### 2.1.1.2 Coarse Aggregate

\*\*\*\*\*

NOTE: Coarse aggregates shall be 25.4 mm one inch size maximum. Coarse aggregate may be smaller where reinforcement spacing is close or where dimension of caisson elements is dimensionally thin.

\*\*\*\*\*

Maximum size of coarse aggregate shall be [ ] mm [ ] inch.

#### 2.1.1.3 Reinforcing Steel

\*\*\*\*\*

NOTE: Reinforcing steel grades shall conform to one of the following:

ASTM A 615/A 615M for deformed billet - steel bars shall be 400 or 500 MPa Grades 60 or 75

ASTM A 966/A 966M for rail-steel deformed bars shall be 400 MPa Grade 60

ASTM A 617/A 617M for axle-steel deformed bars shall be 400 MPa Grade 60

\*\*\*\*\*

[ASTM A 615/A 615M] [ASTM A 966/A 966M] [ASTM A 966/A 966M] Grade [ ]. Steel shall be welded into cages in accordance with AWS D1.4/D1.4M.

#### 2.1.2 Welding

Shop and field welding shall be in accordance with AWS D1.1/D1.1M. Qualification of welding procedures, welders, and welding operators shall be in accordance with AWS D1.1/D1.1M. Records of test results of welding procedures not prequalified and copies of records for each qualified welding operator, containing records on positions of welding and types of electrode qualifications, shall be kept by the Contractor and be available for examination by the Contracting Officer.

#### 2.1.3 Casing Steel

\*\*\*\*\*

NOTE: Minimum wall thickness should be determined based on the structural loading conditions.

\*\*\*\*\*

ASTM A 36/A 36M. Zinc coating of casing steel shall conform to ASTM A 123/A 123M. Casings shall have outside diameters not less than



indicated shaft sizes and shall be a minimum of [6.4 mm] [1/4 inch] [\_\_\_\_\_] thick.

## 2.2 CAISSON DRILLING EQUIPMENT

\*\*\*\*\*  
NOTE: Caisson drilling equipment criteria should be evaluated and specified for contract site conditions. Reference: Drilled Pier Foundations - Woodward, Gardener, Greer - McGraw-Hill Book Co. Requirements should be included for determination of minimum equipment standards.  
\*\*\*\*\*

Caisson drilling equipment shall have minimum torque capacity and downward force capacity suitable for the site conditions.

## PART 3 EXECUTION

### 3.1 INSTALLATION

\*\*\*\*\*  
NOTE: Caissons selected for contract shall be based on analysis of subsurface investigation and design requirements. Complete installation information shall be provided to the Contracting Officer.  
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#### 3.1.1 Excavation

Drill caissons to depths and dimensions shown. [Excavate or drill the bottom of excavations to bell diameters and shapes shown.] Drilling of caisson shall not be within 6 m 20 feet of concrete placed within last 3 days. Clean bottoms of caissons of loose, soft, or disturbed materials and level. Dispose of excavated material [in the area indicated] [off Government property] [\_\_\_\_\_] . Excavations made below indicated depths, without specific direction by the Contracting Officer, shall be filled with concrete. Where, in the opinion of the Contracting Officer, materials are encountered at the indicated depths that do not provide the required bearing capacity or would result in unsatisfactory construction, the excavation shall be extended as directed by the Contracting Officer and an adjustment in the contract requirements will be made.

#### 3.1.2 Protection and Casings

In drilling caissons, protect surrounding soil and excavated walls against cave-ins, displacement of the surrounding earth, and retention of ground water by means of temporary steel casings, sheeting, or use of bentonite slurry. Casings shall not be driven within 6 m 20 feet of concrete placed within last 3 days. If Contracting Officer determines that the structural integrity of the caisson will be impaired, the casing shall be left in place and an adjustment in the contract requirements will be made. Withdraw temporary steel casings, as concrete is placed, maintaining sufficient head of concrete within the casing to prevent extraneous material from falling in from the sides and mixing with the concrete. Casings may be jerked upward a maximum of 102 mm 4 inches to break the bottom seal but thereafter removed with a smooth, continuous motion. All voids surrounding the casing shall be filled with concrete extruded from the bottom of the casing as it is being raised, with all free water

surrounding the casing being forced to the surface ahead of the rising concrete. Provide venting if necessary to ensure removal of water around the casing as the concrete level rises and the casing is being removed.

#### 3.1.2.1 Cleaning Casings

Clean inside of steel casings thoroughly and oil before reuse.

#### 3.1.2.2 Temporary Casings

The temporary casing shall be in place from the caisson top to the ground surface until the concrete has set if the elevation of the top of the caisson is below the adjacent ground surface.

#### 3.1.2.3 Casings with Soft Subbase

Continuously remove water that flows into the excavations and the excavation bottom prior to concrete placement. The maximum permissible water depth will be 50 mm 2 inches at the start of concrete placement. If severe water conditions make it impossible or impractical to dewater the excavation, deepen the excavation to undisturbed material and place concrete using underwater tremie after water movement has stabilized.

#### 3.1.3 Filling

\*\*\*\*\*  
NOTE: The criteria of placing concrete within 3  
hours should be modified with agency requirements.  
\*\*\*\*\*

Prior to placing concrete, inspect caisson excavation to ensure that deleterious material or detrimental conditions are not present in the excavation. Concrete shall be placed within 3 hours after completing excavation. Place concrete continuously by methods that ensure against segregation and dislodging of excavation sidewalls and completely fill the bell and shaft. Place concrete by pumping, tremie, or drop chutes. For concrete placed by pumping or tremie, the discharge shall be kept a minimum of 914 mm 3 feet below the fresh concrete surface during placement.

##### 3.1.3.1 Keys for Placement in Lifts

Bring concrete to a true level surface inside the shaft and form a full width cross key or install dowels should it become necessary to interrupt placing concrete in any caisson. Prior to placing additional concrete, clean surfaces of laitance and slush with one to one portland cement grout. The grout shall have a water cement ratio not exceeding that of the concrete.

##### 3.1.3.2 Chute Placement

Place concrete in dry batter caissons with a drop chute extending within 914 mm 3 feet of the concrete surface in the excavation.

##### 3.1.3.3 Concrete Vibration

Vibrate concrete for full height of caisson for caissons without permanent encasing. For caisson, with permanent encasing, vibrate only the bell of the caisson.

#### 3.1.4 Reinforcement

Install as indicated. Insert securely in the caissons, in position and alignment, as shown, [prior to concrete placement] [prior to the concrete reaching an elevation [ ] m [ ] feet below the bottom elevation of the reinforcement].

#### 3.2 TOLERANCES

\*\*\*\*\*  
**NOTE: Tolerances should be correlated with design criteria and types of caisson.**  
\*\*\*\*\*

##### 3.2.1 Alignment

Caissons out of center or plumb beyond the tolerance specified shall be corrected to comply with the tolerances and the Contractor shall bear any cost of correction. Method of correction shall be approved by the Contracting Officer.

##### 3.2.2 Cross Sections of Shafts [and Bells]

Shall not be less than design dimensions.

##### 3.2.3 Top Location of Caissons

\*\*\*\*\*  
**NOTE: Offset of less than 76 mm 3 inches may be required if the eccentric loading is critical to the column structure.**  
\*\*\*\*\*

Install with top location deviating not more than [76] [ ] mm [3] [ ] inches from centerline locations.

##### 3.2.4 Vertical Caissons

Install plumb within a maximum of 38 mm 1 1/2 inches for the first 3 m 10 feet and 12.7 mm 1/2 inch for each 3 m 10 feet of additional depth.

##### 3.2.5 Batter Caissons

\*\*\*\*\*  
**NOTE: Consult the project structural engineer if lesser inclination tolerance is required.**  
\*\*\*\*\*

Install not more than [2] [ ] percent from specified inclination.

##### 3.2.6 The Center of the Caisson

Shall be established after construction is completed and the center marked by a suitable permanent mark.

### 3.3 TESTS

#### 3.3.1 Penetration Tests

\*\*\*\*\*  
NOTE: The requirement for performing penetration tests would be based on the availability of current information on bearing conditions at caisson locations. At least one caisson location should require a penetration test in each area of substantially different subsoil conditions.  
\*\*\*\*\*

##### 3.3.1.1 Caisson Tests

After excavation, make penetration tests in accordance with ASTM D 1586 in the bottoms of the caissons, in locations indicated, to determine bearing conditions.

##### 3.3.1.2 Blow Count and Penetration Depth

\*\*\*\*\*  
NOTE: Drive the sampler with blows from a 64 kg 140 pound hammer falling 762 mm 30 inches until either 457 mm 18 inches have been penetrated or 100 blows have been applied.  
\*\*\*\*\*

Perform the tests after caisson bottoms have been cleaned. Minimum blow count shall be [ ] per m [ ] per foot. [Penetration tests shall be taken to a depth of [ ] m [ ] feet below the bearing elevation. The Contractor shall obtain and retain jar samples, as directed by the Contracting Officer.]

##### 3.3.1.3 Failure of Test

\*\*\*\*\*  
NOTE: An additional 305 to 610 mm one to two foot drilling of shaft may be necessary.  
\*\*\*\*\*

If the minimum blow count is not obtained, drill the shaft an additional [ ] mm [ ] feet and rerun the penetration test.

##### 3.3.1.4 Test Approval

The Contracting Officer will approve tests and authorize subsequent concrete placement or initiate redesign procedures.

#### 3.3.2 Proof Test Holes

\*\*\*\*\*  
NOTE: Require proof testing if the soundness of rock below the caisson bearing level is unknown. Indicate location of each caisson to be proof tested.  
\*\*\*\*\*

#### 3.3.2.1 Soundness of Rock Test

After excavation, proof test the soundness of the rock below the caisson bearing level by percussion or rotary core, drilling one hole in each caisson in locations indicated.

#### 3.3.2.2 Drilling

Holes shall be 51 mm 2 inch diameter and drilled with a uniform downward pressure to a depth below the bearing level equal to the design caisson shaft diameter but to a minimum of 1.2 m 4 feet.

#### 3.3.2.3 Drilling Records

Record penetration time for successive 152 6 inch increments, noting conditions encountered.

#### 3.3.2.4 Test Approval

The Contracting Officer will approve test holes and authorize subsequent concrete placement or initiate redesign procedures.

#### 3.3.3 Load Tests

\*\*\*\*\*  
NOTE: Specify load tests when needed to confirm design capacities. At least one caisson location should be load tested in each area of substantially different subsoil conditions. Indicate number, size, and location of test caisson and sequence.  
\*\*\*\*\*

##### 3.3.3.1 Location

Perform caisson load tests in locations indicated.

##### 3.3.3.2 Test Records

\*\*\*\*\*  
NOTE: The requirement of performing the load test under the direct supervision of a registered professional engineer may be waived at the discretion of the design agency.  
\*\*\*\*\*

Perform tests and recording of data under supervision of a registered professional engineer provided by the [Government] [Contractor] and in the presence of the Contracting Officer.

##### 3.3.3.3 Apply Loads

Apply load in concentric manner with magnitude of load accurately determined and controlled.

##### 3.3.3.4 Caisson Supports

Laterally support top of caisson during entire load test.

#### 3.3.3.5 Settlement Readings

Load caisson to [150] [200] percent of design load, but do not exceed ultimate concrete strength at time of loading. Apply load in increments of [\_\_\_\_]. Maintain full test load for a period of [24] [\_\_\_\_] consecutive hours and make settlement readings at not less than [1/2] [\_\_\_\_]-hour intervals. [Perform load test in accordance with **ASTM D 1143**, except the maximum load shall not exceed [200] [\_\_\_\_] percent of the design load.]

#### 3.3.3.6 Test Results

\*\*\*\*\*  
NOTE: Residual settlement shall not exceed **12.7 mm**  
**1/2 inch** for medium sized piers. Equally, the  
settlement caused by twice the design load shall not  
exceed **12.7 mm 1/2 inch**.  
\*\*\*\*\*

Tested installations will be considered satisfactory if:

- a. No apparent distress occurs in caisson construction.
- b. Residual settlement, after test load is removed, shall not exceed [\_\_\_\_] mm [\_\_\_\_] inch.
- c. Twice the design load does not cause a gross settlement of more than [\_\_\_\_] mm [\_\_\_\_] inch.

#### 3.3.3.7 Rejected Caisson

Test caissons found inadequate because of improper instrumentation, testing, or construction procedures shall be removed and replaced with new caissons and retested.

### 3.4 RECORDS

Keep complete and accurate records of all caisson installations. Include locations, shaft diameters, [bell dimensions,] top and bottom elevations, depths of test holes, casing dimensions, concrete strength, concrete volume, quantity of rock excavation, excavation condition, dates of excavation and concrete placement, bearing strata description, and subsurface water conditions. Location shall be based on the survey of the registered surveys or engineer provided by the Contractor. All records, including corrective measures, shall be tabulated.

-- End of Section --