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UFGS-02456N (February 2002)

Preparing Activity: NAVFAC

Superseding
UFGS-02456N (September 2001)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated 25 June 2004

Latest change indicated by CHG tags
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SECTION 02456N

PRESTRESSED CONCRETE PILES
02/02

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NOTE: This guide specification covers the requirements for prestressed, pretensioned and post-tensioned 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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NOTE: The extent and location of the work to be accomplished should be indicated on the project drawings or included in the project specification.
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NOTE: Do not use this specification on LANTDIV projects. Use LANTDIV NFGS-L-02456 PRESTRESSED CONCRETE PILES instead.
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NOTE: The following information shall be shown on the drawings:

1. Locations and design loads of piles.

2. Size, shape, and length of piles.

3. Locations, sizes, and number of longitudinal ducts for prestressing steel. Unit stresses for prestressing strands or wire.

4. Details of reinforcement and tendons.

5. Details of splices, if required.

6. Locations of test piles, if required.

7. Soil data, where required.

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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.

ACI INTERNATIONAL (ACI)

ACI 211.1	(1991) Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete
ACI 214R	(2002) Evaluation of Strength Test Results of Concrete
ACI 318M/318RM	(2002) Metric Building Code Requirements for Structural Concrete and Commentary
ACI SP-66	(1994) ACI Detailing Manual

AMERICAN WELDING SOCIETY (AWS)

AWS D1.4	(1998) Structural Welding Code - Reinforcing Steel

ASTM INTERNATIONAL (ASTM)

ASTM A 416/A 416M	(2002) Steel Strand, Uncoated Seven-Wire for Prestressed Concrete
ASTM A 421/A 421M	(2002) Uncoated Stress-Relieved Steel Wire for Prestressed Concrete
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 A 706/A 706M	(2003) Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement
ASTM A 82	(2002) Steel Wire, Plain, for Concrete Reinforcement
ASTM C 109/C 109M	(2002) Compressive Strength of Hydraulic Cement Mortars (Using 2-in. [50-mm] Cube Specimens)
ASTM C 136	(2001) Sieve Analysis of Fine and Coarse Aggregates
ASTM C 143/C 143M	(2003) Slump of Hydraulic Cement Concrete
ASTM C 150	(2002ae1) Portland Cement
ASTM C 172	(1999) Sampling Freshly Mixed Concrete
ASTM C 260	(2001) Air-Entraining Admixtures for Concrete
ASTM C 31/C 31M	(2003a) Making and Curing Concrete Test Specimens in the Field
ASTM C 33	(2003) Concrete Aggregates
ASTM C 39	(1993a) Compressive Strength of Cylindrical Concrete Specimens
ASTM C 494/C 494M	(1999ae1) Chemical Admixtures for Concrete
ASTM C 59/C 59M5	(2000; Rev A) Blended Hydraulic Cements
ASTM C 618	(2003) Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete
ASTM D 1143	(1981; R 1994e1) Piles Under Static Axial Compressive Load

PRECAST/PRESTRESSED CONCRETE INSTITUTE (PCI)

PCI JR-119	(1972) Grouting of Post-Tensioned Prestressed Concrete
PCI JR-382	(1993) Design, Manufacture and Installation of Prestressed Concrete Piling
PCI MNL-116	(1999) Quality Control for Plants and Production of Structural Precast Concrete Products

PCI STD-112 (1984) Standard Prestressed Concrete Piles Square, Octagonal and Cylinder

1.2 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

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NOTE: When the size and complexity of project warrants certification by a registered engineer, insert requirements; otherwise delete.

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Piles

Driving helmets, capblocks, and pile cushions

SD-05 Design Data

Concrete mix design

Submit a concrete mix design before concrete is placed, for each type of concrete used for the piles.

SD-06 Test Reports

Aggregates

Concrete

[Test piles]

[Load tests]

Submit concrete cylinder compressive strength test results. [Submit test pile records] [and] [load test data].

SD-07 Certificates

Precasting manufacturer's quality control procedures

Pile driving plan

Batter pile support plan

Prestressing steel

SD-11 Closeout Submittals

Pile records

Submit pile [and test pile] records.

1.3 REQUIREMENTS

1.3.1 Piling

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NOTE: Choose type of pile applicable to project. If both types of piles are required, consideration should be given to preparation of two separate sections. Separate sections are not recommended when both types of piles are specified with only one type to be furnished. Delete sentence in brackets when test piles are not required.

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Provide prestressed [pretensioned] [or] [post-tensioned] concrete piles, PCI JR-382. [From test pile data the Government will determine and list "calculated" tip elevations or driving resistances for each pile.] This information will be given to the Contractor no later than 10 days from receipt of complete test data. Use this list as the basis for ordering the piles. Do not order piles until list is provided by the Government. Test piles shall be [1.5] [_____] meter [5] [_____] feet longer than the bid length.

[1.3.2 Pile Lengths and Quantity

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NOTE: Use this paragraph for lump-sum contracts. Lump-sum method should be used in all but very special cases. Fill in Table I as required selecting columns applicable to project. Generally, pile capacity, location, and tip elevation are shown on plans. Delete this paragraph for unit-price contracts.
****

Base bids upon the [number, size, capacity, and length of piles as indicated.] [following Table I:

Table I

[Location]	Number	Size	[Capacity]	[Length]

Should total number of piles or number of each length vary from that specified as the basis for bidding, an adjustment in the contract price and time for completion will be made. Adjustments in contract price will not be made for [pile splices;] cutting off piles; for any portion of a pile remaining above cut-off elevation; or for broken, damaged, or rejected piles.]

][1.3.3 Measurement and Payment

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NOTE: Delete this paragraph for lump-sum contracts.

For PACNAVENGCOM projects: Where there is unit pricing for piles, use this paragraph and edit applicable attachments from Document 00101 for inclusion in Standard Form 1442, "Solicitation, Offer and Award" and "Schedule of Bid Items." Select first bracketed text.

For SOUTHDIV projects, where there is a need for unit pricing of piles, include this paragraph. Refer to SOUTHNAVFACENGCOM Instruction 00010, "Instructions for Preparing Basis of Bid Statement With Unit-Priced Items," for method of specifying unit price bid items. Select first bracketed text.

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[For unit price bid, see SF 1442, "Solicitation, Offer and Award" and "Schedule of Bid Items."] [Section 00101 BID SCHEDULES.]

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NOTE: For LANTNAVFACENGCOM projects, use the following for measurement and payment.
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[Requirements of "FAR 52.211-18, Variation in Estimated Quantity" shall not apply to payment for piling. Each pile and test pile acceptably provided will be paid for at the bid unit price per unit length, which price shall include items incidental to furnishing and driving the piles including mobilization and demobilization, [jetting] [predrilling], redriving uplifted piles, [an additional 1.5 m 5 feet in furnished length for any test pile not driven beyond estimated pile length,] and cutting off piles at the cutoff elevation. [The cost for additional length for the test piles shall be included in the total unit price cost for the job.] Payment will be made for job [and test piles] at the bid unit price for the length of pile, from tip to final cutoff, actually provided, excluding buildups and splices directed by the Contracting Officer to be made. Where the tip to cutoff length is less than that calculated from the results of test pile driving [and load testing], payment for that portion of pile not driven will be made at 75 percent of the bid unit price and no other payment will be made for making the cutoff. Payment for buildups will be made at 125 percent of the bid unit price. Payment for splices, as specified, will be made at 25 times the unit price per meter foot bid for 250 mm 10 inch

piling, 22 times the unit price per meter foot bid for 300 mm 12 inch piling, and 18 times the unit price per meter foot bid for all other piling. Should the actual cumulative pile length driven (tip to cutoff) vary more than 25 percent from the total pile length specified as a basis for bidding, at the direction of the Contracting Officer, the unit price per unit length will be adjusted in accordance with provisions of "FAR 52.236-2, Differing Site Conditions." Piles required to be pulled at no fault of the Contractor will be paid for at the bid unit price for furnishing and driving the pile in its original position plus 25 percent of the amount to cover the cost of pulling. Such pulled piles when redriven will be paid for at 25 percent of the bid unit price for the length driven. [Payment for each acceptably provided complete test loading of a single pile will be made at the contract unit price per test, which price shall include furnishing, placing, and removing testing equipment, and placing and removing test loads. At the direction of the Contracting Officer, load tests may be waived at a credit to the Government of the unit price bid therefor.]]

]1.4 QUALITY ASSURANCE

1.4.1 Piles

Prepare in accordance with ACI SP-66. Indicate placement of reinforcement including tendons. Indicate location of special embedded or attached lifting devices, employment of pick-up points, support points other than pick-up points, and any other methods of pick-up. [Provide certification of a professional engineer registered in any jurisdiction, that layout and details of reinforcement and tendons conform with that shown on the structural design drawings.]

1.4.2 Quality Control Procedures

Submit [_____] copies of precasting manufacturer's quality control procedures established in accordance with PCI MNL-116.

1.4.3 Installation Procedures

Submit installation instructions for pile driving plan and batter pile support plan.

1.4.4 Concrete Mix Design

Certify, using a Government-approved independent commercial testing laboratory, that proportioning of mix is in accordance with ACI 211.1 or ACI 318M/318RM for specified strength and is based on aggregate data which has been determined by laboratory tests during last twelve months.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Cement

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NOTE: Insert type of cement required. Generally, Types I and II and Type III, with 8 percent maximum C3A are used. In very special cases, Type V, "low alkali," which has limited availability, may be used.

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NOTE: Cement type and quantity of cement required in mix design is dependent upon the environment, soil conditions, need for corrosion protection, and location of piling:

(a) CHLORIDE PROTECTION:

Normal Use. In fresh water or air environment, specify Type I or Type II cement. Type III may be permitted provided tricalcium aluminate (C3A) content is limited to 8 percent.

Marine Use. In soil or water environments, subject to chlorides above 1,000 ppm, specify Type II cement and minimum 7.85 sacks of cement per cubic meter six sacks cement per cubic yard.

Seawater Exposure. In direct contact with ocean water, specify Type II and a minimum of 9.15 sacks of cement per cubic meter seven sacks of cement per cubic yard.

(b) SULFATE RESISTANCE

Normal Use. In soils with negligible amount of sulfate, specify Type I, II, or III (tricalcium aluminate (C3A) content, max. 8 percent) cement. When in doubt, specify Type II cement and a minimum of 7.85 sacks of cement per cubic meter six sacks of cement per cubic yard.

Moderate Sulfate Exposure. In exposures with moderate sulfate content (between 0.10 and 0.20 percent in soil and less than 1500 ppm in water), specify Type II or III (tricalcium aluminate (C3A) content, max. 8 percent) and a minimum of 7.85 sacks of cement per cubic meter six sacks of cement per cubic yard.

Severe Sulfate Exposure. In exposures with high sulfate content (exceeds 0.20 percent in soil or 1500 ppm in water), specify Type V and a minimum of 9.15 sacks of cement per cubic meter seven sacks of cement per cubic yard.

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NOTE: For exposed piles in areas where reactive aggregates are found, provide for additional tests and certification to insure that reactive aggregates will not be used. While not wholly conclusive, petrographic examination (ASTM C 295, chemical test (ASTM C 28/c 28M9), provide valuable indicators. The mortar bar method (ASTM C 227), while more reliable, requires at least 6 months and preferably one year to yield results. In areas where reactive aggregates can not be avoided, specify use of low

alkali cement. Service records of concrete made with these materials along with tests should be used in evaluating these materials.

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NOTE: Minimum cover for reinforcing steel in concrete structures is dependent upon the environment, soil conditions, need for corrosion protection, and location of piling. For normal exposure minimum cover is 50 mm 2 inches. For piles exposed to marine conditions (chloride content above 1000 ppm), use 75 mm 3 inches minimum cover except at corners where 100 mm 4 inches of cover should be provided. In normal and marine conditions, 38 mm 1 1/2 inch cover may be used for post-tensioned, centrifugally cast piles using no-slump concrete, with minimum 9.15 sacks of cement per cubic meter seven sacks cement per cubic yard. For additional detailed guidance, see following publications: ACI 543R, "Recommendations for Design, Manufacture and Installation of Concrete Piles" (ACI Manual, Part 3); State of California, Department of Public Works, Design Specifications, Volume 1, Bridge Planning and Design Manual, Chapter 6. Piles to be used in a marine environment may receive a protective coating, particularly if the piles are steam cured. The protective coating should be applied to that portion of pile which remains aboveground or water line. Show areas to be protected on drawings. A marine environment is defined as in or within about 300 m 1000 feet of the ocean or tidal water.

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ASTM C 150, [Type [_____]] [Type [_____], low alkali]. [ASTM C 59/C 59M5, Type [_____].] [Use cement with a tricalcium aluminate (C3A) content of less than 8 percent.]

2.1.2 Water

Use potable water.

2.1.3 Aggregates

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NOTE: For exposed piles in areas where reactive aggregates are found, provide for additional tests and certification to insure that reactive aggregates will not be used. While not wholly conclusive, petrographic examination (ASTM C 295, chemical test (ASTM C 28/c 28M9), provide valuable indicators. The mortar bar method (ASTM C 227), while more reliable, requires at least 6 months and preferably one year to yield results. In areas where reactive aggregates can not be avoided, specify use of low alkali cement. Service records of concrete made with these materials along with tests should be used in evaluating these materials.

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NOTE: Include modification to ASTM C 33 when reactive aggregates could be encountered. More modifications may be required. Additional tests and certifications may be required in the submittal paragraphs.
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ASTM C 33 [, except as modified herein. Provide aggregate free from any substance which may be deleteriously reactive with alkalies in cement in an amount sufficient to cause excessive expansion of concrete]. Do not mix, store in same stockpile, or use fine aggregates from different sources of supply in same concrete mix or same structure without approval. Prior to pile fabrication, submit certified test reports for the following tests specified in ASTM C 33[,in addition, [twice] [____] during each shift when the concrete plant is operating, the gradation of each size of aggregate shall be tested in accordance with ASTM C 136]:

a. Grading

b. Amount of material finer than 75 micrometers No. 200 sieve

c. Organic impurities

d. Soundness

e. Clay lumps and friable particles

f. Coal and lignite

g. Weight of slag

h. Abrasion of coarse aggregate

i. Fineness modulus

j. Reactive aggregates

k. Freezing and thawing

2.1.4 Admixtures

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NOTE: For guidance in use of either water-reducing admixtures, set retarding admixtures, or combination of admixtures, see ACI 543R-74, "Recommendations for Design, Manufacture, and Installation of Concrete Piles.
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If required, ASTM C 494/C 494M, [Type A] [Type B] and ASTM C 618, Type [N] [F] [C]. [Air-entraining admixture shall conform to ASTM C 260.] Do not use admixtures containing chlorides.

2.1.5 Prestressing Steel

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NOTE: Generally wire conforming to ASTM A 421 is

used only for post-tensioned cylinder piles.
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Use seven-wire stress relieved strand conforming to ASTM A 416/A 416M [or stress relieved wire conforming to ASTM A 421/A 421M]. Use prestressing steel free of grease, oil, wax, paint, soil, dirt, and loose rust. Do not use prestressing strands or wire having kinks, bends, or other defects.

2.1.6 Reinforcing Steel

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NOTE: Minimum cover for reinforcing steel in concrete structures is dependent upon the environment, soil conditions, need for corrosion protection, and location of piling. For normal exposure minimum cover is 50 mm 2 inches. For piles exposed to marine conditions (chloride content above 1000 ppm), use 75 mm 3 inches minimum cover except at corners where 100 mm 4 inches of cover should be provided. In normal and marine conditions, 38 mm 1 1/2 inch cover may be used for post-tensioned, centrifugally cast piles using no-slump concrete, with minimum 9.15 sacks of cement per cubic meter seven sacks cement per cubic yard. For additional detailed guidance, see following publications: ACI 543R, "Recommendations for Design, Manufacture and Installation of Concrete Piles" (ACI Manual, Part 3); State of California, Department of Public Works, Design Specifications, Volume 1, Bridge Planning and Design Manual, Chapter 6. Piles to be used in a marine environment may receive a protective coating, particularly if the piles are steam cured. The protective coating should be applied to that portion of pile which remains aboveground or water line. Show areas to be protected on drawings. A marine environment is defined as in or within about 300 m 1000 feet of the ocean or tidal water.
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NOTE: Insert grade of reinforcement.
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[ASTM A 615/A 615M] [ASTM A 616/A 616M] [ASTM A 617/A 617M], Grade [_____] or ASTM A 706/A 706M. Weld reinforcing steel in accordance with AWS D1.4.

2.1.7 Ties and Spirals

Steel, ASTM A 82 for spirals and ASTM A 615/A 615M for ties.

2.1.8 Anchorages and End Fittings

ACI 318M/318RM, for post-tensioned assemblies.

2.1.9 Grout

Provide cement grout for prestressed piles using materials conforming to requirements stipulated herein for concrete mixes or for post-tensioned piles, PCI JR-119. Use admixtures, if required, known to have no injurious

effects on steel or concrete. Do not use calcium chloride.

2.2 CONCRETE MIX DESIGN

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NOTE: Cement type and quantity of cement required in mix design is dependent upon the environment, soil conditions, need for corrosion protection, and location of piling:

(a) CHLORIDE PROTECTION:

Normal Use. In fresh water or air environment, specify Type I or Type II cement. Type III may be permitted provided tricalcium aluminate (C3A) content is limited to 8 percent.

Marine Use. In soil or water environments, subject to chlorides above 1,000 ppm, specify Type II cement and minimum 7.85 sacks of cement per cubic meter six sacks cement per cubic yard.

Seawater Exposure. In direct contact with ocean water, specify Type II and a minimum of 9.15 sacks of cement per cubic meter seven sacks of cement per cubic yard.

(b) SULFATE RESISTANCE

Normal Use. In soils with negligible amount of sulfate, specify Type I, II, or III (tricalcium aluminate (C3A) content, max. 8 percent) cement. When in doubt, specify Type II cement and a minimum of 7.85 sacks of cement per cubic meter six sacks of cement per cubic yard.

Moderate Sulfate Exposure. In exposures with moderate sulfate content (between 0.10 and 0.20 percent in soil and less than 1500 ppm in water), specify Type II or III (tricalcium aluminate (C3A) content, max. 8 percent) and a minimum of 7.85 sacks of cement per cubic meter six sacks of cement per cubic yard.

Severe Sulfate Exposure. In exposures with high sulfate content (exceeds 0.20 percent in soil or 1500 ppm in water), specify Type V and a minimum of 9.15 sacks of cement per cubic meter seven sacks of cement per cubic yard.

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NOTE: For exposed piles in areas where reactive aggregates are found, provide for additional tests and certification to insure that reactive aggregates will not be used. While not wholly conclusive, petrographic examination (ASTM C 295, chemical test (ASTM C 28/c 28M9), provide valuable indicators. The mortar bar method (ASTM C 227), while more

reliable, requires at least 6 months and preferably one year to yield results. In areas where reactive aggregates can not be avoided, specify use of low alkali cement. Service records of concrete made with these materials along with tests should be used in evaluating these materials.

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NOTE: Minimum cover for reinforcing steel in concrete structures is dependent upon the environment, soil conditions, need for corrosion protection, and location of piling. For normal exposure minimum cover is 50 mm 2 inches. For piles exposed to marine conditions (chloride content above 1000 ppm), use 75 mm 3 inches minimum cover except at corners where 100 mm 4 inches of cover should be provided. In normal and marine conditions, 38 mm 1 1/2 inch cover may be used for post-tensioned, centrifugally cast piles using no-slump concrete, with minimum 9.15 sacks of cement per cubic meter 7 sacks cement per cubic yard. For additional detailed guidance, see following publications: ACI 543R, "Recommendations for Design, Manufacture and Installation of Concrete Piles" (ACI Manual, Part 3); State of California, Department of Public Works, Design Specifications, Volume 1, Bridge Planning and Design Manual, Chapter 6. Piles to be used in a marine environment may receive a protective coating, particularly if the piles are steam cured. The protective coating should be applied to that portion of pile which remains aboveground or water line. Show areas to be protected on drawings. A marine environment is defined as in or within about 300 m 1000 feet of the ocean or tidal water.

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NOTE: Insert the minimum 28 day compressive strength required by the design. A minimum of 35 MPa 5000 psi is generally required. Insert aggregate size, either 19 mm 3/4 inch or 25 mm one inch is generally maximum.

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ACI 211.1 or ACI 318M/318RM, Chapter 4. Use concrete with a minimum compressive strength of [_____] MPa psi at 28 days and a maximum size aggregate of [_____] mm inches. Provide concrete shall be air entrained with a minimum of 4.5 percent and a maximum of 7 percent.

2.3 FABRICATION OF PRETENSIONED PILES

2.3.1 Formwork

Provide forms of metal, braced and stiffened against deformation, accurately constructed, watertight, and supported on unyielding casting beds. Forms shall permit movement of pile without damage during release of prestressing force. Form precast dowel holes with galvanized flexible metal conduit. [Inside forms or void tubes not to be grouted may be

treated cardboard, plywood, or other material. Anchor void forms firmly so they will not move, float or collapse during placing of concrete. If a moving mandrel is used for forming inner void, take special precautions to prevent fallout of inner surfaces, tensile cracks, and separation of concrete from strands.] Make piles to dimensional tolerances in accordance with PCI MNL-116.

2.3.2 Pretensioning

Measure tension to which steel is to be pretensioned by jack pressure read on a calibrated gage and verify by elongation of steel. Use gage calibrated within last 6 months by a laboratory approved by Contracting Officer. Provide means for measuring elongation of steel to nearest 3 mm 1/8 inch. When difference between results of measurement and gage reading is more than 5 percent, determine cause of discrepancy and correct. Give tensioning steel a uniform prestress prior to being brought to design prestress. Induce same initial prestress in each unit when several units of prestressing steel in a pile are stretched simultaneously.

2.3.3 Casting

2.3.3.1 Conveying

Clean conveying equipment thoroughly before each run. Convey concrete from mixer to forms as rapidly as practicable by methods which will not cause segregation or loss of ingredients. Deposit concrete as nearly as practicable to its final position. During placing, make any free vertical drop of the concrete less than 0.91 m 3 feet. Remove concrete which has segregated in conveying or placing.

2.3.3.2 Placing and Casting

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NOTE: Select chamfer required. Consult with local producers. Where project requires a large quantity of piling a specific value may be specified, otherwise, use a minimum or a range of values.
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Perform concrete casting within 3 days after pretensioning steel; however, do not deposit concrete in forms until placement of reinforcement and anchorages has been inspected and approved by pile manufacturer's quality control representative. Produce each pile of dense concrete straight with smooth surfaces with reinforcement retained in its proper position during fabrication. Use vibrator with heads smaller than the minimum distance between steel for pretensioning. Make surface of pile ends perpendicular to axis of pile. Chamfer, [a minimum of 19 mm 3/4 inch,] [[_____] mm [_____] inch,] [between 19 mm and 28 mm 3/4 inch and 1 1/8 inch,] ends of piles and corners of square piles.

2.3.4 Curing of Piles

Cure piles using moist or accelerated curing.

2.3.4.1 Moist Curing

Moist cure using moist burlap coverings, plastic sheeting, or membrane curing compound until minimum strength to detension is achieved.

2.3.4.2 Accelerated Curing

After placement of concrete, moist cure for a period of 4 hours. Accelerated cure until concrete has reached specified release strength. Enclose casting bed for accelerated curing with a suitable enclosure. During application of steam or heat, increase the air temperature at a rate not to exceed 15.5 degrees C 60 degrees F per hour. Cure at a maximum temperature of 71 degrees C 160 degrees F until concrete has reached specified release strength. Reduce temperature at a rate not to exceed 15.5 degrees C 60 degrees F per hour until a temperature of 6 degrees C 20 degrees F above ambient air temperature is reached. After accelerated curing, moist cure using either water or membrane curing until a total accelerated and moist curing time of 72 hours is achieved.

2.3.5 Detensioning

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NOTE: Specify "release strength." Release strength of 30 MPa 4000 psi (Design strength) of 35 MPa 5000 psi or 0.8 of the 28 day design strength is desirable; however, some regions use 0.7 of the design strength 25 MPa 3500 psi for design strength of 35 MPa 5000 psi. A minimum release strength of 0.6 of the design strength is required. Check with local pile manufacturers.
****

Perform releasing of prestressed steel in pretensioned piles in such an order that eccentricity of prestress will be minimized. Gradually release tension in strands from anchorage. Detension after approval by pile manufacturer's quality control representative. Perform transfer of prestressing force when concrete has reached a minimum compressive strength of [_____] MPa psi.

2.4 FABRICATION OF POST-TENSIONED PILES

2.4.1 Forms

Use metal forms, braced and stiffened to prevent deformation under pressure of wet-concrete during spinning. Use forms that provide, including seams, a smooth surface. Use end forms providing a plane surface perpendicular to axis of cylindrical form with the following tolerances: for abutting end surfaces, 2 mm to 3 mm 1/16 inch to 1/8 inch; for head end surfaces, 13 mm 1/2 inch; for point end surfaces, 75 mm 3 inches.

2.4.2 Steel Reinforcement

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NOTE: Check with pile manufacturer for standard details which will vary with design requirements.
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Reinforce each pile or pile section with spiral steel as shown. Hold spiral steel securely in position in form during spinning operation and position so there will be a minimum concrete cover of 31 mm 1 1/4 inch.

2.4.3 Longitudinal Ducts for Prestressing Steel

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NOTE: Check with pile manufacturer for standard details which will vary with design requirements.
****

Position longitudinal ducts sleeves for prestressing steel in pile wall to provide a minimum concrete cover of 38 mm 1 1/2 inch to outer surface of pile. Provide number, diameter, and arrangement of longitudinal holes for prestressing steel as shown.

2.4.4 Casting

Post-tensioned piles shall be cast as monolithic units.[Cylindrical piles shall be manufactured by the centrifugal casting process and cast in full lengths or in sections.]

2.4.5 Curing

After centrifugal casting and initial set, steam cure pile or pile sections, with form on, for at least 4 hours at a temperature not to exceed 71 degrees C 160 degrees F. Following steam curing, reduce temperature at a rate not to exceed 15.5 degrees C 60 degrees F per hour until a temperature of 6 degrees C 20 degrees F higher than ambient air temperature is reached. After steam curing, continue curing using either membrane or water curing until a total curing time of at least 72 hours is achieved. Apply membrane curing compound to surfaces of pile or pile sections to retain water for complete hydration.

2.4.6 Pile Assembly

Assemble sectional piles after compressive strength of the concrete in each section is at least 30 MPa 4000 psi as determined by test cylinders cured in the same manner as pile sections. Where membrane curing is used, remove curing compound from abutting end-surface of sections. Position pile sections in accurate alignment so that axis of pile does not deviate from a straight line more than 3 mm per 3 m 1/8 inch per 10 feet of length. Position adjacent sections so that maximum deviation of outside surfaces at joint will not exceed 6 mm 1/4 inch, and so that maximum deviation circumferentially in alignment of prestressing cable ducts at joint will not exceed 6 mm 1/4 inch. Cover abutting end surfaces of each section with a sealing material of sufficient thickness to fill voids between end surfaces, except prestressing cable ducts, when sections are brought together under compressive strength equal to or greater than that of the concrete. Use sealing material as resistant to exposure and weathering as concrete. After applying sealing material, bring pile sections together and hold with a minimum pressure of 690 kPa 100 psi on the gross concrete area until sealing material has set.

2.4.7 Post-Tensioning

Prestress piles after concrete has attained a compressive strength of 30 MPa 4000 psi. Tension prestressing cables to an average unit stress as indicated. Measure specified tension by a pressure gage on stressing jack and verify by the elongation of steel. Provide jack gage calibrated within past 6 months by a laboratory approved by the Contracting Officer. Provide means for measuring elongation of steel to nearest 3 mm 1/8 inch. When difference between results of measurement and gage reading is more than 5 percent, determine cause of discrepancy and correct. Maintain tension in cables by mechanical end-locks or anchors until final stress transfer. Aggregate prestress loss through transfer of stressing force

from jack to temporary anchorage shall not exceed an average of 10 percent in any one cable or an average of 5 percent for all cables in one pile.

2.4.8 Grouting

After completion of prestressing, flush cable ducts clean and completely fill with grout consisting of portland cement and water or portland cement, sand, and water mixed to a consistency suitable for pumping. Use grout having a minimum 28-day compressive strength of 30 MPa 4000 psi as determined by tests on 50 mm 2 inch cubes and conforming to ASTM C 109/C 109M. After each cable duct has been filled with grout and end closed off, raise grout pressure to a minimum of 690 MPa 100 psi. Maintain that pressure by grout pump for a minimum of one minute. Maintain prestressing force by mechanical end-locks or anchors until grout has attained sufficient strength to maintain required effective prestress. During this period do not move or handle pile in any manner that could result in damage to grout.

2.4.9 Stress Transfer

Do not transfer prestressing force from temporary end-locks to grouted cables until concrete and grout have reached a minimum compressive strength of 30 MPa 4,000 psi. Reject piles that show evidence of prestressing cable slippage. Evidence of prestressing cable slippage is a "cup and cone" fracture when cutting cables with a burning torch after end lock is removed.

[2.5 PROTECTION FROM FREEZING

For hollow piles exposed to freezing, provide precast drain holes through pile wall at approximate ground water elevation and fill pile with free-draining material. For piles standing in open water, place a concrete plug from lowest freeze depth to a minimum of 300 mm one foot above maximum high water level and provide precast drain holes through pile wall just above surface of concrete plug.

]2.6 EQUIPMENT

2.6.1 Pile Hammers

Furnish a hammer capable of developing the indicated ultimate pile capacity considering hammer impact velocity; ram weight; stiffness of hammer and pile cushions; cross section, length, and total weight of pile; and character of subsurface material to be encountered. [Use the same type pile hammer, operating at the same rate and in the same manner, as that used for driving test piles.] Obtain required driving energy of hammer, except for diesel hammers, by use of a heavy ram and a short stroke with low impact velocity. At final driving, operate pile hammer in accordance with manufacturer's recommendation for driving either end bearing piles or friction piles. At final driving, operate diesel powered hammers at rate recommended by manufacturer for hard driving. Maintain pressure at steam or air hammer so that: (1) for double-acting hammer, the number of blows per minute during and at completion of driving of a pile is equal approximately to that at which hammer is rated; (2) for single-acting hammer, there is a full upward stroke of the ram; and (3) for differential type hammer, there is a slight rise of hammer base during each upward stroke.

2.6.2 Driving Helmets and Cushion Blocks

2.6.2.1 Driving Helmets or Caps and Pile Cushions

****
NOTE: Insert minimum and maximum thicknesses for pile cushion. An absolute minimum would be 75 mm 3 inches and the actual required thickness would depend upon pile length, hammer energy, design load, required final penetration resistance, and character of subsurface material to be encountered. Generally thicker blocks are required for longer piles, larger hammers, and harder driving. A Wave Equation analysis is useful in determining required thicknesses for pile cushion. Minimum thickness is to protect head of pile. Pile cushion should also have a maximum thickness to insure effective driving. Select when pile cushion is to be replaced. It is generally recommended that a new pile cushion be used at the start of driving of each pile.
****

Use a steel driving helmet or cap including a pile cushion between top of pile and driving helmet or cap to prevent impact damage to pile. Use a driving helmet or cap and pile cushion combination capable of protecting pile head, minimizing energy absorption and dissipation, and transmitting hammer energy uniformly over top of pile. Provide driving helmet or cap fit sufficiently loose around top of pile so that pile may be free to rotate without binding within driving helmet. [During test pile installation, demonstrate to satisfaction of Contracting Officer that equipment to be used on project performs specified function.] Use pile cushion of solid wood or of laminated construction using plywood, softwood or hardwood boards with grain parallel to end of pile. Provide pile cushion with thickness of [_____] mm inches minimum and [_____] mm inches maximum. Replace pile cushion [at start of driving of each pile] [when it becomes highly compressed, charred or burned, or has become spongy or deteriorated in any manner]. Show details of driving helmets, capblocks, and pile cushions. Submit 2 weeks prior to [test] pile installation.

2.6.2.2 Hammer Cushion or Capblock

****
NOTE: Select either wood or aluminum/micarta capblock. Delete inappropriate sentences. An aluminum/micarta capblock is recommended because of its consistent elastic properties and long life. If final pile penetration resistance is based on a Wave Equation analysis, the type capblock used should be the same as that used in the analysis.
****

Use a hammer cushion or capblock between driving helmet or cap and hammer ram consisting of [a solid hardwood block with grain parallel to the pile axis and enclosed in a close-fitting steel housing] [aluminum and micarta (or equal) discs stacked alternately in a steel housing]. Use steel plates at top and bottom of capblock. [Replace wood capblock when it becomes highly compressed, charred or burned or becomes spongy or deteriorated in any manner]. [Replace aluminum or micarta discs that have become damaged,

split or deteriorated in any manner]. [Do not replace wood capblock during final driving of any pile.] Do not use small wood blocks, wood chips, rope or other materials that permit excessive loss of hammer energy.

2.7 PRODUCT QUALITY CONTROL

Where piling is manufactured in a plant with an established quality control program as attested to by a current certification in the PCI "Certification Program for Quality Control" perform product quality control in accordance with PCI MNL-116. Where piling is manufactured by specialists or in plants not currently enrolled in the PCI "Certification Program for Quality Control," set-up a product quality control system in accordance with PCI MNL-116 and perform concrete and aggregate quality control testing using an independent commercial testing laboratory approved by the Contracting Officer in accordance with the following.

2.7.1 Aggregate Tests

Take samples of fine and coarse aggregate at concrete batch plant and test. Perform mechanical analysis (one test for each aggregate size) in accordance with ASTM C 136. Tabulate results of tests in accordance with ASTM C 33.

2.7.2 Strength Tests

Sample concrete in accordance with ASTM C 172 at time concrete is deposited for each production line. Perform slump tests in accordance with ASTM C 143/C 143M. Mold cylinders in accordance with ASTM C 31/C 31M. Mold at least six cylinders per day or one for every [15] [45] cubic meter [20] [60] cubic yards of concrete placed, whichever is greater. Cure cylinders in same manner as piles and for accelerated curing, place at coolest point in casting bed. Perform strength tests in accordance with ASTM C 39. Test two cylinders of each set at 7 days or 14 days, or at a time for establishing transfer of prestressing force (release strength) and removal of pile from forms. Test remaining cylinders of each set 28 days after molding.

2.7.3 Changes in Proportions

If, after evaluation of strength test results, compressive strength is less than specified compressive strength, make adjustments in proportions and water content and changes in temperature, moisture, and curing procedures as necessary to secure specified strength. Submit changes in mix design to Contracting Officer in writing.

2.7.4 Compressive Strength Test Results

Evaluate compressive strength test results at 28 days in accordance with ACI 214R using a coefficient of variation of 10 percent. Evaluate strength of concrete by averaging test results of each set of standard cylinders tested at 28 days. Not more than 10 percent of individual cylinders tested shall have a compressive strength less than specified average compressive strength.

PART 3 EXECUTION

3.1 PILE DRIVING

3.1.1 Driving Piles

****
NOTE: Delete items in brackets dealing with tip elevation and driving resistance when test piles or load tests are not used. Delete item in brackets regarding predrilling or jetting when procedure is not used. If needed, insert maximum hammer energy for no tip resistance. This can be determined by comparing tensile stresses in pile resulting from a Wave Equation Analysis with effective prestress in pile.
****

Drive piles to [or below "calculated"] [indicated] tip elevation [to reach a driving resistance in accordance with the schedule which the Government will prepare from the test-pile driving data]. During initial driving and until pile tip has penetrated beyond layers of very soft soil [or below bottom of predrilled or prejetted holes], use a reduced driving energy of the hammer [of [_____] joules foot pounds per blow maximum or as otherwise directed by Contracting Officer]. Remove fluid soil and water rising inside hollow pile more than 3 m 10 feet above the original ground or water level or to within 1.5 m 5 feet of pile top before driving is continued, unless methods approved by Contracting Officer are used to prevent pile damage. If a pile fails to reach ["calculated"] [indicated] tip elevation, [or if a pile reaches ["calculated"] tip elevation without reaching required driving resistance,] Notify Contracting Officer and perform corrective measures as directed. Provide hearing protection when noise levels exceed 140 dB. Piles or pile sections shall not be handled or moved in any manner that would result in cracking or permanent damage to the concrete or to the grout surrounding the prestressing cables. Piles shall not be driven until the concrete has attained a minimum strength of [_____] MPa. psi. Piles may be driven without pile guides or leads providing a hammer guide frame is used to keep the pile and hammer in alignment.

3.1.2 Protection of Piles

****
NOTE: Delete references to batter piles when not applicable to the project.
****

Take care to avoid damage to piles during handling, placing pile in leads, and during pile driving operations. Support piles laterally during driving, but allow rotation in leads. [Take special care in supporting battered piles to prevent excessive bending stresses in pile.] Square top of pile to longitudinal axis of pile. Maintain axial alignment of pile hammer with that of the pile. Use a special driving head to drive piles having strands or mild steel reinforcement projecting from head.

3.1.3 Tolerances in Driving

****
NOTE: Omit references to batter piles when not applicable to the project. Select appropriate

tolerances for type of pile.
****

Drive piles with a variation of not more than 2 percent from vertical for plumb piles or more than 4 percent from required angle for batter piles. Maintain and check axial alignment of pile and leaders at all times. If subsurface conditions cause pile drifting beyond allowable axial alignment tolerance, notify Contracting Officer and perform corrective measures as directed. Place butts within 100 mm 4 inches of location indicated. [Manipulation of piles within specified tolerances is permitted, to a maximum of 1 1/2-percent of their exposed length above ground surface or mudline.] In addition to specified tolerances, maintain a location to provide a clear distance of at least 125 mm 5 inches from butt to edge of pile cap. If clear distance can not be maintained, then notify Contracting Officer. Check each pile for heave. Redrive heaved piles to required point elevation.

[3.1.4 [Jetting] [Pre-Drilling] of Piles

****
NOTE: Jetting should generally not be permitted. See note for paragraph entitled "Test Piles."
****

Discontinue at a depth approximately 1.5 m 5 feet above "calculated" tip elevation, and achieve remaining penetration by driving. Before starting final driving set pile to within 300 mm one foot of jetted, pre-drilled, or spudded depth and firmly seat piles in place by application of a number of reduced energy hammer blows.

]3.1.5 Splices

****
NOTE: Splicing of piles normally should not be permitted except where extremely long or heavy piles are required. If splices are permitted, drawings should indicate splice details. (See PCI standard drawings for typical splice details).
****

[Splicing of piles is not permitted.] [Make splices as indicated. Payment will be made as an adjustment to the contract price.]

3.1.6 Build-Ups

3.1.6.1 Pretensioned Piles

****
NOTE: Insert compressive strength required by design, usually a minimum of 35 MPa 5,000 psi. Insert maximum percent of build-ups permitted for project. The percent will depend on criticality of pile failure at build-up; whether the top of the pile is designed as a moment connection; exposure of piles to external physical or corrosive damage. Normally, for piles supporting piers exposed to seawater, limit percentage of build-ups to 10 percent.
****

Where required, pile section may be extended to cut-off elevation by means of a cast-in-place reinforced concrete build-up. Make build-up in accordance with PCI STD-112. Construct build-ups made after completion of driving in accordance with detail, "Build-Up Without Driving." Make build-ups to be driven in accordance with detail "Build-Up With Driving." Have details of means for protecting joints by a suitable mortar or epoxy approved by Contracting Officer. Where build-ups are exposed to water, protect cast-in-place section from water during curing period. Concrete in build-up shall have a minimum compressive strength of [_____] MPa psi. Build-ups will not be permitted on more than [_____] percent of total number of piles. If this percent figure is exceeded, or if in the judgment of the Contracting Officer, the clustered location of build-ups is undesirable, withdraw piles of insufficient length and replace with longer piles. Payment for such withdrawal and replacement will be made as an adjustment to the contract price.

3.1.6.2 Post-Tensioned Piles

Build-up piles to specified cut-off elevation by a cast-in-place extension of the pile, by a pile section, or by use of an acceptable length of pile cut-off. Make splice between pile and build-up by a poured plug of reinforced concrete extending a minimum of one outside-pile-diameter into the pile and an equal length into build-up where possible. Splice plug may be an extension of pile-to-cap connecting plug. If pile tops are damaged during driving, remove damaged portion and build-up pile as necessary.

3.1.7 Pile Cut-Off

Cut off piles with a smooth level cut using pneumatic tools, sawing, or other suitable methods approved by Contracting Officer. Use of explosives for cutting is not permitted.

3.2 FIELD QUALITY CONTROL

3.2.1 Test Piles

****

NOTE: Indicate location and number (if required) of piles (first option) on plans. Where second option is used, list appropriate soil boring test hole numbers. Jetting should generally not be permitted for piles:

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

2. Subject to uplift or lateral forces.

3. Adjacent to existing structures.

4. In closely spaced clusters unless the load capacity is confirmed by test.

****

Use test piles of type, and drive as specified for piling elsewhere in this section. The Government will use Contractor test pile data to determine

"calculated" pile tip elevation or necessary driving resistance. Drive test piles [at the locations indicated] [in vicinity of soil boring test holes Nos. [_____,] [_____,] and [_____]]. Drive test piles to [indicated tip elevation] [indicated bidding lengths]. [Drive piles driven one day an additional 150 mm 6 inches on the next working day, unless refusal (20 blows per 25 mm one inch is encountered).] Record any increase or decrease in driving resistance. If there is a decrease in driving resistance, a load test, at Government expense, may be required by the Contracting Officer. Use test piles, if located properly and offering adequate driving resistance in finished work. [Pre-drilling or jetting is permitted only when test piles clearly establish validity of its use, or as directed by the Contracting Officer.]

3.2.2 Load Tests

****
NOTE: If pile load tests are required and approved by the Contracting Officer, specify number and location of piles. Select method of load test. In ASTM D 1143, permit anchor piles only if approved by Navy or Army Geotechnical Branch. Insert figure (tons) corresponding to 225 percent of the design load. Select appropriate acceptance criteria. The offset method (first option) is usually recommended.
****

Perform load tests on [_____] piles in accordance with ASTM D 1143 as modified herein. [Do not use anchor piles.] Provide apparatus for applying vertical loads as required by method, using load from weighted box or platform [or reaction frame attached to sufficient uplift piles to safely take required load] applied to pile by hydraulic jack. Increase load in increments until rapid progressive settlement takes place or until application of total load of [_____] metric tons tons. Consider load test satisfactory when [after one hour at full test load gross settlement of pile butt is not greater than gross elastic pile compression plus 4 mm 0.15 inch plus one percent of pile tip diameter or width in [_____] mm inches,] [slope of gross load-settlement curve under full test load does not exceed 1.5 mm per metric ton 0.05 inches per ton,] [net settlement after removal of test load does not exceed 19 mm 3/4 inch.] Make load tests at locations shown on driven test piles. Additional load tests, at Government expense, may be required by the Contracting Officer. Loading, testing, and recording and analysis of data must be under the direct supervision of a Registered Professional Engineer provided and paid for by the Contractor.

3.2.3 Pile Records

****
NOTE: Omit reference to load test when not required in project. Omit reference to test piles and "calculated tip elevation" when test piles are not driven. Where special or unusual soil conditions are expected, consultation with EFD Code 411, Geotechnical Branch regarding special engineering supervision of driving, testing, recording and analysis of data for project may be useful.
****

For each driven pile, keep a record of the number of blows required for each meter foot of penetration and number of blows for the last 150 mm 6 inches

penetration or fraction thereof [as required] for the "calculated" [driving resistance]. Include in the record the beginning and ending times of each operation during driving of pile, type and size of hammer used, rate of operation, stroke or equivalent stroke for diesel hammer, type of driving helmet, and type and dimension of hammer cushion (capblock) and pile cushion used. Record retap data and unusual occurrences during pile driving. Notify Contracting Officer 10 days prior to driving of [test] piles [and load test]. The following log is a preprinted form for recording pile driving data.

[3.2.3.1 SPECIAL INSPECTION AND TESTING FOR SEISMIC-RESISTING SYSTEMS

****

NOTE: Include this paragraph <u>only</u> when special inspection and testing for seismic-resisting systems is required by paragraph 3.2 of FEMA 302, NEHRP RECOMMENDED PROVISIONS FOR SEISMIC REGULATIONS FOR NEW BUILDINGS AND OTHER STRUCTURES.

This paragraph will be applicable to both new buildings designed according to TI 809-04, SEISMIC DESIGN FOR BUILDINGS, and to existing building seismic rehabilitation designs done according to TI 809-05, SEISMIC EVALUATION AND REHABILITATION FOR BUILDINGS.

The designer must indicate on the drawings all locations and all features for which special inspection and testing is required in accordance with Chapter 3 of FEMA 302. This includes indicating the locations of all structural components and connections requiring inspection.

Add any additional requirements as necessary.

****

Special inspections and testing for seismic-resisting systems and components shall be done in accordance with Section 01452A SPECIAL INSPECTION FOR SEISMIC-RESISTING SYSTEMS.]

PILE DRIVING LOG

CONTRACT NO._____ CONTRACT NAME_____
CONTRACTOR_____ TYPE OF PILE_____
PILE LOCATION_____ PILE SIZE: BUTT/TIP: _____ LENGTH_____
GROUND ELEVATION_____ CUT OFF ELEVATION_____
PILE TIP ELEVATION_____ VERTICAL (_____) BATTER 1 ON (_____)
SPLICES ELEVATION_____ COMPANY_____

HAMMER: MAKE & MODEL_____ WT. RAM_____
STROKE_____ RAM RATED ENERGY_____
DESCRIPTION & DIMENSIONS OF DRIVING CAP_____
CUSHION MATERIALS & THICKNESS_____

INSPECTOR_____

"DEPTH" COLUMN OF PILE DRIVING RECORD REFERENCED TO:
_____ CUT-OFF ELEVATION
_____ FINISH FLOOR ELEVATION

TIME: START DRIVING_____ FINISH DRIVING_____ DRIVING TIME_____
INTERRUPTIONS (TIME, TIP ELEV. & REASON)_____
JET PRESSURE & ELEVATIONS_____

_____

DRIVING RESISTANCE

DEPTH M	NO. OF BLOWS	DEPTH M	NO. OF BLOWS	DEPTH M	NO. OF BLOWS
0	_____	5.4	_____	10.8	_____
0.3	_____	5.7	_____	11.1	_____
0.6	_____	6.0	_____	11.4	_____
0.9	_____	6.3	_____	11.7	_____
1.2	_____	6.6	_____	12.0	_____
1.5	_____	6.9	_____	12.3	_____
1.8	_____	7.2	_____	12.6	_____
2.1	_____	7.5	_____	12.9	_____
2.4	_____	7.8	_____	13.2	_____
2.7	_____	8.1	_____	13.5	_____
3.0	_____	8.4	_____	13.8	_____
3.3	_____	8.7	_____	14.1	_____
3.6	_____	9.0	_____	14.4	_____
3.9	_____	9.3	_____	14.7	_____
4.2	_____	9.6	_____	15.0	_____
4.5	_____	9.9	_____	15.3	_____
4.8	_____	10.2	_____	15.6	_____
5.1	_____	10.5	_____	15.9	_____

SHEET 1 OF 2

PILE DRIVING LOG

16.2	_____	23.1	_____	29.7	_____
16.5	_____	23.4	_____	30.0	_____
16.8	_____	23.7	_____	30.3	_____
17.1	_____	24.0	_____	30.6	_____
17.4	_____	24.3	_____	30.9	_____
17.7	_____	24.6	_____	31.2	_____
18.0	_____	24.9	_____	31.5	_____
18.3	_____	25.2	_____	31.8	_____
18.6	_____	25.5	_____	32.1	_____
18.9	_____	25.8	_____	32.4	_____
19.2	_____	26.1	_____	32.7	_____
19.5	_____	26.4	_____	33.0	_____
19.8	_____	26.7	_____	33.3	_____
20.1	_____	27.0	_____	33.6	_____
20.4	_____	27.3	_____	33.9	_____
20.7	_____	27.6	_____	34.2	_____
21.0	_____	27.9	_____	34.5	_____
21.3	_____	28.2	_____	34.8	_____
21.6	_____	28.5	_____	35.1	_____
21.9	_____	28.8	_____	35.4	_____
22.2	_____	29.1	_____	35.7	_____
22.5	_____	29.4	_____	36.0	_____
22.8	_____				

Driving resistance in blows per 25 mm for last 0.30 m of penetration:

DEPTH_____ DEPTH_____

25mm___ 50mm___100mm___125mm___150mm___175mm___200mm___225mm___ 250mm___

275mm___300mm___

ELEV._____ ELEV._____

REMARKS_____

CUT OFF ELEVATION: FROM DRAWING _____

TIP ELEVATION = GROUND ELEVATION - DRIVEN DEPTH = _____

DRIVEN LENGTH = CUT OFF ELEVATION - TIP ELEVATION = _____

CUT OFF LENGTH = PILE LENGTH - DRIVEN LENGTH = _____

SHEET 2 OF 2

PILE DRIVING LOG

CONTRACT NO._____ CONTRACT NAME_____
CONTRACTOR_____ TYPE OF PILE_____
PILE LOCATION_____ PILE SIZE: BUTT/TIP: _____ LENGTH_____
GROUND ELEVATION_____ CUT OFF ELEVATION_____
PILE TIP ELEVATION_____ VERTICAL (_____) BATTER 1 ON (_____)
SPLICES ELEVATION_____ COMPANY_____

HAMMER: MAKE & MODEL_____ WT. RAM_____
STROKE_____ RAM RATED ENERGY_____
DESCRIPTION & DIMENSIONS OF DRIVING CAP_____
CUSHION MATERIALS & THICKNESS_____

INSPECTOR_____

"DEPTH" COLUMN OF PILE DRIVING RECORD REFERENCED TO:
_____ CUT-OFF ELEVATION
_____ FINISH FLOOR ELEVATION

TIME: START DRIVING_____ FINISH DRIVING_____ DRIVING TIME_____
INTERRUPTIONS (TIME, TIP ELEV. & REASON)_____
JET PRESSURE & ELEVATIONS_____

_____

DRIVING RESISTANCE

DEPTH FT.	NO. OF BLOWS	DEPTH FT.	NO. OF BLOWS	DEPTH FT.	NO. OF BLOWS
0	_____	18	_____	36	_____
1	_____	19	_____	37	_____
2	_____	20	_____	38	_____
3	_____	21	_____	39	_____
4	_____	22	_____	40	_____
5	_____	23	_____	41	_____
6	_____	24	_____	42	_____
7	_____	25	_____	43	_____
8	_____	26	_____	44	_____
9	_____	27	_____	45	_____
10	_____	28	_____	46	_____
11	_____	29	_____	47	_____
12	_____	30	_____	48	_____
13	_____	31	_____	49	_____
14	_____	32	_____	50	_____
15	_____	33	_____	51	_____
16	_____	34	_____	52	_____
17	_____	35	_____	53	_____

SHEET 1 OF 2

PILE DRIVING LOG

54	_____	77	_____	99	_____
55	_____	78	_____	100	_____
56	_____	79	_____	101	_____
57	_____	80	_____	102	_____
58	_____	81	_____	103	_____
59	_____	82	_____	104	_____
60	_____	83	_____	105	_____
61	_____	84	_____	106	_____
62	_____	85	_____	107	_____
63	_____	86	_____	108	_____
64	_____	87	_____	109	_____
65	_____	88	_____	110	_____
66	_____	89	_____	111	_____
67	_____	90	_____	112	_____
68	_____	91	_____	113	_____
69	_____	92	_____	114	_____
70	_____	93	_____	115	_____
71	_____	94	_____	116	_____
72	_____	95	_____	117	_____
73	_____	96	_____	118	_____
74	_____	97	_____	119	_____
75	_____	98	_____	120	_____
76	_____				

DRIVING RESISTANCE IN BLOWS PER INCH FOR LAST FOOT OF PENETRATION:

DEPTH_____ DEPTH_____

1"___2"___3"___4"___5"___6"___7"___8"___9"___10"___11"___12"___

ELEV._____ ELEV._____

REMARKS_____

CUT OFF ELEVATION: FROM DRAWING _____

TIP ELEVATION = GROUND ELEVATION - DRIVEN DEPTH = _____

DRIVEN LENGTH = CUT OFF ELEVATION - TIP ELEVATION = _____

CUT OFF LENGTH = PILE LENGTH - DRIVEN LENGTH = _____

SHEET 2 OF 2

-- End of Section --