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USACE / NAVFAC / AFCESA / NASA **UFGS-31 62 21 (November 2008)**

Preparing Activity: USACE **Superseding UFGS-31 62 21 (April 2006)**

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated October 2012
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11/08

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SECTION 31 62 21

PILING: COMPOSITE, WOOD AND CAST IN-PLACE CONCRETE
11/08

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NOTE: This guide specification covers the requirements for composite, wood and cast-in-place concrete piles.

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 items(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

1.1 UNIT PRICES

1.1.1 Piling

Piling will be paid at the contract unit price per linear m foot (including test piles), for "Piling" multiplied by the total linear m feet of acceptable piles actually installed. The Contracting Officer reserves the right to increase or decrease the total length of piles to be furnished and installed by changing the foundation pile locations or elevations, requiring the installation of additional piles, or requiring omission of piles. Payment will constitute full compensation for furnishing, delivering, handling, and installing the foundation piles. The Contractor will not be allowed payment for withdrawn, broken, or rejected piles or (except for test piles) for any portion of any pile remaining above the cut-off point.

1.1.2 Load Test

The contract includes [_____] metric ton -ton pile 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 contract price for "Additional Pile Load Test" or "Omitted Pile Load Test."

1.1.3 Pile Withdrawals

Pile Withdrawals will be paid at the contract unit price each for "Pile Withdrawals" multiplied by the number of piles withdrawn as directed. The Contracting Officer reserves the right to increase or decrease the number of pile withdrawals. Adjustments in the contract price will be made in accordance with the CONTRACT CLAUSES.

1.1.4 Basis of Payment

****
NOTE: This paragraph anticipates bids on a lump sum price, with directed changes in accordance with the CONTRACT CLAUSES or with the unit prices defined above. Where the contract is based on unit price, this paragraph should be deleted and replaced by the following paragraph:
****

The contract price for piling will include the cost of all necessary equipment, tools, material, labor, and supervision required to: deliver, handle, install, cut off, and withdraw the piles (including test piles), and conduct the load tests. Payment for piles will be based on the lengths of acceptable piles measured from cut-off elevations to final tip elevations. No additional payment will be made for: damaged, rejected, or misplaced piles, withdrawn piles, other than test piles withdrawn as directed, any portion of a pile remaining above the cut-off elevation, backdriving, cutting off piles, splicing, build-ups, or any cut-off lengths of piles.

1.1.4.1 Piling Quantities

The contract price for piling, including [_____] test piles, will be based on the following quantities and will include [_____] -metric ton -ton load tests and [_____] test pile withdrawals.

Number of Piles	Size (mm)	Total Length m
[_____]	[_____]	[_____]

Number of Piles	Size (inches)	Total Length (feet)
[_____]	[_____]	[_____]

1.1.4.2 Variations in Pile Quantities

Based on the results of driving and loading the test piles, the Contracting Officer will determine and will list for the Contractor calculated pile tip elevations and the minimum driving resistances for all piles. The Contracting Officer reserves the right to increase or decrease the total length of piles to be furnished and installed by changing the pile locations or elevations, requiring the installation of additional piles, or directing the omission of piles from the requirements shown and specified. Should the total length of piles installed vary from that specified because of added or omitted piles or variations in the pile lengths, the contract price for piling will be adjusted by the applicable contract unit price per linear meter foot (by size) for "Additional Pile Length" or "Omitted Pile Length" and multiplied by the actual length added or omitted.

1.1.4.3 Variations in the Number of Pile Load Tests

The Contracting Officer reserves the right to increase or decrease the number of pile load tests from that specified. For each load test added or deleted, the contract price will be adjusted by the applicable contract unit price for "Each Additional Pile Load Test" or "Each Omitted Pile Load Test."

1.1.4.4 Variations in Test Pile Withdrawals

Should the number of test pile withdrawals be increased above the specified number at the direction of the Contracting Officer, the contract price for piling will be adjusted by the contract price for "Each Additional Test Pile Withdrawn" and multiplied by the number of additional test piles withdrawn.

1.2 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.

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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 ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M 133	(2012) Standard Specification for Preservatives and Pressure Treatment Processes for Timber

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2010; Errata 2010) Structural Welding Code - Steel
AWS D1.4/D1.4M	(2011) Structural Welding Code - Reinforcing Steel

ASTM INTERNATIONAL (ASTM)

ASTM A615/A615M	(2012) Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM A996/A996M	(2009b) Standard Specification for Rail-Steel and Axle-Steel Deformed Bars for Concrete Reinforcement
ASTM D1143/D1143M	(2007e1) Piles Under Static Axial Compressive Load
ASTM D25	(2012) Round Timber Piles

1.3 SYSTEM DESCRIPTION

The work shall be performed by a Contractor specializing in the required foundation system and having experience installing the specified foundation system under similar subsurface conditions.

1.3.1 Subsurface Data

Subsurface soil data logs are [shown on the drawings] [appended to the SPECIAL CONTRACT REQUIREMENTS]. The subsoil investigation report and samples of material taken from subsurface investigations may be examined at [_____].

1.3.2 Equipment

Submit detail drawings, to demonstrate compliance of driving equipment, including [metal shoes and] cap blocks, splicing of timber and concrete sections, and the forming, reinforcing and casting of piles.

1.3.2.1 Pile Hammer

Provide a hammer with a delivered energy suitable for the total weight of the pile, the character of subsurface material to be encountered, and the pile capacity to be developed. The driving energy of the hammer shall be not less than 20.3 kN-m 15,000 foot-pounds. Operate diesel-powered hammers at the rate recommended by the manufacturer throughout the entire driving period. Maintain sufficient pressure at the steam hammer so that:

a. For a double-action hammer, the number of blows per minute during

and at the completion of driving of a pile is equal approximately to that at which the hammer is rated;

b. For a single-acting hammer, there is full upward stroke of the ram; and

c. For a differential type hammer, there is a slight rise of the hammer base during each upward stroke.

1.3.2.2 Driving Helmets or Caps

a. Use a driving helmet or cap, including a pile cushion, between the top of the pile and the ram to prevent impact damage to the pile. The driving helmet, or cap and pile cushion combination, shall completely cover the top surface of the pile and be capable of protecting the head of the pile, minimizing energy absorption and dissipation, and transmitting hammer energy uniformly over the top of the pile.

b. The driving helmet or cap shall fit loosely around the top of the pile so that the pile is not restrained by the driving cap, if the pile tends to rotate during driving. The pile cushion may be of solid wood, of laminated construction using plywood, softwood, or hardwood boards, or of other approved cushioning material. The pile cushion shall be retained by the driving helmet.

c. The minimum thickness of the pile cushion shall be 75 mm 3 inches and the thickness shall be increased so as to be suitable for the size and length of pile, character of subsurface material encountered, hammer characteristics, and required driving resistance. Use a new pile cushion at the start of driving for each pile and replaced whenever it becomes highly compressed, charred, burned, or deteriorated in any manner during driving.

1.4 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.

The Guide Specification technical editors have designated 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 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.][information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government.] Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Equipment

SD-03 Product Data

Pile Driving

SD-06 Test Reports

Field Test and Inspections

1.5 DELIVERY, STORAGE, AND HANDLING

Piles shall be stored and handled avoiding overstress or any other condition that may cause injury to the piles. Untreated piles to be stored for an extended period of time shall be inspected periodically, as well as shortly before driving, to detect damage due to fungus and insect attack. If treated piles are to be stored in a horizontal position for an extended period of time, they shall be inspected periodically to ensure that the treatment does not seep to the lower half of the pile to the extent that the upper half does not contain a sufficient amount of treatment.

PART 2 PRODUCTS

2.1 PILES

2.1.1 Wood Sections

Sections of the wooden piles shall be not less than [_____] mm inches in diameter at the butt (before forming of the tenon). Provide Douglas Fir or Southern Pine piles [clean peeled][rough peeled] conforming to ASTM D25. Piles shall [be pressure treated in accordance with AASHTO M 133, for Land and Fresh Water Piles by Pressure][not be treated].

2.1.2 Metal Shells

Provide metal shells of steel of sufficient strength and rigidity to withstand all driving stresses, to prevent distortion caused by driving adjacent piles, to prevent collapse due to soil or hydrostatic pressure, and to maintain their shape, free from dents or deformation. Thickness of shells shall be as indicated. Provide watertight shells to exclude groundwater during concrete placement. The actual or superficial perimeter

of a cross section of the piles, at any point in their length, shall be circular. Design the joint as specified herein, and in a manner to prevent the entrance of soil while driving, the leaking of concrete during placing, and the entrance of water at a rate that would not allow the shell to be properly dewatered before placement of concrete. The shells shall be [step-tapered type with a minimum nominal diameter of [_____] mm inches at the joint between wood and shell and the diameter shall increase from the joint to the cut-off elevation at a rate of not less than 10 mm per meter 1 inch per 8 feet of length] [or] [constant-section shells with a minimum nominal diameter of [_____] mm inches].

2.1.3 Concrete

Materials, mixing, and placing of concrete shall conform with the requirements of Section 03 30 00.00 10 CAST-IN-PLACE CONCRETE. Concrete shall have a minimum compressive strength of [_____] MPa psi at 28 days using [_____] -mm -inch maximum-size coarse aggregate. Slump shall be [_____] to [_____] mm inches for manual compaction and [_____] to [_____] mm inches when concrete is mechanically vibrated.

2.1.4 Reinforcing Steel

Provide reinforcing steel of the dimensions and sizes indicated and complying with [ASTM A615/A615M, Grade [40] [60]] [ASTM A996/A996M, Grade [50] [60]].

PART 3 EXECUTION

3.1 PILE DRIVING

****

NOTE: Past experience with similar structures is probably the best indicator of the need for protection. If protection is to be provided, this paragraph should be expanded to cover the type and extent of protection required. The following typical references offer detailed information on different types of pile protection:

a. Design and Construction of Ports and Marine Structures, by Alonzo DeF. Quinn, McGraw-Hill Book Company, New York, 1961.

b. Cathodic Protection, by L. M. Applegate, McGraw-Hill Book Company, New York, 1960.

c. Protection of Piling in Marine Environments, published by US Steel Corporation.

Additionally, the Construction Engineering Research Laboratory in Champaign, Illinois has done extensive research on pile protection, and may be contacted for information.

****

Submit a complete and accurate record of each driven pile indicating the pile location (as driven), size, length, final elevations of tip and top, elevation of top of wood section, pile weight, number of splices and locations, blows required for each m foot of penetration throughout the

entire length of the pile and for the final 150 mm 6 inches of penetration, and the total driving time. The record should also include the type and size of the hammer used, the rate of operation, and the type and dimensions of the driving helmet and cushion block used. Record any unusual conditions encountered during pile installation and immediately report them to the Contracting Officer.Perform driving with fixed leads to hold the pile firmly in position, alignment, and in axial alignment with the hammer. Drive piles to or below the "calculated" tip elevation to reach a driving resistance in accordance with the schedule that the Contracting Officer will prepare from the load test results.

a. The pile hammer used for driving shall be the same type, operated at the same rate and in the same manner, as that used for driving the test piles. If a pile fails to reach the "calculated" tip elevation or if a pile reaches the "calculated" tip elevation without reaching the required driving resistance, notify the Contracting Officer and perform corrective measures as instructed.

b. No piles shall be driven until the excavation or fill in the area that piles are to occupy has been completed to within 305 mm 12 inches of the grade indicated. Accomplish final grading after the pile driving has been completed. No piles shall be driven within 6 m20 feet of concrete less than 7 days old, unless so directed. Carefully locate piles to the lines and spacing shown and drive them to either the plumb position or the batter indicated.

c. Limit dynamic driving stresses to the crushing strength of the timber. If the pile encounters a sudden high driving resistance, cease driving and immediately notify the Contracting Officer and proceed as directed. If during driving, the pile encounters a sudden decrease in penetration resistance, investigate the cause; unless a satisfactory reason is found and the pile is undamaged, reject the pile and replace it without additional cost to the Government.

d. Take care to operate the hammer at its short stroke when the tip of the pile encounters soft material of little resistance either at the start of the driving or in passing into poor subsoil. The hammer should continue at its short stroke until sufficient resistance is built up to prevent damage due to tensile wave stresses. When driving is interrupted before final penetration is reached, the record of the penetration shall not be taken until after at least a 305 mm 12 inches penetration has been accomplished on the resumption of driving. Minimum penetration of the tops of wood piles being used in composite piles shall be 600 mm 2 feet below the low water table.

e. The length of the metal shell may vary according to requirements for proper seating of the piles, elevations of groundwater, and the required pile cut-off. Where piles longer than the specified length measured from point to cut-off elevations are required to provide specific bearing capacities, provide the longer piles by furnishing longer wood sections as directed. As an option, provide longer piles by increasing the lengths of concrete sections, but only after approval. Upon approval, where the specified bearing capacities are obtained with piles of less than the specified lengths, shorter piles may be used, but the tops of wood sections shall be driven at least 600 mm 2 feet below the water table.

3.1.1 Concrete Placement

Use an approved method for placing concrete in the shells. Place the concrete in a continuous flow from joint to top of piles. However, no concrete shall be placed in any shell until all other piles within a radius of 6 m 20 feet [or heave range] have been driven. Shells shall be free of deformations and water. Place concrete by tremie and not dropped through water.

3.1.2 Splices

Unless otherwise directed, construct field splices as indicated. Splices shall maintain the true alignment and position of the pile sections and develop the full strength of the pile in both bearing and bending. Proprietary prefabricated splicer sleeves may be used upon approval.

3.1.3 Tolerances in Driving

****
NOTE: Foundation piles should not be more than 75 to 150 mm (3 to 6 inches) from their intended plan position.
****

Top of any pile at elevation of cutoff shall be within [_____] mm inches of the planar location indicated. Manipulation of piles to force them into position will not be permitted. Check piles for heave and redrive those found to have heaved to the required tip elevation. Piles damaged or driven outside the above tolerances shall be replaced, or additional piles driven at locations specified by the Contracting Officer at no expense to the Government.

3.1.4 Cutting of Piles

Cut off piles at the elevations indicated by an approved method; remove surplus material from the job site.

3.1.5 Rejected Piles

Withdraw piles damaged, mislocated, or driven out of alignment beyond the maximum tolerances and replace them with new piles; or cut off and abandon them. Additional piles shall be driven as directed; excess cut off from piles and unacceptable piles shall be removed from the site of work. Perform all work, in connection with withdrawing and removing from the site rejected piles; without additional cost to the Government.

3.1.6 Predrilling

****
NOTE: Predrilling is normally terminated at a depth equal to two thirds of the total length of the pile embedment.
****

Predrilling will be permitted only when approved. The hole shall be [_____] mm inches less in diameter than the diagonal dimension of the pile. All predrilled piles shall be seated by final driving to provide the required pile capacities.

3.1.7 Collars or Bands

Use collars or bands of an approved design where required for the protection of the top of piles against splitting, brooming, and other damage when the piles are being driven.

3.1.8 Metal Shoes

Where indicated or directed, securely attach metal shoes of an approved design to the piles in a manner described in the detail drawings.

3.1.9 Joints

Joints between the wood and concrete sections shall be as indicated in the detail drawings.

3.1.10 Welding

Conform all field welding, and preparation of materials for welding, to AWS D1.1/D1.1M or AWS D1.4/D1.4M, as appropriate, using proper materials and experienced personnel whose ability and qualifications to do acceptable work have been fully demonstrated.

3.1.11 Pile Heave

When large pile clusters or piles are driven with very close spacing, take periodic elevations on the tops of all piles to observe and determine pile heave. Such elevations shall be taken on a telltale pipe 50 mm 2 inches in diameter placed inside the pile shell and bearing on the top of the wood section. When such checking indicates that pile heave has occurred and when pile driving progresses beyond effective pile heave range, all heaved piles shall be redriven to either the original resistance or the elevation, or both, as directed. If pile heave occurs along the shell portion of the pile, resulting in separation of the joint, the Contractor may resort to predrilling to eliminate heave or may provide a joint of sufficient tension capacity, as authorized, without additional cost to the Government.

3.1.12 Curing

[Maintain concrete in a moist condition for not less than 7 days for normal portland cement and for not less than 3 days for high-early-strength cement. For each decrease of 2 degrees 5 degrees below 20 degrees C 70 degrees F in the average curing temperature, these curing periods shall be increased by 4 days for units of normal portland cement and by 2 days for units of high-early-strength cement.] [Curing shall be in accordance with Section 03 30 00.00 10 CAST-IN-PLACE CONCRETE.]

3.1.13 Long Piles

Piles having a slenderness ratio greater than [22] [_____] shall be handled and driven with special precautions to ensure against overstress or leading from a plumb or true position. The slenderness ratio shall be the pile length divided by the least radius of gyration of the pile. When a high-resistance strata lying near the surface must be penetrated, spud piles may be used only when authorized by the Contracting Officer to minimize hard driving of long piles during the early stages of driving operations.

3.1.14 Jetting of Piles

****
NOTE: Jetting generally should not be permitted:

a. For piles dependent on side friction in fine-grained soils (high clay or silt content) with low-permeability where considerable time is required for the soil to reconsolidate around the piles.

b. For piles subject to uplift or lateral forces.

c. For piles adjacent to existing structures.

d. For piles in closely spaced clusters unless the load capacity is confirmed by test.
****

[Jetting of piles will not be permitted] [Jetting shall be discontinued at a depth approximately 1.5 m 5 feet above the "calculated" tip elevation; the remaining penetration shall be achieved by driving. Before the driving of the final 1.5 m5 feet is started, the pile shall be firmly seated in place by the application of a number of reduced-energy hammer blows].

3.2 FIELD TEST AND INSPECTIONS

Submit a complete report on the pile test, within [seven] [_____] days of completion of each pile test, including, but not limited to, a description of the pile driving equipment, driving records for both test piles and reaction piles, complete test data, analysis of test data, and recommended allowable design loads based on the pile test results. Prepare the report by or under the direct supervision of a registered professional engineer experienced in pile load testing and load test analysis.

3.2.1 Test Piles

Test piles shall be of the type and shall be driven in the manner specified. The Contracting Officer will use test pile and load test data to determine "calculated" pile tip elevations and the necessary driving resistance. Test piles that are located within the tolerances indicated and that provide a safe design capacity as determined by the results of a satisfactory load test may be used in the finished work. Drive test piles [at the locations indicated] [in the vicinity of the soil boring test holes No. [_____]]. [Jetting will be authorized only when pile testing clearly establishes the validity of its use.] Drive test piles to the tip elevation specified or indicated. Withdraw the specified number of test piles as indicated after reaching the "calculated" tip elevation for visual inspection of the pile.

3.2.2 Load Tests

Perform load tests, at locations shown or directed, on test piles placed to the tip elevation indicated except as otherwise directed. Loading, testing, and recording of data shall be under the direct supervision of a registered professional engineer, as well as the analysis of the load test data. The installation of piles shall not proceed in a new area with substantially different subsurface conditions until a satisfactory load test has been performed in that area and the results approved. Allow a minimum of [_____] days after submission of the test pile data for

approval. Unless otherwise directed, piles shall not be tested sooner than 3 days after driving unless sufficient time has elapsed to allow the cast-in-place section of the pile to develop its design strength before testing. Test loading shall conform to ASTM D1143/D1143M, cyclic loading method. Apply the load to the pile or pile group by [hydraulic jacks acting against an anchored reaction frame] [hydraulic jacks acting against a weighted platform or box] [direct loading of a weighted platform] using a spherical bearing to transmit the load to the pile.

3.2.3 Safe Design Capacity

The safe design capacity of a test pile, as determined from the results of load tests, shall be the lesser of the two values computed according to the following:

a. One-half of the load which causes a net settlement after rebound of not more than 0.23 mm per metric ton 0.01 inch per ton of total test load.

b. One-half of the load which causes a gross settlement of not more than 25 mm 1 inch, provided the load-settlement curve shows no sign of failure.

3.2.4 Inspection

The Contracting Officer may require that certain wood sections be withdrawn for test and inspection before the shell section is added to determine the condition of the wood sections. When so required, such wood sections shall be redriven only when approved. Withdrawn piles not suitable for redriving shall be treated as a rejected pile as specified in paragraph PILE DRIVING. Provide a suitable light for inspecting the interiors of pile shells.

3.2.5 Pile Capacity

The capacity, as driven, of single piles not in clusters in the structure shall be not less than [_____] metric tons tons. Determine the capacity by the following formula, modified according to the data obtained by the load tests:

a. For single-acting hammers: R = 166.7WH/(S + 2.54 P/W) R = 2WH/(S + 0.1 P/W)

b. Double-acting hammers: R = 166.7E/(S + 2.54 P/W) R = 2E/(S + 0.1 P/W)

Where: R is the allowable static pile load in newtons pounds. W is the weight of the striking part of the hammer in newtons pounds. H is the effective height of fall in m feet. E is the actual energy delivered by the hammer per blow in newton-meters foot-pounds. S is the average net penetration in mm inches per blow for the last 5 blows after the pile has been driven to a depth where successive blows produce approximately equal net penetration (a minimum distance of 1 meter 3 feet for friction piles). P is the weight of the pile in N pounds. (If P is less than W, P/W shall be taken as unity.)

-- End of Section --