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USACE / NAVFAC / AFCESA **UFGS-02462 (August 2004)**

Preparing Activity: USACE **Superseding UFGS-02459A (February 1998)**

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated 25 June 2004
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DIVISION 02 - SITE CONSTRUCTION

SECTION 02462

PILING: COMPOSITE, WOOD AND CAST IN-PLACE CONCRETE

08/04

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SECTION 02462

PILING: COMPOSITE, WOOD AND CAST IN-PLACE CONCRETE
08/04

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

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).

Use of electronic communication is encouraged.

Brackets are used in the text to indicate designer choices or locations where text must be supplied by the designer.
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PART 1 GENERAL

1.1 REFERENCES

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NOTE: Issue (date) of references included in project specifications need not be more current than provided by the latest guide specification. Use of SpecsIntact automated reference checking is recommended for projects based on older guide specifications.
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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 WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2002) Structural Welding Code - Steel
AWS D1.4	(1998) Structural Welding Code - Reinforcing Steel

ASTM INTERNATIONAL (ASTM)

ASTM A 615/A 615M	(2003a) Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
ASTM A 616/A 616M	(1996a) Rail-Steel Deformed and Plain Bars for Concrete Reinforcement
ASTM A 617/A 617M	(1996a) Axle-Steel Deformed and Plain Bars for Concrete Reinforcement
ASTM D 1143	(1981; R 1994e1) Piles Under Static Axial Compressive Load
ASTM D 1760	(2001) Pressure Treatment of Timber Products
ASTM D 25	(1999e1) Round Timber Piles

1.2 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 in paragraph MEASUREMENT AND PAYMENT. Where the contract is based on unit price, this paragraph should be deleted and replaced by the following paragraph:
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The contract price for piling shall 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.

1.2.1 Piling Quantities

The contract price for piling, including [_____] test piles, shall be based on the following quantities and shall 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)
[_____]	[_____]	[_____]

1.2.2 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 shall 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.

1.2.3 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 shall be adjusted by the applicable contract unit price for "Each Additional Pile Load Test" or "Each Omitted Pile Load Test."

1.2.4 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 shall be adjusted by the contract price for "Each Additional Test Pile Withdrawn" and multiplied by the number of additional test piles withdrawn.

1.3 MEASUREMENT AND PAYMENT

1.3.1 Piling

The Contractor will be paid at the contract unit price per linear meter foot (including test piles), for "Piling" multiplied by the total linear meters 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 shall 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.

1.3.2 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."

1.3.3 Pile Withdrawals

The Contractor 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.

1.4 SUBMITTALS

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NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

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 projects.

Submittal items not designated with a "G" are considered as being for information only for Army projects and for Contractor Quality Control approval for Navy 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 01330 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Equipment

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.

Pile Driving

A complete and accurate record of each driven pile. The record shall indicate 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 meter 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 also shall 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. Any unusual conditions encountered during pile installation shall be recorded and immediately reported to the Contracting Officer.

SD-06 Test Reports

Field Test and Inspections

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. The report shall be prepared by or under the direct supervision of a registered professional engineer experienced in pile load testing and load test analysis.

1.5 EXPERIENCE

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.

1.6 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 [_____].

1.7 EQUIPMENT

1.7.1 Pile Hammer

The hammer used shall have 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). 15,000 foot-pounds. Diesel-powered hammers shall be operated at the rate recommended by the manufacturer throughout the entire driving period. Sufficient pressure shall be maintained 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.

1.7.2 Driving Helmets or Caps

A driving helmet or cap, including a pile cushion, shall be used 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 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. 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 completely cover the top surface of the pile and shall be retained by the driving helmet. The minimum thickness of the pile cushion shall be 75 mm (3 inches) 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. A new pile cushion shall be used at the start of driving for each pile and shall be replaced whenever it becomes highly compressed, charred, burned, or deteriorated in any manner during driving.

1.8 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

Wood sections of the piles shall be not less than [_____] mm inches in diameter at the butt (before forming of the tenon). Wood piles shall be Douglas Fir or Southern Pine [clean peeled] [rough peeled] conforming to ASTM D 25. Piles shall [be pressure treated in accordance with ASTM D 1760,

Table 2, Treatment of Land and Fresh Water Piles by Pressure Processes] [not be treated].

2.1.2 Metal Shells

Metal shells shall be 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. The shells shall be watertight 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. The joint shall be designed 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 03300A CAST-IN-PLACE STRUCTURAL 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

Reinforcing steel shall be of the dimensions and sizes indicated and shall comply with [ASTM A 615/A 615M, Grade [40] [60]] [ASTM A 616/A 616M, Grade [50] [60]] [ASTM A 617/A 617M, Grade [40] [60]].

PART 3 EXECUTION

3.1 PILE DRIVING

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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.

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Driving shall be done with fixed leads that shall hold the pile firmly in position, alignment, and in axial alignment with the hammer. Piles shall be driven 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. 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, the Contractor shall notify the Contracting Officer and perform corrective measures as instructed. 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. Final grading shall be accomplished after the pile driving has been completed. No piles shall be driven within 6 meters 20 feet of concrete less than 7 days old, unless so directed. Piles shall be carefully located to the lines and spacing shown and shall be driven to either the plumb position or the batter indicated. Dynamic driving stresses shall be limited to the crushing strength of the timber. If the pile encounters a sudden high driving resistance, driving shall cease and the Contractor shall immediately notify the Contracting Officer and shall proceed as directed. If during driving, the pile encounters a sudden decrease in penetration resistance, the cause shall be investigated. Unless a satisfactory reason is found and the pile is undamaged, the pile shall be rejected and replaced without additional cost to the Government. Care shall be taken 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. 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, the longer piles shall be provided by furnishing longer wood sections as directed. The Contractor may 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

An approved method shall be used for placing concrete in the shells. The concrete shall be placed 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. Concrete shall be placed by tremie and shall not be dropped through water.

3.1.2 Splices

Unless otherwise directed, field splices shall be constructed as indicated. Splices shall maintain the true alignment and position of the pile sections and shall 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

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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. Piles shall be checked for heave and those found to have heaved shall be redriven 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

Piles shall be cut off at the elevations indicated by an approved method and surplus material shall be removed from the job site.

3.1.5 Rejected Piles

Piles damaged, mislocated, or driven out of alignment beyond the maximum tolerances shall be withdrawn and replaced by new piles, or shall be cut off and abandoned. Additional piles shall be driven as directed, and excess cut off from piles and unacceptable piles shall be removed from the site of work. All work in connection with withdrawing and removing from the site rejected piles shall be done without additional cost to the Government.

3.1.6 Predrilling

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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

Collars or bands of an approved design shall be used 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 metal shoes of an approved design shall be securely attached 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

All field welding and preparation of materials for welding shall conform to AWS D1.1/D1.1M or AWS D1.4, as appropriate, using proper materials and experienced personnel whose ability and qualifications to do acceptable work shall be fully demonstrated.

3.1.11 Pile Heave

When large pile clusters or piles are driven with very close spacing, periodic elevations shall be taken 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

[Concrete shall be maintained 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 03300A CAST-IN-PLACE STRUCTURAL 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 m 5 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

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. Test piles shall be driven [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.] Test piles shall be driven to the tip elevation specified or indicated. The specified number of test piles shall be withdrawn as indicated after reaching the "calculated" tip elevation for visual inspection of the pile.

3.2.2 Load Tests

Load tests at locations shown or directed shall be made 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. The analysis of the load test data shall be under the supervision of the registered professional engineer. 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. A minimum of [_____] days after submission of the test pile data shall be allowed for approval. Unless otherwise directed, piles shall not be tested sooner than 3 days after driving unless sufficient time shall have elapsed to allow the cast-in-place section of the pile to develop its design strength before testing. Test loading shall conform to ASTM D 1143, cyclic loading method. The load shall be applied 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. A suitable light shall be provided 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. The capacity will be determined by the following formula, modified according to the data obtained by the load tests:

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

And 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 meters. 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 --