## PART 1 GENERAL

### 1.1 REFERENCES

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 CONCRETE INSTITUTE INTERNATIONAL (ACI)**

<table>
<thead>
<tr>
<th>Standard</th>
<th>Year</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACI 214R</td>
<td>(2011)</td>
<td>Evaluation of Strength Test Results of Concrete</td>
</tr>
<tr>
<td>ACI 318</td>
<td>(2008; Errata 2010)</td>
<td>Building Code Requirements for Structural Concrete and Commentary</td>
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<tr>
<td>ACI 543R</td>
<td>(2000)</td>
<td>Design, Manufacture, and Installation of Concrete Piles</td>
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**ASTM INTERNATIONAL (ASTM)**

<table>
<thead>
<tr>
<th>Standard</th>
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<th>Title</th>
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<tr>
<td>ASTM A615</td>
<td>(2009b)</td>
<td>Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement</td>
</tr>
<tr>
<td>Standard Number</td>
<td>Standard Title</td>
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<tr>
<td>ASTM C 1202</td>
<td>(2010) Standard Test Method for Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration</td>
<td></td>
</tr>
<tr>
<td>ASTM C 494</td>
<td>(2010a) Standard Specifications for Chemical Admixtures for Concrete</td>
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</table>
| ASTM C 618      | (2008a) Standard Specifications for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in...
Concrete

ASTM C 666  (2003; R 2008) Resistance of Concrete to Rapid Freezing and Thawing


PRECAST/PRESTRESSED CONCRETE INSTITUTE (PCI)

PCI JR-382  (1993) Recommended Practice for Design, Manufacture and Installation of Prestressed Concrete Piling


1.2 Acceptance Criteria

Piles shall be driven to a minimum depth of thirty eight (38) feet below MLLW elevation. Pile shall be octagonal, 16 inches in diameter and 50 feet in length.

1.3 PILE REQUIREMENTS

Provide precast prestressed concrete pile, PCI JR-382. Production of pile shall be in accordance with PCI MNL-116.

1.4 SUBMITTALS

Engineer approval is required for submittals.

The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:
SD-01 Preconstruction Submittals

Installation Procedures

Order List

Precasting manufacturer's quality control procedures

Provide instructions and procedures on how the Contractor will assist the Engineer in the processes of Inspection and Monitoring of piles during installation.

SD-02 Shop Drawings

Piles

SD-03 Product Data

Pile Driving Equipment

Submit descriptions of pile driving equipment, including hammers, power packs, driving helmets, cap blocks, pile cushions, leads, extractors, and jetting equipment at least 30 days prior to commencement of work. For navigation purposes, the maximum width/beam of Contractor’s barge (or other waterborne vessel(s)) will be limited to 30 ft.

SD-05 Design Data

Concrete mix design

Submit a concrete mix design at least two (2) weeks before concrete is placed.

SD-06 Test Reports

Aggregates

Concrete Compressive Strength

Submit concrete cylinder compressive strength test results.

SD-07 Certificates

Aggregates

Admixtures

Prestressing steel
Cement

Fly ash and Pozzolan

Ground Slag

SD-11 Closeout Submittals

Pile records

Submit pile records

1.5 QUALITY ASSURANCE

1.5.1 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, other methods of pick-up, and embedded jet tubes. Provide certification of a Professional Engineer registered in California, that layout and details of reinforcement and tendons conform to that shown on the structural design drawings.

Piles shall have suitable numbers, at least five (5") inches in height, impressed in the concrete, consecutively indicating the sequence in which they were manufactured. These numbers shall be located in the face of the pile, approximately mid-height on the pile. A record shall be kept of each pile showing a number and any other pertinent data required by the District.

1.5.2 Quality Control Procedures

Submit the precasting manufacturer's quality control procedures and inspection records established in accordance with PCI MNL-116.

1.5.3 Installation Procedures

Submit information on the type of equipment proposed to be used, proposed methods of operation, pile driving plan including proposed sequence of driving, and details of all pile driving equipment and accessories.

1.5.4 Concrete Mix Design

Certify, using a Engineer-approved independent commercial testing laboratory, that proportioning of mix is in accordance with ACI 211.1 or ACI 318 for specified strength and is based on aggregate data which has been determined by laboratory tests during last twelve months. Submit a complete list of materials including type; brand; source and amount of cement, fly ash, pozzolan, ground slag, and admixtures; and applicable reference specifications. Submit additional data regarding concrete aggregates if the source of aggregate changes. Submittal shall
clearly indicate where each mix design will be used when more than one mix design is submitted.

1.6  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.

1.6.1  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 Owner’s Representative. Piles which are damaged during delivery, storage, or handling to the extent they are rendered unsuitable for the work, in the opinion of the Owner’s Representative, shall be rejected and removed from the project site, or may be repaired, if approved, at no cost to the Owner.

1.6.1.1  Repairable Cracks

Piles with cracks equal to or greater than 0.006 inches but less than 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.

1.6.1.2  Non-Repairable Cracks

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

1.6.2  Pile Sweep

Sweep shall be limited to 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, or portland cement in combination with natural pozzolan or fly ash and conforms to appropriate specifications listed below.

2.1.1.1  Cement
ASTM C 150, Type II or III with a maximum alkali content of 0.40 percent; or ASTM C 595, Type IP(MS) or IS(MS) blended cement except as modified herein. The blended cement shall consist of a mixture of ASTM C 150/C 150M cement (with alkali content not exceeding 0.40 percent) and one of the following materials: ASTM C 618 pozzolan or fly ash, or ASTM C 989 ground iron blast-furnace slag, or ASTM C 1240 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 C 150, including equivalent alcalis indicated in the optional chemical requirements. Use cement with a tricalcium aluminate (C3A) content of less than 5 percent. Type III cement shall not be used in conjunction with silica fume.

2.1.1.2 Fly Ash and Pozzolan

ASTM C 618, Class N, or F except that the maximum total alkalis shall be 3.0 percent, and the maximum allowable loss on ignition shall be 3 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 C 989, Grade 120.

2.1.1.4 Silica-Fume

ASTM C 1240, 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 the table below.

2.1.1.5 Supplemental Cementitious Materials (SCM) Content

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

SUPPLEMENTARY CEMENTITIOUS MATERIALS CONTENT

<table>
<thead>
<tr>
<th>SCM</th>
<th>Minimum Content</th>
<th>Maximum Content</th>
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</thead>
<tbody>
<tr>
<td>Class N Pozzolan or Class F Fly Ash with</td>
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<tr>
<td>SiO₂ plus Al₂O₃ plus Fe₂O₃ greater than 70 percent</td>
<td>25 percent</td>
<td>35 percent</td>
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<tr>
<td>Class N Pozzolan or Class F Fly Ash with with SiO₂ plus Al₂O₃ plus Fe₂O₃ greater than 80 percent</td>
<td>20 percent</td>
<td>35 percent</td>
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</tbody>
</table>
Class N Pozzolan or
Class F Fly Ash with
with SiO2 plus Al2O3 plus Fe2O3
greater than 90 percent  
15 percent  35 percent

SUPPLEMENTARY CEMENTITIOUS MATERIALS CONTENT

<table>
<thead>
<tr>
<th>SCM</th>
<th>Minimum Content</th>
<th>Maximum Content</th>
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<tbody>
<tr>
<td>GGBF Slag</td>
<td>30 percent</td>
<td>50 percent</td>
</tr>
<tr>
<td>Silica Fume</td>
<td>5 percent</td>
<td>10 percent</td>
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</table>

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

ASTM C 33, Provide aggregate free from any substance which may be deleteriously reactive with alkalis 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. 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 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

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 C 1260. 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 C 1567, shall be performed as follows: utilize the Contractor's proposed low alkali portland 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 C 1567 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 Engineer for evaluation and acceptance.

2.1.4 Admixtures

Chemical admixtures shall conform to ASTM C 494; Type A, Type B. Air-entraining admixture shall conform to ASTM C260. A corrosion inhibiting admixture shall also be used. Do not use admixtures containing chlorides.

2.1.5 Prestressing Steel

Use seven-wire stress-relieved or low-relaxation strand conforming to ASTM A416, Grade 270. 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 Ties and Spirals

Steel, ASTM A82 for spirals and ASTM A615 for ties.

2.1.7 Anchorages and End Fittings

ACI 318.

2.1.8 Grout
Provide cement grout for prestressed piles using materials conforming to requirements stipulated herein for concrete mixes. Use admixtures, if required, known to have no injurious effects on steel or concrete. Do not use calcium chloride.

2.1.9 Pile Caps

2.2 CONCRETE MIX DESIGN

ACI 211.1 or ACI 318, Chapter 4. Concrete shall have a minimum compressive strength of 5000 psi at 28 days and a maximum size aggregate of 3/4 inches. Concrete shall be air entrained with a minimum of 4.5 percent and a maximum of 7.5 percent. Mix shall contain fly ash, ground iron blast furnace slag or silica fume to meet the requirements specified herein to mitigate Alkali-Silica Reactivity (ASR). For marine exposure, ensure a dense concrete free of shrinkage cracks, with a minimum degree of permeability. The maximum water cement ratio shall be 0.40.

2.3 FABRICATION

2.3.1 Formwork

Formwork and dimensional tolerances shall be in accordance with PCI MNL-116, and as specified herein. 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.

2.3.2 Pretensioning

Pretensioning shall be performed in accordance with PCI MNL-116, and as specified herein. Use gage calibrated within last 6 months by a laboratory approved by Engineer. Provide means for measuring elongation of steel to nearest 1/8 inch. 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.

Initial prestress in strands shall not exceed 70% of the ultimate strength of the strands and the loss of prestress due to initial stress transfer and subsequent creep or shrinkage shall be assumed to be 30 ksi. Minimum net concrete cover over the reinforcing steel shall be as shown on the contract drawings. Clear net spacing between wire strands shall not be less than two inches (2”). Initial prestress in the concrete section shall be as shown on the plans and shall be at least seven hundred pounds per square inch (700 psi), and no more than 1,300 psi.

All stressing strands shall be stressed uniformly either singly or simultaneously to design load, before concrete is poured, by means of hydraulic jack or jacks equipped with accurate pressure gauges permitting the stress to be computed at any time. Elongation of the strand shall be measured at the completion of the tensioning operation and shall conform to elongation tables.
furnished by the manufacturer of the strand. If there is a difference of over five (5%) percent between the steel stress determined from adjusted elongation and from the gauge reading, the cause of the discrepancy shall be ascertained and corrected before operations are continued. When multiple strands are tensioned simultaneously a dynamometer shall be used to ascertain that the same initial stress is in each element prior to completing the full stressing operation.

Prestress shall not be transferred until the concrete in the piles has attained strength in compression of at least four thousand pounds per square inch (4000 psi). Transfer of prestress shall be accomplished by the simultaneous gradual releasing of all strands with hydraulic jacks in all cases where this is possible.

Where release by jack is impracticable, each strand shall be burned simultaneously at exposed points between anchorages. The sequence of burning shall follow a pattern calculated to equalize the forces being transferred throughout the cross-section of the member. Heating for release shall utilize a low-oxygen flame. At least a four inch (4") section of wire shall be uniformly heated to reduce the tensile strength and prevent the shock encountered when strands are burned with a high-oxygen flame at a single point.

2.3.3 Casting
2.3.3.1 Conveying

Convey concrete to formwork in accordance with PCI MNL-116, and as specified herein. Clean conveying equipment thoroughly before each run. During placing, make any free vertical drop of the concrete less than 3 feet. Remove concrete which has segregated in conveying or placing.

2.3.3.2 Placing and Casting

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. Concrete shall be deposited continuously and as rapidly as practicable after the placing of each pile section has been started and until the entire pile section has been completed in the casting bed. Hand mixing of concrete for piles will not be permitted, nor will retempering be permitted. Produce each pile of dense concrete straight with smooth surfaces with reinforcement retained in its proper position during fabrication.

During and immediately after depositing concrete in piles, electric or air vibrators shall be used to vibrate the forms in conjunction with the spacing adjacent to the forms and around the reinforcing steel, to thoroughly compact the mixture. Use vibrator with heads smaller than the minimum distance between steel for pretensioning. Particular pains shall be taken to handle the concrete in such a manner as to ensure dense concrete with a surface free from honeycomb or voids.

The frequency of vibrators shall not be less than thirty-six hundred (3600) cycles per minute. Intensity of vibration shall be sufficient to cause the concrete to flow and settle into place, and to make the effect on the concrete visible over a radius of at least two feet (2'). Vibrators shall be
applied at points not over two feet (2') apart and there shall be an average of not less than twenty (20) seconds of vibration per foot of pile.

Make surface of pile ends perpendicular to axis of pile. Chamfer, between 3/4 inch and 1 1/4 inch, ends of piles.

2.3.3.3 Finish

Uniformed surface of each pile will have a Class 1 steel trowel finish for the top 15 ft of the pile.

2.3.4 Curing of Piles

Cure piles using moist or accelerated curing. Curing of piles shall be in accordance with the PCI MNL-116 except as follows.

2.3.4.1 Moist Curing

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

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 40 degrees F per hour. Cure at a maximum temperature of 150 degrees F until concrete has reached specified release strength. Reduce temperature at a rate not to exceed 20 degrees F per hour until a temperature of 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 De-tensioning

De-tensioning shall be performed in accordance with PCI MNL-116, and as specified herein. Gradually release tension in strands from anchorage. De-tension after approval by pile manufacturer's quality control representative. Perform transfer of prestressing force when concrete has reached a minimum compressive strength of 4000 psi.

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 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 Engineer in accordance with the following.

2.4.1 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.

2.4.2 Slump and Strength Tests

Sample concrete in accordance with ASTM C172 at time concrete is deposited for each production line. Perform slump tests in accordance with ASTM C 143. Mold cylinders in accordance with ASTM C 31. Mold at least six cylinders per day or one for every 20 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.

2.4.3 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 Engineer in writing.

2.4.4 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 design strength.

2.4.5 Chloride Ion Concentration

Sampling and determination of water soluble chloride ion content in accordance with ASTM C 1218/C 1218M. 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 C 1202, and be below 2,000 coulombs.
PART 3  EXECUTION

3.1  GENERAL

A. The Contractor shall protect nearby structures from damage.
B. The Contractor shall perform driving during 8:00 a.m. and 5:00 p.m. hours unless otherwise specified in the Specifications and/or Permits to minimize the effects of vibrations or noise on nearby buildings, structures or docks.

3.2  PILE DRIVING EQUIPMENT

3.2.1  Pile Hammers

Furnish a hammer capable of driving to the indicated pile tip elevation 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. 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.

3.2.2  Driving Helmets and Cushion Blocks

3.2.2.1  Driving Helmets or Caps and Pile Cushions

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 that fits sufficiently loose around top of pile so that pile may be free to rotate without binding within driving helmet. 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 3 inches minimum and the thickness shall be increased so as to be suitable for the size and length of pile, character of the sub-surface material to be encountered, hammer characteristics, and the required driving resistance. Replace pile cushion at the start of driving of each pile and 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 pile installation.
3.2.2.2 Hammer Cushion or Capblock

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. 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. 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 PRELIMINARY WORK

3.3.1 Order List

The Contractor shall submit to the Engineer for approval, an itemized list for piles prior to placing the order with the supplier. The list shall indicate the pile size and lengths required at each location as shown on the plans and the corresponding ordered length of each pile.

3.3.2 Pile Length Markings

The Contractor shall mark each pile prior to driving with horizontal lines at one foot intervals, and the number of feet from pile tip at 5 foot intervals.

3.4 PILE DRIVING

3.4.1 Driving Piles

Notify Engineer 10 days prior to driving of piles. Piles may be driven when the specified 28-day concrete strength has been achieved but not less than 7 days after casting. All concrete piles shall be driven with a hammer approved by the District. It is recommended that the rated energy of the hammer be between 40,000 and 60,000 ft-lb/blow. Drive piles to indicated tip elevation. During initial driving and until pile tip has penetrated beyond layers of very soft soil or below bottom of prejetted holes, use a reduced driving energy of the hammer as required to prevent pile damage. Refusal criteria shall be established by the Engineer. If a pile fails to reach indicated tip elevation, notify Engineer and perform corrective measures as directed. Practical refusal can be defined as 50 blows per foot using the recommended hammer energy.

Pile driving will incorporate noise attenuation methods as prescribed by NOAA Fisheries. Monitor underwater sound levels. If sound levels are found to be over 180 decibals at approximately 300 ft distance from the piles and approximately 10 ft below water, then sound attenuation measures will be required prior to continuing pile driving to ensure that sound levels remain at or below 180 decibals. 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 may be driven without pile guides or leads, providing a hammer guide frame is used to keep the pile and hammer in alignment.
3.4.2 Protection of Piles

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. Square top of pile to longitudinal axis of pile. Maintain axial alignment of pile hammer with that of the pile. If the Contractor elects to use a pile head with projecting strands or mild steel reinforcement, prevent direct impact forces from being transmitted through the reinforcement, by using a special driving head.

3.4.3 Tolerances in Driving

Drive piles with a variation of not more than 2 percent from vertical. Maintain and check axial alignment of pile and leads at all times. If subsurface conditions cause pile drifting beyond allowable axial alignment tolerance, notify Engineer and perform corrective measures as directed.

Place butts within 4 inches of location indicated. Manipulation of piles within specified tolerances will be permitted, to a maximum of 1 1/2-percent of their exposed length above mudline. In addition to specified tolerances, maintain a location to provide a clear distance of at least 5 inches from butt to edge of pile cap. If clear distance cannot be maintained, then notify Engineer. Check each pile for heave. Redrive heaved piles to required point elevation.

3.4.4 Rejected Piles

Piles damaged or impaired for use during handling or driving, mislocated, or driven out of alignment beyond the maximum tolerance shall be withdrawn and replaced by new piles. Excess cut-off from piles and unacceptable piles shall be removed from the work site. All work in connection with withdrawing and removing rejected piles from the site shall be done at no additional cost to the Owner.

3.4.5 Jetting of Piles

Water jets will be permitted. Jetting may be used to assist driving piles through strata that cannot be penetrated practically 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 5 feet above the indicated pile tip elevation. Drive pile the final 5 feet of penetration. Jetting method and equipment shall be approved by the Engineer 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.
3.4.6 Predrilling of Piles

Predrilling to remove soil or other material representing the bulk of the volume of the pile to be driven will not be permitted.

3.4.7 Splices

Splicing of piles is not permitted.

3.4.8 Pile Cut-Off

Cut-off piles with a smooth level cut using pneumatic tools, sawing, or other suitable methods approved by Engineer. Use of explosives for cutting is not permitted. Cut-off sections of piles shall be removed from the site upon completion of the work.

3.4.9 Pile Caps

All marine guide piles shall be furnished with pile caps to protect exposed surfaces and prevent the roosting of birds. Pile caps shall be made of UV rated fiberglass a minimum of 1/8 in. thick and shall be fastened to piles using a marine grade epoxy adhesive.

3.4.10 On-Site Casting

On-site casting of guide piles is specifically prohibited.

3.5 FIELD QUALITY CONTROL

3.5.1 Defects and Correction

A. Any concrete piles having surface defects or fissures in excess of the size and number described shall not be accepted. Any piles having less than the number mentioned may be accepted, providing repairs as specified herein are satisfactorily accomplished prior to driving.

B. Repairs may be made only to those piles having five or less voids, and/or fissures in the top twenty feet (20') of the piles. If more than five such defects occur, the pile will be unconditionally rejected.

C. Surface defects or voids pertinent to this article shall be those having a mean diameter in excess of one-half inch (½") and a depth of three-eighths inch (3/8") or more. A fissure shall be defined as any channel or opening of finite size penetrating the interior of the concrete to a depth greater than three-eighths inch (3/8").

D. If there are fewer than five (5) surface defects and fissures in the upper twenty feet (20') of any concrete pile, the Contractor shall repair all surface defects and fissures in the herein defined category on all surfaces throughout the length of this pile regardless of their location with respect to the top twenty feet.
E. The grout and dry patching material for repairs shall consist of Portland Cement mortar mixed in the proportion of one (1) part Portland Cement (Type II) to three (3) parts of fine sand (passing a no. 14 to 20 mesh sieve) by volume. No more water than necessary for proper placing shall be used. The mortar shall be mixed thoroughly and then be allowed to stand for an hour or more before using, stirring occasionally to keep it from stiffening. No mortar shall be used which has been prepared for longer than one and one-half (1-1/2) hours and if stiffening should occur within this period, the mix shall be discarded. No water shall be added to the mortar after it has first been prepared under any circumstances.

1. Prepare the area as follows:
   a. Probing: The depth and direction of any and all fissures shall be ascertained by probing with a 12-gauge wire, after which a 3/8 to ½ inch drill shall be used to enlarge the fissure to the depth and in the direction which was indicated by the probing. In the event the drill is broken off in the concrete, it shall be removed by any feasible means, and in no case shall be left embedded in the concrete.
   b. Cleaning: All concrete surfaces to be repaired shall first be thoroughly scrubbed with a coarse, stiff, short, bristle brush prior to the application of the dry packing. The object of this cleaning is to uncover holes which may be concealed by a thin film of laitance or mortar.
   c. Hosing: The brushed surfaces shall be thoroughly hosed with a pressure nozzle to remove dirt and foreign objects.

2. The Contractor shall use the following repair methods:
   a. Dry Packing: After the free water has disappeared, but while the concrete surface is still damp, dry patching shall be applied to all indented, damp, concrete surfaces, followed by methods prescribed herein, in a manner which will provide a positive bond between the patching material and all surfaces of the concrete, to the satisfaction of the District.
   b. Grouting: Mortar grout shall be compacted into the pre-drilled fissures in such a manner as to permit no voids of entrained air and which will provide a positive bond between the concrete and the mortar at all interfaces, to the satisfaction of the District. Following this step, all surface voids shall be dry packed by means mutually acceptable between the Contractor and the District.
   c. Curing Repairs: Mortar patches shall be kept moist for not less than five (5) days after placement. It is particularly important to cure patches made in such repairs as the mortar will not bond properly if it dries prematurely and subsequent shrinkage may produce secondary fissures which are more dangerous than the original.

3.5.2 Pile Records
Keep a complete and accurate record of each pile driven. Indicate the pile location, deviations from pile location, cross section shape and dimensions, original length, mudline elevation, tip elevation, cut-off elevation, number of blows required for each foot of penetration and number of blows for the last 6 inches penetration or fraction thereof for the specified tip elevation. 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 such as redriving, heaving, weaving, obstructions, jetting, and any driving interruptions.

End of Section