



## Iowa Department of Transportation

### SPECIAL PROVISIONS FOR STEEL OPEN ENDED PIPE (OEP) PILES AND PILE DRIVING

Mills County  
NHSX-534-1(68)--3H-65

Effective Date  
July 19, 2011

THE STANDARD SPECIFICATIONS, SERIES OF 2009, ARE AMENDED BY THE FOLLOWING MODIFICATIONS AND ADDITIONS. THESE ARE SPECIAL PROVISIONS AND THEY SHALL PREVAIL OVER THOSE PUBLISHED IN THE STANDARD SPECIFICATIONS.

#### 090128.01 DESCRIPTION

This work shall consist of installing steel open ended pipe piling as shown on the contract plans and approved working drawings and as specified herein. The piling contractor is responsible for furnishing of all materials, tools, equipment, services, transportation, labor, and supervision required for installation and dynamic monitoring and testing of steel open-ended pipe (OEP) piles for this project.

#### 090128.02 MATERIALS.

Use piles that comply with the following requirements for the class of pile specified:

- A. **Steel Pipe Piles:** Section 4167.
- B. **Concrete for Steel Pipe Piles:** Section 2403, Class C, Slump 4-6 in.
- C. **Reinforcing for Steel Pipe Piles:** Section 2404.

#### 090128.03 CONSTRUCTION.

##### A. Delivery and Inspection of Piling.

1. When demonstration piles are specified in the Contract, the locations and lengths shown on the Plans are subject to change.
2. Prior to delivery the Contractor shall establish the quality of the material in the steel open ended pipe piles. The contractor shall submit to the Engineer the Mill Test Reports and Mill Shipping papers.
3. Pile splices used to make up authorized pile lengths shall be considered to have been made at the Contractor's convenience and shall not be considered eligible for extra compensation under Article 090128.04, A.
4. All piling will be given a visual inspection at the site before driving, to ascertain the quality of the welding done in manufacture or splicing, and to determine that the pile lengths contain no physical defects such as kinks or buckles that would cause the pile to fail in driving or not perform as intended.

##### B. Storage and Handling of Piling.

Store and handle piling to avoid damage. Repair or replace damaged piling as directed.

### **C. Pile Driving Equipment.**

1. The hammer used for driving piles may be of air, hydraulic or diesel type.
2. At least 20 days prior to the start of pile driving operations, the Contractor shall submit a completed pile and driving equipment data form for each hammer proposed for the project and a wave equation analysis in accordance with GRL WEAP or similar program for each pile type and hammer. The Contractor will be notified of the acceptance or rejection of the driving system within 12 calendar days of the Engineer's receipt of the data forms and analyses. The wave equation analysis shall evaluate all anticipated driving conditions from the start of driving to completion. If the wave equation analysis indicates pile damage could occur or the pile could not be driven to the required bearing, modifications or replacements to the proposed methods or equipment will be performed at no additional cost to the Department.
3. Use an approved system. When requested by the Engineer, the Contractor shall furnish the necessary driving system information concerning the pile hammer to be used. The same pile hammer, or a similar hammer, shall be used for driving the demonstration piles as will be used for driving the piles authorized as a result of the demonstration pile driving, except as may otherwise be indicated by driving conditions. Variations in the driving system will not be permitted without the Engineer's approval. If the hammer performance deviates from the manufacturer's recommended specifications, take immediate corrective action. The Engineer will not allow driving to continue until the system is performing to the manufacturer's specifications.
4. Changes in the driving system will be considered after the Contractor has submitted the required data for review. The Contractor will be notified of the acceptance or rejection of the driving system changes within 9 calendar days of the Engineer's receipt of the requested change. Time required for submission, review, and approval of a revised driving system does not constitute the basis for a contract time extension.

### **D. Driving Aids.**

1. Do not use vibratory hammers or driving aids such as jets, followers, and prebored holes unless stated in the contract documents or authorized in writing by the Engineer. When permitted, vibratory hammers may be used for installing production piles only after the pile tip elevation is established by dynamic load test or by a demonstration pile driven with an approved hammer. As condition for approval, perform dynamic load tests and work required to drive demonstration piles as determined by the Engineer.
2. Control production pile installation with vibratory hammers according to power consumption, rate of penetration, specified tip elevation, or other means acceptable to the Engineer. Assure the pile capacity equals or exceeds the design bearing. Use an approved hammer to retap piles driven to full penetration with a vibratory hammer. Pile capacity will be determined by dynamic pile testing.

### **E. Hammer Cushion.**

1. Equip all impact pile driving equipment with suitable thickness hammer cushion material to prevent damage to the hammer or pile. In the Engineer's presence, inspect the hammer cushion for condition, composition, and thickness before beginning pile driving at each structure, and regularly during driving.
2. For hammers with internal cushions, check the cushion regularly at 100 hour intervals during driving. Use the hammer manufacturer's recommended beginning cushion thickness and composition. Report this information to the Engineer prior to driving. Replace the hammer cushion when it has less than 70% of the recommended thickness, has burned, or has been broomed.

### **F. Pile Driving Cap.**

1. Piles driven with impact hammers require an adequate cap to distribute the hammer blow evenly to the top of the pile. Align the cap axially with the hammer and the pile. Guide with leads. Use an

appropriate cap for the type and size of pile. Ensure the cap fits around the top of the pile so that the driving unit is centered during driving.

2. For special types of piles, provide appropriate driving caps, mandrels, or other devices according to the manufacturer's recommendations so that the piles may be driven without damage.
3. Cut all pile tops squarely to ensure proper fit of the driving cap.

#### G. Determination of Pile Lengths.

The Engineer will determine the length from the results of the demonstration pile obtained under the procedure specified in the special provisions. Steel open ended pipe pile lengths will be in multiples of 5 feet.

#### H. Installation

Construct steel pipe piles by first driving steel open ended pipe of the specified type and size in the locations specified in the contract documents, and then filling the pipe with reinforced concrete. Construct the piles according to the following additional requirements:

##### 1. Inspection.

- a. Furnish a light suitable for visual interior inspection of driven pipe piles. This inspection will be conducted before cut off and filling is allowed.
- b. Remove and replace, or otherwise correct as directed by the Engineer, all piles which have been improperly driven, broken, or are otherwise defective.
- c. Ensure the interior of the pile is cleaned to the required depth and free of water at the time of inspection.

##### 2. Cut Off.

Upon completion of driving, inspection, and approval, neatly cut the pile on a horizontal plane at the elevation specified in the contract documents.

##### 3. Filling.

- a. After the piles have been cut off, remove water in piles. If water is present, tremie methods must be used for concrete placement.
- b. Remove soil within the casing to the elevations shown on the plans, if needed.
- c. After reinforcement has been accurately placed, fill pile completely with Class C structural concrete meeting requirements of Section 2403. Unless tremie methods are used for concrete placement, ensure pile is free of accumulated water at the time concrete is placed.
- d. In order to avoid formation of air pockets, place the concrete:
  - Using vibratory methods as specified in Article 2403.03, D or
  - In small charges of not over 2 cubic feet each.

##### 4. Welding.

- a. Limit the number of permitted welds used to develop plan specified lengths of steel pipe piles to those in Table 090128.03-1:

Plan Pile Length, feet	Number of Permitted Welds (splices)
0-50	0
51-100	1
101-150	2

- b. Welds (splices) in excess of the number specified above will not be permitted unless required for a pile extension.

**I. Accuracy in Placing and Driving Piles.**

1. In spotting the points of piles in preparation for driving, use care to locate them as shown in the contract documents or as directed by the Engineer. Limit the deviation from such designated locations to 3 inches or less at the time driving is begun, except as may be made necessary by the presence of unavoidable obstructions.
2. While being driven, hold piles so they deviate the minimum possible amount from the vertical or batter line shown in the contract documents. Firmly and securely hold in place in proper position the leads used in driving piles to assure driving the pile in the line required.
3. Suspend pile driving during and for 12 hours following concrete placement that is within 50 feet of the pile driving operation.

**J. Determination of Bearing Value of Piles.**

Determine the bearing value of piles using data obtained using a dynamic pile driving analyzer and CAPWAP procedures.

1. Dynamic pile testing shall be performed on all production steel open ended pipe piles as directed by the Engineer. The production pile testing shall be performed during initial driving and restrrike (if required) to monitor hammer and drive system performance, assess pile installation stresses and integrity, as well as to evaluate pile capacity.
2. All equipment necessary for the dynamic monitoring such as sensors, cables or wireless transmitters, etc., shall be furnished by the Contractor. The equipment shall conform to the requirements of ASTM D4945. The Contractor will furnish the pile driving analyzer, equipment/instruments, material, and labor necessary for drilling the holes, mounting the instruments, obtaining the data, and performing the CAPWAP analysis. An engineer with a minimum 5 years of experience and/or who has achieved Basic Level or better on the Foundation QA Examination for Providers of PDA Testing Services shall be in charge of Pile Driving Analyzer (PDA) operation and of result interpretation, either on site or by remote connection.
3. CAPWAP analyses of the dynamic pile testing data shall be performed on data obtained from the end of initial driving and the beginning of restrrike of all production piles. CAPWAP analyses shall be performed by an engineer who has achieved Advanced Level or better on the Foundation QA Examination for Providers of PDA Testing Services. The Engineer may request additional analyses at selected pile penetration depths.
4. Within one day of production pile testing, the Contractor shall prepare a hand written daily field report summarizing the dynamic testing results. As a minimum, the daily reports shall include the calculated driving stresses, transferred energy, and estimated ultimate pile capacity at the time of testing. Variations from previous trends in the dynamic test data shall also be noted. Daily field reports shall be transmitted to the Engineer.
5. Once per month, or upon completion of various project or testing phases, the Contractor shall prepare a formal report summarizing the dynamic testing results. This report shall be submitted no later than ten working days after the completion of the reported part of the testing.

**K. Initial and End of Drive Conditions.**

1. Drive the designated pile to at least the depth at which the dynamic test equipment indicates that the capacity shown in the contract documents has been achieved, unless the Engineer directs otherwise. The stresses in the pile will be monitored during driving with the dynamic test equipment to ensure that damage, as determined by the Engineer, does not occur.
2. Do not continue driving beyond a depth at which acceptable pile stress ( $0.9 \cdot F_y$ ) is exceeded. With the Engineer's approval, driving may be stopped when the rate of driving exceeds 200 blows per foot.

3. If an over-stress condition is indicated, the Engineer will suspend driving and determine if plan capacity has been achieved. If necessary, in order to maintain monitored stresses below the accepted values, reduce the driving energy transmitted to the pile by:
  - a. Reducing the energy output of the hammer, or change hammers.
  - b. If nonaxial driving is indicated by the dynamic test equipment measurements, immediately realign the driving system.

**L. Restrikes.**

1. When piles do not achieve the specified driving resistance during driving, the Engineer may require a restrike on a minimum of 2 piles in each pile group at no additional cost to the Department. Only piles with the lowest driving resistance will be considered for restrike.
2. Perform the restrike by allowing the pile to set up for 24 hours, or as directed by the Engineer.
3. Warm up hammers (other than by gravity) by applying a minimum of 20 blows to another pile before the restrike driving begins. Take the bearing for the restrike within the first 6 inches of penetration.
4. The first two blows of a restrike are for seating the cap and assuring proper operation of the hammer. Do not use the first two blows as part of bearing evaluation.
5. Measure the penetration of the next ten blows, or record the number of blows it takes to drive the pile 6 inches. Correct to the appropriate measurement and check for bearing.
  - a. If bearing is achieved, driving may be halted. However, if the Engineer approves, driving may be continued to cut-off as long as acceptable pile stress is not exceeded.
  - b. If penetration is less than 1 inch for the first ten blows, discontinue driving. Record the bearing as refusal.
6. Have the Engineer evaluate piles not achieving the specified driven resistance after a restrike and, if so ordered, extend as required following the procedures of Article 090128.03, O.

**M. Bearing Required.**

Unless modified by the Engineer, drive all piles to the design bearing specified in the contract documents. Ensure the specified design bearing is obtained below scour elevation for substructures subject to scour.

**N. Penetration.**

Unless provided otherwise in the contract documents, drive all piles to the minimum tip elevation indicated on the plans and until the design bearing, determined as provided in Article 090128.03, J, is at least equal to that specified in Article 090128.03, M.

**O. Extensions and Splices.**

Follow Article 090128.03, L when piles driven to the specified depth fail to develop the required design bearing. If the Engineer orders pile extensions, driving will continue as long as practical, then the piles will be extended in the manner specified below:

1. For extensions of steel pipe piles, neatly weld the entire cross section after removing all damaged metal. Ensure the axis of the extension coincides with the axis of the original pile. Perform welding of all steel piles according to Article 2408.03, B.
2. Allow only welders qualified according to Material I.M. 560 to make field extensions of steel piles. Ensure they use an approved welding procedure involving the use of backing plates according to Article 2408.03, B.
3. When designated in the contract documents, the Contractor has the option of extending steel piles by means of mechanical splices approved by the Engineer.

**P. Demonstration Pile.**

1. The lengths of piles are to be determined from results of driving a demonstration pile at the location near Pier No. 5 shown in the plans or a location determined by the Engineer. Drive the demonstration pile to the tip elevation indicated on the plans.
2. Drive and complete the demonstration pile with the same or comparable type of equipment as that which is to be used for driving other piles for the structure.
3. Dynamic pile testing shall also be performed on the demonstration pile. The dynamic testing shall be performed during initial driving and restrikes performed at 1, 3, 7, 14, 28 days after installation to monitor hammer and drive system performance, assess pile installation stresses and integrity, as well as evaluating pile capacity.
4. All equipment necessary for the dynamic monitoring such as sensors, cables or wireless transmitters, etc., shall be furnished by the Contractor. The equipment shall conform to the requirements of ASTM D4945. The Contractor will furnish the pile driving analyzer, equipment/instruments, material, and labor necessary for drilling the holes, mounting the instruments, obtaining the data. An engineer with a minimum 5 years of experience and/or who has achieved Basic Level or better on the Foundation QA Examination for Providers of PDA Testing Services shall be in charge of Pile Driving Analyzer (PDA) operation and of result interpretation, either on site or by remote connection.
5. CAPWAP analyses of the dynamic pile testing data shall be performed on data obtained from the end of initial driving and the beginning of restrike of all demonstration piles. CAPWAP analyses shall be performed by an engineer who has achieved Advanced Level or better on the Foundation QA Examination for Providers of PDA Testing Services. The Engineer may request additional analyses at selected pile penetration depths.
6. The Contractor shall prepare a written report of the demonstration pile program. This report shall include the results of dynamic load test(s) (if performed) and shall contain a discussion of the pile capacity obtained from the dynamic testing. The report shall also discuss hammer and driving system performance, driving stress levels, and pile integrity.
7. The contractor shall cleanout the pipe pile to the elevation shown on the plan for production piles and place concrete by tremie to a depth of 3 feet below the ground surface.
8. Within 10 calendar days, the Engineer will determine the length of production piles to be furnished by considering the results of the demonstration pile.
9. The demonstration pile, at completion of the program, shall be cut off a minimum of 3 feet below the ground surface and the waste material removed from the site. The void remaining after removal of the waste material for the demonstration pipe pile shall be backfilled with cohesive soil having similar characteristics to the near surface surrounding soil.

**090128.04 METHOD OF MEASUREMENT.**

**A. Open Ended Steel Pipe Pile.**

Measurement for the quantities of Open Ended Steel Pipe Piles will be the plan length. For steel pipe piles that are extended, the length measured for payment will be the length of the extension specified by the Engineer. Portions of pile cut-offs used as extensions on the same contract will not be remeasured as additional plan quantity.

**B. Reinforcing Steel.**

Per Article 2404.04.

**C. Demonstration Piles.**

Per Lump Sum.

**090128.05 BASIS OF PAYMENT.****A. Open Ended Steel Pipe Pile.**

Payment will be the contract unit price for the quantities of Open Ended Steel Pipe Piles. The price bid for piles is full compensation for delivering piles to the site, preparing, driving, monitoring driving using pile driving analyzer, cutting, and filling piles, except as modified in this article.

**1. Increased or Decreased Length or Size of Piles.**

Return unused piling (either ordered as directed by the Engineer, or specified in the contract documents and delivered to the job site without having been placed in the leads) to the supplier. Payment will be made for freight, restocking, and handling charges.

**2. Extension of Steel Pipe Piles.**

Payment will be at the contract unit price per linear foot (or unit price per meter) for Open Ended Steel Pipe Piles required to be spliced to obtain lengths greater than specified in the contract. Payment includes all equipment, labor, and materials necessary to complete the splice.

**3. Pile Cut-Offs.**

- a. Pile cut-offs not used as extensions on the same contract become the property of the Contractor. Steel pile cut-offs used as extensions on the same contract will not be paid for as additional plan quantity.
- b. All piles, or portions thereof, which become the property of the Contractor shall be removed from the project site by the Contractor.

**4. Jetting/Removal of Material.**

Any jetting or removal of material from within the pipe pile to achieve the minimum tip elevation will be considered incidental to the pile driving cost.

**B. Reinforcing Steel.**

Per Article 2404.05.

**C. Demonstration Piles.**

1. Payment will be the contract lump sum price. Payment is full compensation for all labor, material, and equipment required to comply with the procedure shown in the contract documents, including the demonstration pile, dynamic pile monitoring, wave equation and CAPWAP analysis, welding, reinforcing steel, concrete and reestablishment of demonstration pile location to original conditions.
2. If additional demonstration piles are deemed necessary, Demonstration Piles ordered by the Engineer and driven under the Engineer's supervision will be considered as extra work and will be paid for as provided in Article 1109.03, B.