

ITEM 410

PRESTRESSED CONCRETE PILING

410.1 Description. This specification shall govern for the casting, prestressing, and manufacture of prestressed concrete piling.

410.2 General. The method of manufacture and prestressing shall comply with the requirements of the plans and in accordance with the approved shop drawings. Prior to beginning the casting of concrete piling, the Contractor shall give the Engineer ample notice as to the location of the casting site and the date on which work will begin.

An inspector representing the Engineer shall have free entry at all times, while the work is being performed, to all parts of the manufacturer's works which concern the manufacture of the piling ordered.

Clean and legible shop drawings on sheets 24" x 36", showing the following information shall be submitted for approval. The margin at the left end shall be 1-1/2 inches wide and the others 1/2 inch wide. The sheets shall include a title in the lower right hand corner, sheet number, name of structure, name of Fabricator and name of the Contractor. Preparation and submittal of drawings may be on 11 x 18 inch sheets, or full size drawings may be reduced to one-half scale, provided they are completely clear and legible.

- A. Fabrication Details. Complete information necessary for fabrication shall be submitted for approval. On projects requiring several sizes of piling, an index sheet showing cast lengths, concrete strengths, strand data, etc., shall be furnished. Contractor shall submit six sets of prints for approval where fabrication is to be at one or more casting yard, two additional sets of prints shall be required for each additional casting location. Index sheets shall reflect the plant location where each piling is to be fabricated.
- B. Prestressing Details. Complete prestressing details shall be submitted showing details of the piling, forms, devices for holding prestressed steel in place, methods and details of arranging strands, anchorage details, methods and details of prestressing the steel, elongations, jack pressures and all other features of proposed prestressing. Calculations shall be included to justify the system and method of prestressing to be used. Fabricator shall submit six prints for handling. The submittal of prestressing details shall be a "one-time" action of each Fabricator.
- C. Methods of Handling and Transportation. Details of handling and transporting need not be submitted for approval, except special devices used for pick up shall be shown on the shop drawings.

All drawings and details shall be checked by the Fabricator before submittal for approval. Submission of drawings shall be in accordance

with the City of Deer Park Engineering Department methods and procedures.

A casting schedule shall be prepared on standard forms and submitted to the City of Deer Park Engineering Department, prior to stressing.

Prior to the casting of piling, detailed drawings reflecting the complete facilities to be used, in fabrication, are required by the City of Deer Park Engineering Department.

The design of casting beds and facilities for pre-tensioned construction, including plans and specifications, shall be done by a Professional Engineer registered in the State of Texas and shall bear his seal. The Fabricator shall furnish a certificate bearing his signature, or that of a responsible officer of the company, that the bed, facilities, and hardware have been constructed in accordance with the above plans and specifications.

The Fabricator shall specify the maximum loading of which the bed is to be used. Prior to approval for that loading, the facilities shall be proof loaded to a minimum ten percent overload for four hours, if deemed necessary by the Engineer. Minor changes in facilities will not require proof loading, but will require submission of the details of changes accompanied with design calculations.

410.3 Materials. Materials for concrete and water for curing shall be in accordance with applicable portions of the Item 421, "Structural Concrete". Material for reinforcing steel (non-prestressed) shall be in accordance with the Item 440, "Reinforcing Steel". Other steel shall be in accordance with this item.

All concrete materials and their preparation and placing shall be in accordance with the Item 421, "Structural Concrete", except that the concrete shall be proportioned to develop a compressive strength of not less than 5,000 psi in 28 days. The following limitations shall also be complied with:

Minimum Cement Content	6.25 sacks per cubic yard
Maximum Cement Content	7.00 sacks per cubic yard
*Maximum Water	6.00 gallons per sack
Maximum Slump	4 inches or as approved by the Engineer
Minimum Compressive Strength	5,000 psi at 28 days
Minimum Compressive Strength at Prestress Transfer	4,000 psi

*Water per sack of cement shall be reduced to the minimum amount that the required workability will permit.

An admixture must be used with Type I or Type III Portland Cement, if used in lieu of air-entrained Portland cement. Entrained air must not exceed four (4) percent. Admixtures shall be in accordance with the Item 421, "Structural Concrete", and must be approved by the Engineer prior to use.

When tested in accordance with ASTM Method C136, coarse aggregate shall conform to the following grading requirements:

Retained On	Percent Retained, by Weight
1-1/2" screen	0
1" screen	0 - 5
3/4" screen	20 - 50
1/2" screen	50 - 75
No. 4 sieve	95 - 100
Loss by Decantation	0 - 1%

Fine aggregate shall consist of clean, hard, durable, uncoated grains of washed sand, free from soft or flaky particles and all other injurious materials. It shall be graded from coarse to fine and when tested by approved methods, shall meet the following grading requirements:

Retained On	Percent Retained, by Weight
3/8" screen	0
No. 4 sieve	0 - 5
No. 20 sieve	15 - 50
No. 100 sieve	85 - 100

When subjected to the color test for organic impurities, fine aggregate shall not show a color darker than the standard color.

B. Prestressing Cables: Cables used to apply the prestressing load to precast prestressed concrete piling shall be uncoated seven wire strand conforming to the requirements of ASTM A416. The cables shall be of the size and number shown on the plans. Cables shall be free of rust, dirt, oil or other injurious materials, before placing concrete. The cables shall meet the following minimum requirements as to strength:

Proportional Limit..... 180,000 psi

Ultimate Tensile Strength.....250,000 psi

The materials for and the method of manufacture of precast concrete piling, shall be in accordance with the guidelines set out in the publication "Recommendations for the Design, Manufacture and Installation of Concrete Piles", prepared by the ACI Committee 543.

410.3 Quality Assurance.

- A. Concrete - Four (4) standard 6-inch diameter by 12-inch concrete cylinders shall be made according to current ASTM specifications for each lot of piling cast. Two (2) cylinders shall be broken prior to transfer of prestress forces to insure that the concrete meets the requirements of 4,000 psi compressive stress at a stress transfer. The other two cylinders shall be tested at 28-days to insure that the minimum 28-day compressive stress of 5,000 psi is obtained. If the cylinders fail to indicate this strength, the mix shall be adjusted.
- B. Prestressing Cables - Tests on at least two (2) samples, taken at random, shall be made to insure that minimum requirements are met. Test samples shall be seven feet long. However, if a certificate from the manufacturer of the cable showing that the cable meets or exceeds the minimum requirements is furnished, the tests need not be made.

410.4 Submittals. The Contractor shall submit six prints of shop drawings, showing complete information necessary for fabrication, for approval by the City Engineer. The drawings shall show type of member, member lengths, dimensions, bevels, erection devices, details of reinforcement, type of concrete, prestressing details, etc.

410.5 Fabrication of Piles.

- A. Concrete Placement - Consolidate concrete using mechanical vibrators. Use no less than 3 vibrators for concrete placement in any individual unit and provide at least one standby vibrator for emergency use to avoid delays. Use vibrators of the high frequency type of not less than 7,000 impulses per minute.

All concrete shall be handled and placed in accordance with the applicable requirements of the Item 421, "Structural Concrete".

Concrete piling shall be cast using steel side forms. Do not use any device that requires that it be left in the member. Construct and maintain bed for casting prestressed members that will provide not more than 1/4 inch vertical variation in any 50 foot length.

Side forms shall be kept in place for a minimum of four hours. Forms may be removed after this time, if concrete has reached sufficient strength to prevent physical damage to member. Forms shall be removed in such a manner that curing of any member is not interrupted for more than 30 minutes. Provide forms with an acceptable contraction device and joints to prevent cracking due to form restriction, or loosen forms from members at proper time to prevent such cracking. Cracking due to form restriction will be cause for rejection.

After form removal, rub surface of members which are not true or that have porous or honeycombed areas. Extend rubbing over sufficient areas around blemished portions to blend rubbed area into surrounding

surface. Remove unsightly discolorations and finish exposed surfaces of members reasonably uniform in color and texture.

Mat curing of concrete shall begin no later than 30 minutes after placement of concrete in forms. Steam curing may be started in 3 hours. Cure pretensioned members continuously, except as provided above for form removal, until concrete strength as indicated by compressive tests of cylinders has reached the required release strength. Curing may then be interrupted for a time interval of not more than 4 hours for removal of member from casting bed to curing area. Member shall be steam or water cured for 3 days after release of tension in member.

Air temperature surrounding the members shall be at 40°F or above from the time placing of concrete commences until curing cycle is complete. If external heating is required, use precautions to provide saturated humidity at surface of members to prevent drying. When steam curing is used, concrete may be placed when air temperature is below freezing, provided that steam is introduced into the jacket immediately behind placement of concrete and the temperature of the air surrounding the concrete kept above 40°F, until steam curing is begun.

When steam curing is used, members shall be kept in a condition of saturated humidity and at a temperature not to exceed 150°F. If the temperature charts indicate that temperature inside the curing jacket is in excess of that shown below, the beams shall not be accepted.

TABLE II

Maximum Temperature Shown on Chart	Maximum Permissible Total Time in Excess of 150°F
151°F to 160°F	1 Hour
161°F to 170°F	30 Minutes
171°F to 180°F	15 Minutes
Over 180°F	None

If temperature charts indicate that temperature inside the curing jacket has fallen below 50°F, add 4 hours to the required curing time (at temperatures in excess of 50°F) for each hour below 50°F. Provide sufficient wet steam inside curing jacket so that the surface of the member is wet. Provide air space of not less than 6 inches between surfaces of member and covering material. Arrange steam outlets so that no live steam is directed at concrete or prestressing tendons. Apply steam slowly, so that the temperature rise inside the curing jacket is not more than 40°F per hour. Do not start steam curing until the concrete has been placed for a minimum of 3 hours.

Decrease temperature at the end of curing at the same rate as applied. Cut off steam and begin strand release operations when the temperature within the curing jacket has been reduced to within 30°F of the outside ambient air temperature or to 90°F, whichever is the lower temperature. Complete release of stress to concrete, while concrete is still warm and moist. Arrange location of steam lines, location of control points for output of steam into curing jacket, and number and type of openings for steam distribution inside curing jacket so that the variation of temperature between any two points in the bed is no more than 20°. Curing at elevated temperatures using other than steam, is not permitted.

Curing of test cylinders to establish concrete strength for the release of tension, shall be in the same manner as members being prestressed. Test cylinders shall be placed at the points where the most unfavorable curing conditions are offered. The average strength of two cylinders shall be considered a test.

- B. Pretensioning - Initially bring tendons to be prestressed in a group to a uniform initial minimum tension of 1,000 pounds (plus or minus 50 pounds) per tendon prior to being given their full pretensioning. Measure this uniform tension by some suitable means such as a dynamometer so that its amount can be used as a check against elongation computed and measured.

After initial stressing, stress group to total tension as required by means of hydraulic jacks equipped with gauges graduated to read directly to one percent of total load to be applied and calibrated to measure accurately the stress induced in the steel. Measure the induced stress by elongation of tendons and check by gauge pressure. Results to be within 5 percent. Provide means for measuring elongation to an accuracy of 1/16 inch for each 100 feet of length between jacking heads. In the event of apparent discrepancies between stresses indicated by gauge pressure and elongation of more than 5 percent, check entire operation, determine source of error, and check before proceeding further. Establish independent references adjacent to each anchorage to indicate any yielding or slippage between time of initial stressing and final release of tendons.

With tendons stressed to full tension, as prescribed above, and with reinforcing in-place, cast members to necessary lengths to provide plan lengths after shrinkage and elastic shortening have occurred. Maintain tendon stress between anchorages until concrete has reached the compressive strength specified, as determined by compressive cylinder tests made for each continuous pour. If all test cylinders for tension release are broken and the required release strength has not been attained, maintain the tendon stress and cure the piling for an extended

period of 24 hours for each 100 psi deficiency or fraction thereof before release of tension. After the above strength requirement is attained, gradually release tension in tendons and cut off tendons, using sequence to minimize shock and reduce premature tendon breakage.

- C. Handling and Erection - Exercise care when handling members. Handle in accordance with approved fabrication and erection plans which indicate method of handling so as to preclude the possibility of overstressing any part of the member. Provide an adequate factor of safety in design to cover dynamic force or impact. Do not remove the members from the casting yard until after tensioning, curing and strength requirements have been attained. Members may be driven any time after curing and tensioning requirements have been fulfilled and the design strength cylinders indicate that the specified 28 day compressive strength has been attained. An adequate number of design strength test cylinders shall be cast to ensure that acceptance of members will be based on cylinder breaks. Design strength cylinder is to be cured initially with members. After the release of stress of members, cylinder shall be cured in accordance with the standard procedure for cylinder curing. Precast piling should be handled and hauled in the flat position. The piling, if so designed, may be picked up by either one or two point pickup.
- D. Defects and Breakage - If a member or portion thereof is broken at any time during construction, it will be rejected and replaced with a satisfactory member at no expense to City of Deer Park. Fine hair cracks on the surface of the member, which do not extend to the plane of nearest reinforcement, will not be cause for rejection unless such cracks are so numerous and extensive as to indicate inadequate curing, in which case, members will be rejected. Members having diagonal cracks on vertical surfaces, which indicates damage from torsion, will be rejected.

410.6 Workmanship and Tolerances. The following tolerances shall apply for fabrication of piling units:

- A. Variation from plan lengths - plus or minus 1 inch
- B. Variation from plan transverse dimensions - plus or minus 1/4 inch
- C. Maximum sweep - 1/8 inch per 10 feet
- D. Head out of square - Maximum 1/8 inch
- E. At any point in the member, small areas of honeycomb which are purely surface in nature, not over 1/2 inch deep, may be repaired. Piling with honeycomb extending to plane of prestressed strands will not be acceptable.

- F. Requirements not covered - conform to current Prestressed Concrete Institute standards.
- G. Members not conforming to the above, shall be rejected, repaired and replaced at no cost to the City of Deer Park.

410.7 Finishing. Exposed surfaces of concrete piles shall be finished as follows: Handling wires and/or other protrusions shall be removed and resulting chips or indentations shall be pointed up with grout. The surfaces shall then be painted with two coats of "Daraweld" masonry paint, or equal.

410.8 Measurement and Payment. Measurement of prestressed concrete piling will be made by the linear foot of acceptable piling complete and in place after all buildups and cut offs have been made. Measurement of pile buildups will be made by the linear foot of the portion of the buildup which extends beyond the specified length of the pile. Measurement of cutoffs will be made by the linear foot, starting at the pile length shown on the plans.

Payment for piles will be made at the unit price bid per linear foot of prestressed concrete piling of the specified size bid.

Payment for the work and materials involved in making each pile buildup will be made at the rate of one and one half (1-1/2) times the unit price bid for Prestressed Concrete Piling. Payment will not be made for more than one buildup on any pile. Payment will be made for only the part of the buildup which extends beyond the pile length shown on the plans.

Payment for cutoffs will be made at the rate of one half (1/2) the unit price bid per foot of Prestressed Concrete Piling. Payment will be made for only the part of the cutoff which lies within the pile length shown on the plans.

The foregoing payments will be full compensation for all material, labor, tools, equipment and incidentals necessary to complete the work in accordance with the plans and specifications.

END OF ITEM 410