

# **Construction Specification 13 – Piling**

## **1. Scope**

The work consists of furnishing and installing the specified kinds and types of piles at the locations shown on the drawings.

## **2. Material**

Piles shall conform to the requirements of following material specifications as appropriate to the kinds of piles specified. For piles of materials other than those listed, the material requirements outlined in Section 14 of this specification shall apply.

511 – Steel Piles

512 – Wood Piles

513 – Precast Concrete Piles

514 – Cast-in-Place Concrete Piles

## **3. Site Preparation**

All excavation within the area to be occupied by bearing piles shall be completed before the piles are driven.

## **4. Protection of Pile Heads**

The heads of all piles shall be protected during driving by suitable caps, rings, heads, blocks, mandrels, and other devices.

The heads of timber piles shall be fitted into a steel head block or fitted with heavy steel or wrought iron rings or wire wrapping.

The heads of steel piles shall be cut square and fitted with a steel driving cap.

The heads of precast concrete piles and casings shall be fitted into cushion type drive caps having a rope or other suitable cushion next to the pile head and fitting into a casting that in turn supports a timber shock block.

Driving heads, mandrels, and other devices shall be provided by the contractor as needed for special types of piles and shall conform to

the recommendations of the pile manufacturer.

## **5. Piles, General**

The contractor shall notify the engineer before pile driving operation commences. Such notice shall be far enough in advance, a minimum of 24 hours, to provide the engineer adequate time to be present for the driving operations. Piles shall be driven only in the presence of the engineer or authorized representative.

The determination of piling order lengths shall be the contractor's responsibility unless otherwise specified.

Unless otherwise approved, piles shall be driven with steam, air, diesel powered hammers or a combination of hammers, or by vibration or water jets. Water jets may be used only when specifically authorized by the engineer. Where jetting is authorized, the jets shall be withdrawn before the specified depth or bearing capacity is obtained and the piles shall be driven with the hammer to the final penetration.

When drop hammers are permitted, the height of drop shall not be more than 8 feet for concrete piles or 12 feet for steel and timber piles, unless otherwise specified.

The driving of piling with followers shall be allowed only when expressly approved by the engineer.

Piles shall not be driven within 20 feet of concrete less than 7 days after placement, including concrete placed in cast-in-place piles with or without predriven shells or casings.

The contractor shall not attempt to drive piles beyond the point of refusal, as indicated by excessive bouncing of the hammer or kicking of the pile.

## **6. Bearing Piles**

Bearing piles shall be driven to the position, line, and batter specified on the drawings. Each pile shall be driven continuously and without

interruption to the specified depth or until the specified bearing capacity is obtained. Deviation from this procedure is permitted only when interruption of driving is caused by conditions that could not reasonably be anticipated.

When a diesel hammer is used, it shall be operated at full throttle when blows are counted for determination of bearing capacity except that throttle adjustments shall be made as necessary to prevent the non-striking parts of the hammer from rising from the pile on the ram upstroke.

## **7. Sheet Piles**

The piling shall be driven in a manner that ensures perfect interlocking throughout the entire length of each pile. The piles shall be held in proper alignment during driving by assembling frames or other suitable temporary guide structures. Temporary guide structures shall be removed when they have served their purpose.

Anytime the forward edge of the sheet pile wall is found to be out of correct alignment,

- a. The piling already assembled and partly driven shall be driven to the required depth.
- b. Taper piles shall then be driven to bring the forward edge into correct alignment before additional regular piling is assembled and driven. The maximum permissible taper in a single pile shall be 0.25 inch per foot of length.

## **8. Estimating Bearing Capacity**

When load tests are not required, the bearing capacity of each pile shall be estimated using one of the following formulas, as appropriate:

Gravity hammers:

$$R = \frac{2WH}{S + 1}$$

Single-acting steam or air hammers and diesel hammers having unrestricted rebound of the ram:

$$R = \frac{2WH}{S + 0.1}$$

Double-acting steam or air hammers and diesel hammers having enclosed rams:

$$R = \frac{2H(W + AP)}{S + 0.1}$$

or

$$R = \frac{2E}{S + 0.1}$$

where:

R = Safe bearing capacity, in pounds

W = Weight of striking parts of hammer, in pounds

H = Height of fall, in feet

A = Area of piston, in square inches

P = Pressure of steam, air, or other gas exerted on the hammer piston or ram, in pounds per square inch

E = The manufacturer's rating for foot-pounds of energy developed by double-acting steam or air hammers, or 90 percent of the average equivalent energy developed by diesel hammers having enclosed rams as evaluated by gauge and chart readings, in foot-pounds

S = Average penetration for the last 5 to 10 blows of a gravity hammer or the last 10 to 20 blows for steam, air, or diesel-powered hammers, in inches per blow

These formulas are applicable when:

- The hammer has a free fall.
- The head of the pile is not crushed.
- The penetration is reasonably quick and uniform.
- There is no sensible bounce after the blow.
- A follower is not used.

Twice the height of the bounce shall be deducted from  $H$  to determine its value in the formula.

If case water jets are used in conjunction with the driving, these formulas are used to determine the bearing power from the results of driving after the jets have been removed.

## **9. Load Tests**

When load tests are specified, the test loads shall be applied gradually, without impact, and in a manner that no lateral forces are applied to the pile. Load testing shall not be started until 24 hours after driving of the test pile is completed unless otherwise specified in Section 14 of this specification. Except as otherwise specified, load tests shall be performed according to the following procedures.

The total test load shall be twice the specified working load and shall be applied to the pile in increments equal to 25 percent of the working load. Settlement of the top of the pile shall be measured to an accuracy of 0.01 inch before and after the application of each load increment and at 2, 4, 8, 15, 30, and 60 minutes after, and then every 2 hours until the next load increment is applied. Additional load shall not be applied until the rate of settlement is less than 0.01 inch in 1 hour.

The total test load shall remain on the pile for a minimum of 24 hours. Settlement shall be measured at 6-hour intervals during this period and at the end of the period, at least twice during removal of the load, and immediately after all of the test load is removed. The net settlement shall be measured about 24 hours after the total load has been removed.

If settlement continues in excess of 0.01 inch per hour under less than the total test load, no additional load shall be applied. However, the load that has been applied shall remain on the pile a minimum of 24 hours, and settlement measurements while the load is on the pile and during and after removal of the load shall be made as if it were the total test load.

## **10. Cutting Off Piles**

The contractor shall cut the piles at the specified elevations. The length of pile cut off shall be sufficient to permit the removal of all damaged material. Steel shells or concrete casings for cast-in-place concrete piles shall be cut off at the specified elevation before being filled with concrete.

Steel bearing piles shall be cut off in clean, straight lines as shown on the drawings. Any irregularities shall be leveled off with deposits of weld metal or by grinding before placement of bearing caps.

Precast concrete piles and concrete casings shall be cut off in a manner that prevents damage to the rest of the pile or casing or to the projecting reinforcement required for connecting the piles to the structure.

Timber piles that are to be capped shall be accurately cut off so that true bearing is obtained on every pile without the use of shims.

## **11. Defective Piles**

Any pile damaged in driving, driven out of proper location, driven below the specified cutoff elevation, or inaccurately cut off shall be corrected by one of the following methods, as approved by the engineer:

- a. The defective pile shall be pulled and replaced or re-driven.
- b. A new pile shall be driven adjacent to the defective pile.
- c. The defective pile shall be spliced or built up or a sufficient part of the footing shall be extended to properly embed the pile.

Pile shells abandoned in place after driving shall be filled with concrete or sand-cement grout as appropriate to the conditions that are present.

All piles pushed up by the driving of adjacent piles or by any other cause shall be re-driven to final grade.

Any sheet pile ruptured in the interlock or otherwise damaged during driving shall be pulled and replaced.

## **12. Correcting Surface Heave**

Any excess material resulting from displacement of earth by pile driving shall be removed. Materials disturbed by pile driving shall be conditioned and compacted to a minimum density equal to adjacent undisturbed material.

### **13. Measurement and Payment**

Method 1 – For items of work for which specific unit prices are established in the contract, each type, kind, and length of pile driven in place is counted. Payment for furnishing and driving each type, kind, and length of pile is made at the contract unit price. Such payment will constitute full compensation for all labor, equipment, materials, and all other items necessary and incidental to the completion of the work.

Method 2 – For items of work for which specific unit prices are established in the contract, each type, kind, and length of pile furnished, accepted, and stockpiled in good condition at the site of the work is counted. Payment for furnishing each type, kind, and length of pile is made at the contract unit price. Payment for driving each type and kind of pile is made at the contract unit price. Such payment will constitute full compensation for all labor, equipment, materials, and all other items necessary and incidental to the completion of the work.

Method 3 – For items of work for which specific unit prices are established in the contract, the length of each type and kind of pile driven is computed to the nearest foot as the difference between the measured length of pile before driving and measured length of pile cut off after driving. Payment for furnishing and driving each type and kind of pile is made at the contract unit price. Such payment will constitute full payment for all labor, equipment, materials, and other items necessary and incidental to the completion of the work.

Method 4 – For items of work for which specific unit prices are established in the contract, the area of sheet pile walls, acceptably placed in accordance and within the neat lines shown on the drawings, is computed to the nearest square foot. Payment is made at the contract unit price for each type, kind, and weight of piling. Such payment will constitute full payment for all labor, equipment, materials, and other items necessary and incidental to the completion of the work.

All Methods – The following provisions apply to all methods of measurement and payment:

The measurement of the number of linear feet of piles (or number of piles) furnished and the number of piles driven shall include test and tension piles specified in the contract. Piles furnished and driven at the option of the contractor are not included. No payment is made for furnishing or driving pile, including test piles, to replace piles lost or damaged before the completion of the contract while in stockpile or during handling and driving.

When load tests are specified, payment for each test is made at the contract unit price per test. Such payment will constitute full compensation for all labor, equipment, materials, and all other items necessary and incidental to perform the test, except furnishing and driving piling.

When splices are specified, payment for each splice is made at the contract unit price. Such payment shall constitute full compensation for labor, equipment, materials, and all other items necessary and incidental to the completion of the work.

Compensation for any item of work described in the contract, but not listed in the bid schedule is included in the payment for the item of work to which it is made subsidiary. Such items and the items to which they are made subsidiary are identified in Section 14 of this specification.

## **14. Items of Work and Construction Details**

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