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USACE / NAVFAC / AFCEC / NASA **UFGS-35 59 13.13 (August 2009)**

Preparing Activity: NAVFAC **Superseding**
UFGS-35 59 13.13 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2018
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DIVISION 35 - WATERWAY AND MARINE CONSTRUCTION

SECTION 35 59 13.13

PRESTRESSED CONCRETE FENDER PILING

08/09

-- End of Section Table of Contents --

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SECTION 35 59 13.13

PRESTRESSED CONCRETE FENDER PILING
08/09

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NOTE: This guide specification covers the requirements for prestressed concrete fender piling.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

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

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**
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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: Refer to NFESC TM 53-89-03, "Prestressed Concrete Fender Piling User Data Package" for details of these fender piles. 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 prestressing steel strands. Unit stresses for prestressing strands or wire.

4. Details of reinforcement and tendons.

5. Soil data, where required.

6. Embedment depth.
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PART 1 GENERAL

1.1 REFERENCES

****
NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.
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The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M 182	(2005; R 2017) Standard Specification for Burlap Cloth Made from Jute or Kenaf and Cotton Mats

AMERICAN CONCRETE INSTITUTE INTERNATIONAL (ACI)

ACI 211.1	(1991; R 2009) Standard Practice for Selecting Proportions for Normal, Heavyweight and Mass Concrete
ACI 212.3R	(2016) Chemical Admixtures for Concrete
ACI 214R	(2011) Evaluation of Strength Test Results of Concrete
ACI 318M	(2014; ERTA 2015) Building Code Requirements for Structural Concrete & Commentary
ACI SP-66	(2004) ACI Detailing Manual

AMERICAN WELDING SOCIETY (AWS)

AWS D1.4/D1.4M	(2011) Structural Welding Code - Reinforcing Steel

ASTM INTERNATIONAL (ASTM)

ASTM A1064/A1064M	(2017) Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
ASTM A153/A153M	(2016) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A307	(2014; E 2017) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
ASTM A416/A416M	(2017) Standard Specification for Low-Relaxation, Seven-Wire for Prestressed Concrete
ASTM A501/A501M	(2014) Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing
ASTM A53/A53M	(2012) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A563	(2015) Standard Specification for Carbon and Alloy Steel Nuts
ASTM A563M	(2007; R 2013) Standard Specification for Carbon and Alloy Steel Nuts (Metric)
ASTM A615/A615M	(2016) Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM A706/A706M	(2016) Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement
ASTM A996/A996M	(2016) Standard Specification for Rail-Steel and Axle-Steel Deformed Bars for Concrete Reinforcement
ASTM C1202	(2017) Standard Test Method for Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration
ASTM C1218/C1218M	(2017) Standard Test Method for Water-Soluble Chloride in Mortar and Concrete

ASTM C1240	(2014) Standard Specification for Silica Fume Used in Cementitious Mixtures
ASTM C1260	(2014) Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method)
ASTM C136/C136M	(2014) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C143/C143M	(2015) Standard Test Method for Slump of Hydraulic-Cement Concrete
ASTM C150/C150M	(2017) Standard Specification for Portland Cement
ASTM C1567	(2013) Standard Test Method for Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method)
ASTM C171	(2016) Standard Specification for Sheet Materials for Curing Concrete
ASTM C172/C172M	(2017) Standard Practice for Sampling Freshly Mixed Concrete
ASTM C260/C260M	(2010a; R 2016) Standard Specification for Air-Entraining Admixtures for Concrete
ASTM C309	(2011) Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C31/C31M	(2017) Standard Practice for Making and Curing Concrete Test Specimens in the Field
ASTM C311/C311M	(2017) Standard Test Methods for Sampling and Testing Fly Ash or Natural Pozzolans for Use in Portland-Cement Concrete
ASTM C33/C33M	(2016) Standard Specification for Concrete Aggregates
ASTM C39/C39M	(2017b) Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C494/C494M	(2017) Standard Specification for Chemical Admixtures for Concrete
ASTM C595/C595M	(2017) Standard Specification for Blended Hydraulic Cements
ASTM C618	(2017) Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C666/C666M	(2015) Resistance of Concrete to Rapid

Freezing and Thawing

ASTM C989/C989M	(2017) Standard Specification for Slag Cement for Use in Concrete and Mortars
ASTM D1894	(2014) Static and Kinetic Coefficients of Friction of Plastic Film and Sheeting
ASTM D2240	(2015) Standard Test Method for Rubber Property - Durometer Hardness
ASTM D256	(2010) Determining the Izod Pendulum Impact Resistance of Plastics
ASTM D4020	(2011) Ultra-High-Molecular-Weight Polyethylene Molding and Extrusion Materials
ASTM D570	(1998; E 2010; R 2010) Standard Test Method for Water Absorption of Plastics
ASTM D638	(2014) Standard Test Method for Tensile Properties of Plastics
ASTM D792	(2013) Density and Specific Gravity (Relative Density) of Plastics by Displacement
ASTM F844	(2007a; R 2013) Washers, Steel, Plain (Flat), Unhardened for General Use

PRECAST/PRESTRESSED CONCRETE INSTITUTE (PCI)

PCI MNL-116	(1999) Manual for Quality Control for Plants and Production of Structural Precast Concrete Products, 4th Edition

1.2 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list to reflect only the submittals required for the project.

The Guide Specification technical editors have designated those items that require Government approval, due to their complexity or criticality, with a "G". Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

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

Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy, Air Force, and NASA projects.

Use the "S" classification only in SD-11 Closeout Submittals. The "S" following a submittal item indicates that the submittal is required for the Sustainability eNotebook to fulfill federally mandated sustainable requirements in accordance with Section 01 33 29 SUSTAINABILITY REPORTING.

Choose the first bracketed item for Navy, Air Force and NASA projects, or choose the second bracketed item for Army projects.
****

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.] Submittals with an "S" are for inclusion in the Sustainability eNotebook, in conformance to Section 01 33 29 SUSTAINABILITY REPORTING. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

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

Fly ash and Pozzolan

Ground Slag

Silica fume

Concrete

Submit concrete cylinder compressive strength test results.

SD-07 Certificates

Precasting manufacturer's quality control procedures

Suitability of pile driving equipment

[Curing of piles

][Silica fume manufacturer's representative

] Prestressing steel

Portland cement

Concrete mix design

Reinforcing steel

[Rubbing surface

] Bolts, nuts, and washers

1.3 REQUIREMENTS

1.3.1 Piling Lengths and Quantity

Provide prestressed pretensioned concrete piles. Base bids upon the number, size, and length of piles as indicated. Adjustments in the contract price will not be made for cutting off piles or for broken, damaged, or rejected piles.

1.3.2 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 in the U.S. or its territories, that layout and details of reinforcement and tendons conform with that shown on the structural design drawings.]

1.3.3 Driving Helmets, Capblocks, and Pile Cushions

Show details of driving helmets, capblocks, and pile cushions. Submit 2 weeks prior to [test] pile installation.

1.4 QUALITY ASSURANCE

1.4.1 Quality Control Procedures

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

[1.4.1.1 Curing of Piles

Submit proposed materials and methods.

]1.4.2 Silica Fume Manufacturer's Representative

Provide statement that the manufacturer's representative will be present at plant to ensure proper mix, including high range water reducer (HRWR), and batching methods.

1.4.3 Aggregates

Prior to pile fabrication, submit certified test reports for the following tests specified in ASTM C33/C33M:

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

1.4.4 Fly Ash and Pozzolan

Furnish fly ash and pozzolan test results performed within 6 months of submittal date. Sampling and testing shall be in accordance with ASTM C311/C311M.

1.4.5 Silica Fume

Furnish silica fume test results performed within 6 months of submittal date. Sampling and testing shall be in accordance with ASTM C311/C311M.

1.4.6 Portland Cement

Certification identifying cement; brand name, type, mill location, quantity to be used, size of lot represented by quality control sample, lot number, and destination of shipment.

1.4.7 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 for specified strength and is based on aggregate data which has been determined by laboratory tests during last 12 months.

1.5 DELIVERY, STORAGE, AND HANDLING

Piles shall be stored, handled, and transported in accordance with PCI MNL-116 except as follows. Methods used for handling and storage of piles shall be such that the piles are not subjected to excessive bending stress, cracking, spalling, or other damage.

1.5.1 Damaged Piles

The Contractor shall inspect each pile for sweep and structural damage such as cracking and spalling before transporting them to the project site and immediately prior to placement in the driving leads. Any unusual cracks (cracks other than crazing, surface drying, shrinkage cracks and end cracks) shall be brought to the attention of the Contracting Officer. Piles which are damaged during delivery, storage, or handling to the extent they are rendered unsuitable for the work, in the opinion of the Contracting Officer, shall be rejected and removed from the project site, or may be repaired, if approved, at no cost to the Government.

1.5.1.1 Repairable Cracks

Piles with cracks equal to or greater than 0.15 mm 0.006 inches but less than 1.5 mm 0.06 inches shall be rejected or repaired. As an alternate to pile rejection, the Contractor may submit a proposal to repair deficient piles, which shall be restored prior to driving to provide its required design capacity, perform its intended function in the structure, and take into consideration long term durability in corrosive environment.

1.5.1.2 Non-Repairable Cracks

Piles with cracks equal to or greater than 1.5 mm 0.06 inches shall be rejected.

1.5.2 Pile Sweep

Sweep shall be limited to 3 mm per 3 M 1/8 inch per 10 feet over the length of the pile. Piles having excessive sweep shall be rejected.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Cementitious Materials

Cementitious materials shall be portland cement, [blended cement] or portland cement in combination with natural pozzolan or fly ash [or ground granulated blast furnace slag] and conforms to appropriate specifications listed below.

2.1.1.1 Cement

****

NOTE: Insert type of cement required. Generally, Types II, or I/II, is preferred. Type I, or Type III with 8 percent maximum C3A and "low alkali" may be used. Do not use Type III in conjunction with silica fume. In very special cases, Type V, "low alkali," which has limited availability, may be used.

****

****

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 and it is low alkali.

Marine Use. In soil or water environments, subject to chlorides above 1,000 ppm, within about 300 m 1000 feet of the ocean or tidal water, specify Type II or Type III (with a maximum tricalcium aluminate (C3A) content of 8 percent and low alkali) cement, a minimum cementitious materials content of 335 kilograms per cubic meter 564 pounds per cubic yard and a maximum water to cementitious materials ratio of 0.40.

Seawater Exposure. In direct contact with ocean water, specify Type II or Type III (with a maximum tricalcium aluminate (C3A) content of 8 percent and low alkali) cement, a minimum cementitious materials content of 390 kilograms per cubic meter 658 pounds per cubic yard and a maximum water to cementitious materials ratio of 0.40.

(b) SULFATE RESISTANCE:A minimum cementitious materials content of 335 kilograms per cubic meter 564 pounds per cubic yard is recommended.

Normal Use. In soils with negligible amount of sulfate, specify Type I or Type II cement. Type III cement may be permitted provided tricalcium aluminate (C3A) content is limited to 8 percent and it is low alkali.

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 Type III (with a maximum tricalcium aluminate (C3A) content of 8 percent and low alkali) cement and a maximum water to cementitious materials ratio of 0.40. Do not use Class C fly ash, blast furnace slag, or silica fume for cement replacement.

Severe Sulfate Exposure. In exposures with high sulfate content (exceeds 0.20 percent in soil or 1500 ppm in water), specify Type V or Type II (with a maximum tricalcium aluminate content of 5 percent) cement, and a maximum water to cementitious materials ratio of 0.40. Do not use Class C fly ash, blast furnace slag, or silica fume for cement replacement.

Alkali-Silica Reactivity. When alkali-silica reactivity is a concern, it is recommended to limit

the maximum alkali content of cement to 0.40 or 0.50, when it is locally available, otherwise use 0.60.
****

ASTM C150/C150M, [Type I, II, or III[_____] with a maximum alkali content of [0.40] 0.60 percent][; or][ASTM C595/C595M, Type [IP(MS) or IS(MS)] [_____]] blended cement except as modified herein. The blended cement shall consist of a mixture of ASTM C150/C150M cement (with alkali content not exceeding[0.40] 0.60 percent) and one of the following materials: ASTM C618 pozzolan or fly ash, or ASTM C989/C989M ground iron blast-furnace slag, or ASTM C1240 silica fume. If no satisfactory test results are available (made within the past six months) to prove that the cement alkali content is less than 0.40 percent, then cement with a maximum of 0.60 percent alkali shall be used. Cement certificates shall include test results in accordance with ASTM C150/C150M, including equivalent alkalies indicated in the optional chemical requirements. [Use cement with a tricalcium aluminate (C3A) content of less than [8][5] percent.] Type III cement shall not be used in conjunction with silica fume.

****
NOTE: Fly ash, pozzolan, and ground iron blast-furnace slag increase durability. They may produce uneven discoloration of the concrete during the early stages of construction, depending upon the type of curing provided. Use Fly ash/pozzolan (loss on ignition not exceeding 3 percent) for frost areas to reduce carbon interference with air entraining admixture. Straight replacement with fly ash or natural pozzolan beyond 15 percent may decrease the concrete's strength gain rate. The following options can help mitigate this slower gain rate: (1) a lower water/cement ratio may be used, (2) partial cement replacement can be completed, e. g., 1 sack of cement can be replaced by 1.5 sacks of fly ash, as long as the final replacement ratio meets the requirements, and (3) very fine fly ashes or pozzolans (e. g. with average particle sizes below 5 microns) can be used.
****

2.1.1.2 Fly Ash and Pozzolan

****
NOTE: Loss on ignition greater than 3 percent may result in significant variations in air content. The air entrainment admixture content may need to be varied often to maintain the same level of entrained air.
****

ASTM C618, Class N, or F except that the maximum total alkalies shall be 3 [6] percent. If the aggregates are reactive the maximum calcium oxide content shall be 13.0 percent. Class C shall not be used.

2.1.1.3   Ground Iron Blast-Furnace Slag

ASTM C989/C989M, Grade 120.

2.1.1.4   Silica Fume

****
NOTE: Use silica fume concrete for marine structures where low permiability and enhanced durability are necessary. The silica fume and HRWR additive should be from the same manufacturer. The Contractor and batch plant may need help from the manufacturer. Select weight percentage based on performance required. If used, a replacement of 7 percent is recommended.
****

****
NOTE: Use for high durability and low permeability. The initial cost of the concrete will increase, and supervision at the batch plant, finishing, and curing is necessary. A HRWR must be used with silica fume. The slump can be increased 50 to 125 mm 2 to 5 inches without reducing strength. Finishing may be more difficult. Proper curing is essential because there is a tendency for plastic shrinkage cracking.
****

ASTM C1240, provide silica fume that is a by-product of silicon or ferrosilicon production. Provide percent by weight of the total cementitious materials as indicated in table below.

2.1.1.5   Supplemental Cementitious Materials (SCM) Content

The concrete mix shall contain one of the four SCMs listed below, or a linear combination thereof.

SUPPLEMENTARY CEMENTITIOUS MATERIALS CONTENT		
SCM	Minimum Content	Maximum Content
Class N Pozzolan or Class F Fly Ash with with SiO_2 plus Al_2O_3 plus Fe_2O_3 greater than 70 percent	25 percent	35 percent
Class N Pozzolan or Class F Fly Ash with with SiO_2 plus Al_2O_3 plus Fe_2O_3 greater than 80 percent	20 percent	35 percent
Class N Pozzolan or Class F Fly Ash with with SiO_2 plus Al_2O_3 plus Fe_2O_3 greater than 90 percent	15 percent	35 percent
GGBF Slag	30 percent	50 percent

SUPPLEMENTARY CEMENTITIOUS MATERIALS CONTENT		
SCM	Minimum Content	Maximum Content
Silica Fume	5 percent	10 percent

2.1.2 Water

Water shall be fresh, clean, and potable; free from injurious amounts of oils, acids, alkalis, salts, organic materials, or other substances deleterious to concrete or steel.

2.1.3 Aggregates

****
NOTE: For piles in areas where reactive aggregates are likely to be supplied, provide for additional tests and certification to ensure that reactive aggregates will not be used. While not wholly conclusive, petrographic examination (ASTM C295/C295M), chemical test (ASTM C289/C289M), and mortar bar method (ASTM C227) are valuable indicators. While more reliable, the concrete prism test (ASTM C1293) takes 1 to 2 years to complete and is not practical. The accelerated mortar bar method (ASTM C1260) is similarly reliable and takes only 16 days to yield results. In areas where reactive aggregates can not be avoided, specify use of low alkali cement, and/or cements modified to mitigate alkali-silica reactivity. Service records of concrete made with these materials along with tests should be used in evaluating these materials.
****

****
NOTE: Include modification to ASTM C33/C33M when reactive aggregates could be encountered. More modifications may be required. Additional tests and certifications may be required in the submittal paragraphs.
****

ASTM C33/C33M[, 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. The fineness modulus of fine aggregate shall be not less than 2.40 or greater than 3.0. For piles that will be exposed to freezing and thawing, fine and coarse aggregate subjected to five cycles of the sodium sulfate soundness test shall show a loss not greater than 10 percent. If the selected aggregates fail the soundness test, the Contractor may use the aggregate source, provided concrete specimens made with the aggregates to be used for the piles shall have a durability factor of not less than 80 based on 300 cycles of freezing and thawing when tested in accordance with ASTM C666/C666M. Prior to pile fabrication, submit certified test reports for the following tests specified in ASTM C33/C33M[,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 C136/C136M]:

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

2.1.3.1 Alkali-Silica Reactivity (ASR)

Fine and coarse aggregates to be used in all concrete shall be evaluated and tested by the Contractor for alkali-aggregate activity.

The fine and coarse aggregates shall be evaluated separately, using ASTM C1260. Test results of the individual aggregates shall have a measured expansion equal to or less than 0.08 percent at 16 days after casting. Should the test data indicate an expansion of greater than 0.08 percent, the aggregates(s) shall be rejected or additional testing, using ASTM C1567 shall be performed as follows: utilize the Contractor's proposed low alkali portland cement [blended cement] and SCM in combination with the proposed aggregate for the test portioning. The SCM quantity shall be determined that will meet all the requirements of these specifications and that will lower the ASTM C1567 expansion to equal or less than 0.08 percent at 16 days after casting.

If the above option does not lower the expansion to less than 0.08 percent at 16 days after casting, reject the aggregate(s) and submit new aggregate sources for retesting. Submit the results of testing to the Contracting Officer for evaluation and acceptance.

2.1.4 Admixtures

****

NOTE: For guidance in use of either water-reducing admixtures, set retarding admixtures, or combination of admixtures, refer to ACI 543R, "Recommendations for Design, Manufacture, and Installation of Concrete Piles."

****

Chemical admixtures shall conform to ASTM C494/C494M, [Type A] [Type B]. [Air-entraining admixture shall conform to ASTM C260/C260M.] Do not use admixtures containing chlorides.

2.1.5 Prestressing Steel

Use seven-wire stress-relieved or low-relaxation strand conforming to ASTM A416/A416M, Grade 270 psi. 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

****

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) in or within about 300 m 1000 feet of the ocean or tidal water, use 75 mm 3 inches minimum cover, including chamfered corners. 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 l, 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.

****

****

NOTE: Insert grade of reinforcement. Specify ASTM A706/A706M reinforcing where welding or bending of reinforcement bars is important. In addition, ASTM A934/A934M may be specified for epoxy coating of reinforcing where extra reinforcement protection is required.

****

[ASTM A615/A615M, Grade [300][420] [40][60];] [ASTM A706/A706M, Grade [420] [60];][ASTM A996/A996M, Grade [420] [60]]. Weld reinforcing steel in accordance with AWS D1.4/D1.4M.

2.1.7 Ties and Spirals

****

NOTE: If project has been designed for epoxy rebar, add ASTM A934/A934M, "Epoxy-Coated Prefabricated Steel Reinforcing Bars" in this paragraph and in the paragraph entitled "References."

****

Steel, ASTM A1064/A1064M for spirals and ASTM A615/A615M[ASTM A706/A706M]for ties.

2.1.8 Pipe Sleeves

Use ASTM A53/A53M, Grade B, or ASTM A501/A501M galvanized pipe. Sleeves shall be galvanized in accordance with ASTM A153/A153M with chromate wash. Do not place galvanized pipe in contact with any prestressing or reinforcing steel.

2.1.9 Bolts, Nuts, and Washers

2.1.9.1 Bolts

ASTM A307, Grade A.

2.1.9.2 Nuts

ASTM A563M ASTM A563, Grade A, hex style.

2.1.9.3 Washers

ASTM F844.

2.1.10 Ultrahigh Molecular Weight Polyethylene (UHMWPE) Rubbing Surface

2.1.10.1 General

a. Materials including additives shall be traceable by original lot number.

b. Materials used shall be FDA approved or otherwise harmless to marine life.

c. Fabricated form shall be virgin resin.

2.1.10.2 Resin

a. ASTM D4020. Virgin resin shall be homopolymer of ethylene and have an intrinsic viscosity (IV) between 22.0 and 28.0 dl/g.

b. No reprocessed resin shall be used.

c. Resin shall be oil and moisture free (0.2 percent weight maximum).

2.1.10.3 Composition and Fabricated Form

a. Resin shall comprise a minimum 95.0 percent by weight concentration in the formulation.

b. The finished form shall maintain ultraviolet stability for a minimum of 25 years and be free of saltwater or petroleum product leachable materials.

c. No unfused areas or light patches greater than 300 micrometers No. 50 sieve shall be in the final fabricated form.

d. The fabricated form shall have the following properties:

Density (ASTM D792)	0.92-0.94 g/cc 57.5-58.7 lb/cu.ft
Tensile Strength (ASTM D638)	
Ultimate, minimum	31.7 MPa 4600 psi
Ultimate Elongation, minimum	250 percent
Impact Strength (ASTM D256)	
Test Method A, Izod	Non-break for all five determinations in sample
Hardness (ASTM D2240), minimum	Shore D 65
Coefficient of Friction (ASTM D1894)	
Kinetic, maximum	0.13
Static, maximum	0.20
Water Absorption (ASTM D570)	Nil
Abrasion Index (relative to steel = 100), maximum	10

e. Color shall be black.

2.2 CONCRETE

2.2.1 Contractor-Furnished Concrete Mix Design

****

NOTE: Insert the specified compressive strength, f'c. Consider reducing average overstrength factor to produce a more economical concrete mix design, since these piles are not critical structural elements. ACI 318M may be modified for a specified compressive strength, f'c, over 35 MPa 5000 psi to permit a required average compressive strength, f'cr, of f'c plus 4.8 MPa 700 psi. Concrete may be proportioned in accordance with ACI 214R for the probability of 1 test in 10 falling below the specified compressive strength, f'c, if the mix design reflects actual concrete plant standard deviations and the resulting production concrete conforms to specified requirements. Do not use lightweight or fiber-reinforced concrete.

****

Concrete shall have a minimum specified compressive strength, f'c, of [_____] psi at 28 days. The minimum cementitious materials content shall be 354 kg per cubic meter 600 pounds per cubic yard of concrete. The design shall be prepared in accordance with ACI 211.1 or ACI 318M. The mix design shall be based on current materials previously evaluated by the concrete producer whose established methods of statistical quality control is in conformance with ACI 318M. In the absence of such data, the Contractor shall sample and test the aggregates for the design of concrete.

2.2.2 Concrete Mix Design Proportioning

a. Water and cement ratio shall be equal to or less than 0.40. If fly ash is used, the water and cement ratio shall be calculated as the weight of water divided by the weight of cement plus 60 percent of the weight of fly ash. If silica fume is used, the water and cement ratio shall be calculated as the weight of water divided by the weight of cement plus the weight of silica fume.

b. Maximum aggregate size shall not exceed 19 mm 3/4 inch.

****

NOTE: Air-entrainment may be considered optional only in regions that do not experience freezing temperatures.

****

c. Air-entrainment shall be 4.5 to 7.5 percent. Determine air void structure in accordance with ACI 212.3R. Spacing factor shall be less than 2.5 mm 0.01 inch, the specific surface area shall be greater than 0.39 square meter per 0.000016 cubic meter 600 square inches per cubic inch of air void volume, and the number of air voids per mm inch of traverse shall be significantly greater than the numerical value of the percentage of air in the concrete.

2.2.3 Trial Mixtures

Trial mixtures having proportions and consistencies of the proposed mix design shall be made to document the Contractor's ability to produce workable concrete which does not segregate or show excessive slump loss characteristics.

2.3 FABRICATION OF PRETENSIONED PILES

Piles shall be pretensioned concrete piles. Workmanship shall conform to standard commercial practice in prestressing plants.

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 the prestressing force. Make piles to dimensional tolerances in accordance with PCI MNL-116 and as follows:

a. Length: 10 mm per 3 meters 3/8 inch per 10 feet.

b. Cross section: plus 13 mm to minus 6 mm plus 1/2 inch to minus 1/4 inch.

c. Deviation from straight lines: not more than 3 mm per 3 meters 1/8 inch per 10 feet of length.

d. Pile head: plus or minus 6 mm per 0.30 meter 1/4 inch per foot of head dimension from true right angle plane. Surface irregularities: plus or minus 3 mm 1/8 inch.

e. Location of reinforcing steel

(1) Main reinforcement: 3 to 6 mm 1/8 to 1/4 inch from position designated on drawings.

(2) Spacing of spiral: plus or minus 13 mm 1/2 inch from position designated on drawings.

f. Location of pipe sleeves from true position: plus or minus 10 mm 3/8 inch.

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 one meter 3 feet. Remove concrete which has segregated in conveying or placing.

2.3.3.2 Placing and Casting

****

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.

****

Perform concrete casting within 3 days after pretensioning steel; however, do not deposit concrete in forms until placement of reinforcement and anchorages have 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 and 31 mm 3/4 and 1 1/4 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

a. Impervious sheeting: ASTM C171; waterproof paper, clear or white polyethylene sheeting, or polyethylene-coated burlap.

b. Pervious sheeting: AASHTO M 182.

c. Liquid membrane-forming compound: ASTM C309, white pigmented, Type 2, Class B.

2.3.4.2 Accelerated Curing

After placement of concrete, moist cure for a period of 4 hours. Follow by accelerated curing 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 22 degrees C 40 degrees F per hour. Cure at a maximum temperature of 65 degrees C 150 degrees F until concrete has reached specified release strength. Reduce temperature at a rate not to exceed 11 degrees C 20 degrees F per hour until a temperature of 11 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

****

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.

2.3.6 Marking

Mark pile to identify in-place impact face. Marking shall be clearly visible during driving.

2.4 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 procedures 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.

2.4.1 Aggregate Tests

Take samples of fine and coarse aggregate at the concrete batch plant and test. Perform mechanical analysis (one test for each aggregate size) in accordance with ASTM C136/C136M including determination of the specific gravity. Tabulate the results of the tests in accordance with ASTM C33/C33M.

2.4.2 Strength Tests

Sample concrete in accordance with ASTM C172/C172M at the time the concrete is deposited for each production line. Compression tests shall conform to methods of ASTM C39/C39M and ASTM C31/C31M. Perform slump tests in accordance with ASTM C143/C143M. Mold at least six cylinders per day or for every 15 cubic meter 20 cubic yards of concrete placed, whichever is greater. Test two cylinders of the set at 7 days of 14 days, or at a time for establishing transfer of prestressing force (release strength) and removal of pile from forms. Perform strength tests 28 days after molding using the remaining cylinders of the set. Cure the cylinders in the same manner as the piles and place at the point where the poorest curing conditions are offered. This is the coolest point in the bed for steam curing. Cylinders to be tested at 28 days shall be moist cured.

2.4.3 Changes in Proportions

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

2.4.4 Compressive Strength Test Results

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

2.4.5 Chloride Ion Concentration

Sampling and determination of water soluble chloride ion content in accordance with ASTM C1218/C1218M. Maximum water soluble chloride ion concentrations in hardened concrete at ages from 28 to 42 days contributed from the ingredients including water, aggregates, cementitious materials, and admixtures shall not exceed 0.06 percent by weight of cement.

2.4.6 Chloride Ion Penetration

To ensure the durability of concrete in marine environment, concrete shall be proportioned to have the chloride ion penetration test in accordance with ASTM C1202, and be below 3000 coulombs for concrete specimens tested at 56 days.

PART 3 EXECUTION

3.1 PILE DRIVING

3.1.1 Driving Piles

Piles shall not be driven until 100 percent of design strength has been attained and until at least 14 days after detensioning. Drive piles to the indicated tip elevation and to the minimum embedment depth shown on the drawings. Pile driving shall be conducted as one continuous operation. The pile shall be driven until the resistance criterion is met. During the initial driving and until the pile tip has penetrated beyond layers of very soft soil or below the bottom of prejetted or preformed holes, use a reduced rated driving energy of the hammer of not more than 20,235 Joules 15,000 foot-pounds per blow or as otherwise directed by the Contracting Officer, to prevent high tension-wave driving stresses which could damage the pile. Resistance criterion shall be 20 blows for 0.3 m one foot or less. The Contracting Officer may modify the criteria based upon the actual hammer being used and its rated energy and its compatibility as verified by a pile test program. If a pile fails to reach the indicated butt elevation or minimum embedment, the Contractor shall notify the Contracting Officer and perform corrective measures as directed. Provide hearing protection when noise levels exceed 140 dB.

3.1.2 Pile Driving Leads and Templates

Piles shall be driven with the hammer positioned in a fixed or swinging lead. "Free hammer" will not be permitted. Swinging lead shall be used only in conjunction with a template system to spot the piles.

3.1.3 Installation of Piles

Take care to avoid damage to piles during handling, when placing the pile in leads, and during pile-driving operations. Inspect piles when delivered, when in leads immediately before driving, and after installation. Notify the Contracting Officer of any unusual cracks and perform corrective measures as directed. Laterally support piles during driving, but allow rotation in leads. Take special care to maintain the pile orientation during driving. Square the top of the pile to the longitudinal axis of the pile. Maintain axial alignment of pile hammer with that of pile.

3.1.4 Tolerances in Driving

Drive piles with a variation of not more than one percent from vertical for plumb piles. Maintain and check axial alignment of pile and leads at start of pile driving and when the pile top is approximately 1.5 m 5 feet above the indicated elevation. Make intermediate checks of pile alignment if there is evidence of pile drifting. If subsurface conditions cause pile drifting beyond the allowable axial alignment tolerance, notify the Contracting Officer and perform corrective measures as directed. Place butts within 50 mm 2 inches of the location indicated. Manipulation of pile within specified tolerances is permitted, but do not manipulate piles more than one percent of their exposed length above the mudline. Check piles for heave. Redrive, to the indicated elevation, piles found to be heaved.

3.1.5   Jetting of Piles

****
NOTE: 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.
****

Water jets will[not] be permitted.[Jetting [may] [shall] be used to assist driving piles through strata that cannot be penetrated practicably by use of the hammer alone. [Driving shall be restricted to a static weight while water is being injected to prevent inducing tensile stresses in the piles which damage the concrete.] After the penetration of the strata requiring jetting has been accomplished, jetting shall be discontinued and hammer driving shall be resumed.][Discontinue jetting when the pile tip is approximately 1.5 m 5 feet above the [calculated] [indicated] pile tip elevation. Drive pile the final 1.5 m 5 feet of penetration.][Adequate measures shall be taken for collecting and disposing of runoff water.][Jetting method and equipment shall be approved by the Contracting Officer prior to commencing jetting operation.] Before starting final driving, firmly seat piles in place by application of a number of reduced energy hammer blows.[Measures, including use of a silt curtain, shall be employed to contain turbid water created by jetting piles.]

3.1.6   Pre-drilling of Piles

****
NOTE: Predrilling 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. Located in cohesionless soils.

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

Predrilling to remove soil or other material representing the bulk of the volume of the pile to be driven[will[not] be permitted][shall be provided]. [The diameter of the hole should not exceed two-thirds the width of the pile.][Predrill only to a depth of [_____] meters feet below cut-off elevation prior to setting piles.][Discontinue drilling when the pile tip is approximately 1.5 m 5 feet above the [calculated] [indicated] pile tip elevation. Drive pile the final 1.5 m 5 feet of penetration.]

3.1.7 Splices

Splicing of piles is not permitted.

3.1.8 Buildup

Buildups are not permitted.

3.1.9 Pile Cutoffs

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

3.1.10 Patching

a. Embedded Lifting Loops. Provide a 25 mm one inch minimum conical depression around embedded lifting loops. Cut off lifting loops at bottom of depression and patch depression with epoxy mortar.

b. Pile Butt. Apply 25 mm one inch thick layer of epoxy mortar cover over exposed prestressing strand on pile butt after driving.

3.2 EQUIPMENT

3.2.1 Pile Hammers

Furnish a hammer having a capacity at least equal to the hammer manufacturer's recommendation for the total weight of pile and character of subsurface material to be encountered. Obtain the required driving energy of the hammer, except for diesel hammers, by use of a heavy ram and a short stroke with low-impact velocity. The pile hammer shall be capable of operating at a reduced energy level (1/2 to 2/3 of rated energy level) during seating of the piles in preformed holes and when driving through soft or loose materials. The driving energy of the hammer, at final driving, shall be not less than 40.650 Joules 30,000 foot-pounds.   At final driving, operate the pile hammer in accordance with the manufacturer's recommendation. At final driving, operate diesel-powered hammers at the rate recommended by the manufacturer for hard driving. Maintain sufficient pressure at the steam hammer so that (1) for double-acting 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; (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 the hammer base during each downward stroke.

3.2.2 Driving Helmets, Capblocks, and Pile Cushions

3.2.2.1 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 ensure 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. The driving helmet or cap-and-pile cushion combination shall be capable of protecting the head of the pile, minimize energy absorption and dissipation, and transmit hammer energy uniformly over the top of the pile. The driving helmet or cap shall fit sufficiently loose around the top of the pile so that the pile may be free to rotate without binding within the driving helmet. The Contractor shall demonstrate to the satisfaction of the Contracting Officer that the equipment to be used on the project performs the above function. The pile cushion shall be of laminated construction using softwood boards with the grain parallel to the end of the pile. The thickness of the pile cushion shall be 300 mm 12 inches minimum. The cushion shall not be changed near the end of driving. Replace the pile cushion when it has become compressed beyond two-thirds of its original thickness, charred, or burned, or has become spongy or deteriorated in any manner. Use new cushions for initial driving of each pile. During redriving or restriking of piles, a used cushion assembly shall be used. The Contractor shall submit to the Contracting Officer at least 2 weeks before the start of pile driving operations detailed drawings of the driving helmet and pile cushion to be used.

3.2.2.2 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.

3.3 FIELD QUALITY CONTROL

3.3.1 Pile Records

For each pile, keep a record of the number of blows required for each 0.30 m 0.985 feet of penetration and the number of blows for the last 150 mm 6 inch penetration or fraction thereof. Include in the record the beginning and ending times of each operation during driving of pile, type and size of the hammer used, rate of operation, stroke or equivalent stroke for diesel hammer, type of driving helmet, and type and dimension of the hammer cushion (capblock) and pile cushion used. Record re-tap data and any unusual occurrence during driving of the pile. Include in the record performance characteristics of jet pump, unassisted penetration of pile, jet-assisted penetration of pile, and tip elevation before driving and at end of driving. Notify Contracting Officer 10 days prior to driving of piles. Submit complete and accurate records of installed piles to Contracting Officer within 15 calendar days after completion of the pile driving. Make pile-driving records available to the Contracting Officer at the job site within 24 hours of each day's pile driving. A preprinted form for recording pile driving data, the Pile Driving Log, is included at the end of this section.

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 --