Piling – Driven Piling

Revision and Approval

Revision	Date	Nature of Changes	Approved By
1	02-28-2025	Revised	John Lammers
0	03-30-2022	Original issue	Richard Foley

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Background

This process establishes the Structure Construction (SC) responsibilities and procedures for review and authorization of driven piling submittals, quality assurance, materials, construction, and payment that apply to all driven piling specified in Section 49-2 of the *Contract Specifications*.

Additional unique requirements for this process are detailed in:

- BCM 11, *Welding*
- BCM 49-1, *Piling – General*

Prior to reviewing this Bridge Construction Memo (BCM), it is essential to review *Contract Specifications*, Section 49-2, *Piling – Driven Piling*, that this BCM is based on as identified in the title block above. The information in the *Contract Specifications* typically will not be repeated in the text of this BCM.

Process Inputs

1. All driven piling:
   a. Form CEM-3101, *Notice of Materials to Be Used*
   b. Form TL-0029, *Report of Inspection of Material*
   c. Form SC-4803, *Pile Quantity & Driving Record (Driven Piles)*
   d. Form SC 4805, *Log Pile Sheet*

e. Form SC-4806, *Pile Layout Sheet*

f. Form SC-4809, *Pile Driving (US Customary) Blows Per Foot using Gates Formula (Vertical & Battered)*

g. Pile and Driving Data Form submittals for each hammer

h. Authorized pile handling work plan submittal

i. Driving system submittal for each hammer (when specified)

j. Printed hammer energy readouts from the Contractor (when required)

k. Driven Piling Placement Training Video

2. Steel piling:
   a. Shop drawings for pile handling devices
   b. Inspection request form
   c. Field welding submittals
   d. Certificates of compliance
   e. Material test report
3. Precast prestressed concrete piling:
   a. Shop drawings (when requested)

Procedure

1. All work associated with this process is charged as Project Direct – Construction.
2. Inspection levels of field work for this process are:
   a. Benchmark for:
      i. Inspection of piling delivered to the project.
   b. Intermittent for:
      i. Field welding of steel piling.
   c. Continuous for:
      i. Inspection of the pile driving operation.
      ii. Determining pile acceptance during pile driving.
3. Before construction begins:
   a. Review the following documents:
      i. Contract documents for noise, vibration, and other environmental requirements.

ii. Contract documents for difficult pile installation conditions per BCM 49-1, *Piling – General*.

iii. Structures portion of the Resident Engineer's (RE) Pending File, foundation report, and project *Information Handout* for applicable environmental commitments and railroad requirements.

iv. The Code of Safe Practices (COSP) and the various Cal/OSHA requirements for driven piling construction in California Code of Regulations (CCR) Title 8, Chapter 4, Subchapter 4, Construction Safety Orders, including but not limited to:

1. Article 6, *Excavations*
2. Article 9, *Derricks, Cranes, Boom-type Excavators*
3. Article 12, *Pile Driving and Pile Extraction*
4. Article 15, *Cranes and Derricks in Construction*
5. Article 24, *Fall Protection*

b. Coordinate action with the following:

i. Discuss with Resident Engineer (RE) and Contractor any existing facilities concerns and agency requirements, such as overhead power lines, underground utilities, environmental and railroad requirements. Verify that the Contractor called Underground Service Alert (DigAlert in Southern CA, USAN in Northern CA)

ii. Contact Foundation Testing and Instrumentation (FTI) to review the pile driving requirements and timeframe for FTI's involvement for the project. FTI is a branch found within the Division of Engineering Services - Geotechnical Services (DES-GS), Office of Geotechnical Support.

iii. Discuss guidelines for hard driving, soft driving, and restrike with the SC Substructure Engineer (within SC Headquarters) and the appropriate GS Geoprofessional and how it applies to construction:

1. Discuss the possibility of installing driven piles using a vibrating hammer, and if so, to what elevation, with the Structural Designer and GS Geoprofessional. Note that the Structural Designer in this case is referring to the DES Bridge Design (BD) Engineer of Record.
2. Discuss with and concur on the definition of "refusal" and remedial measures with the GS Geoprofessional and FTI. Refer to the *Foundation Manual*, Chapter 7, *Driven Piles*, Section 7-7, *Driving Challenges*.

c. Review and authorize each submittal required by *Contract Specifications* for this process, as follows:

i. Discuss requirements for Pile and Driving Data Forms and driving systems submittal (DSS) requirements during the preconstruction conference per the *Foundation Manual*, Chapter 7, *Driven Piles*, Section 7-5, *Nominal Resistance/Bearing Capacity.*

ii. Review and authorize or reject the submitted Pile and Driving Data Forms:

1. Contact FTI for questions regarding information on the Pile and Driving Data Forms, which are included in the *Special Provisions* and completed by the Contractor.
2. Discuss issues preventing authorization of the Pile and Driving Data Forms with the Contractor.

iii. If a DSS is required, perform an initial review of the submitted DSS for completeness:

1. Review the DSS with the RE to verify compliance with any additional project requirements and request contingency plan from the Contractor as needed.
2. Request additional information from the Contractor if needed until the DSS is complete.
3. Forward the complete DSS to FTI for review. Authorize or reject the DSS based on FTI recommendation. Refer to the *Foundation Manual*, Section 7-5, *Nominal Resistance/Bearing Capacity.*
4. Notify the Contractor in writing of rejection or authorization of the DSS.

iv. Perform a review of the authorized pile handling work plan submitted per BCM 49-1, *Piling – General*, and verify compatibility of the pile handling work plan, Pile and Driving Data Forms, and the DSS.

v. For steel pipe piling:

1. Verify with the Materials Engineering and Testing Services Representative (METS Rep) that the proposed steel pipe piling fabrication facility is on the Department's Authorized Facility Audit Lists.
2. Review American Welding Society (AWS) D1.1 requirements via the ACCURIS link; account setup and login required. Alternatively, request copy from the METS Rep.
3. Discuss shop drawing review and authorization, certificates of compliance, steel pipe piling fabrication, welding certifications for Class N steel pipe piling, and field welding requirements with the Contractor and METS Rep.

vi. For structural shape steel piling and precast prestressed concrete piling:

1. Review submittals and notify the Contractor in writing of rejection or authorization of the steel piling and/or concrete piling submittals.

d. Review materials, as follows:

   i. Review and discuss with the METS Rep any materials to be inspected and released via Form CEM 3101, *Notice of Materials to be Used*, and Form TL-0029, *Report of Inspection of Material*, and which materials are to be field released via CEM-4102, *Material Inspected and Released on Job*. Utilize the forms to justify any materials on hand payments.

      1. Confirm steel that meets the contract requirements is being procured and that METS has been notified.

   ii. For field welding of steel piling, verify welding quality control plan and welder certification requirements have been met per BCM 11, *Welding*.

   iii. Perform timely field verification that the materials delivered meet contract requirements and were not damaged in shipping.

   iv. Collect orange inspection release tags and match them with the appropriate Form TL-0029, *Report of Inspection of Material.*

   v. Verify material condition meets the requirements of the contract documents.

e. Prepare for construction of driven piling by performing the following:

   i. Coordinate with FTI if dynamic monitoring or pile load tests are required per BCM 49-1, *Piling – General*.

   ii. Prepare the following SC Forms: Form SC-4803, *Pile Quantity and Driving Record (Driven Piles)*, Form SC-4805, *Log Pile Sheet*, and Form SC-4806, *Pile Layout Sheet*, for all locations with driven piling. See *Foundation Manual*, Chapter 7, *Driven Piles*, Section 7-6*, Preparing to Drive Piles*.

   iii. Prepare bearing acceptance criteria:

      1. For driven piling to be accepted using the Gates formula, prepare pile acceptance charts for each authorized hammer using Form SC-4809, *Pile Driving (US Customary) Blows Per Foot Using Gates Formula*, as described in Attachment 2, *Driven Piling – Acceptance Criteria*, with modifications as required to account for battered piling.

      2. For driven piling to be accepted using bearing acceptance criteria determined by dynamic monitoring, verify bearing acceptance criteria has been received from FTI per BCM 49-1, *Piling – General*.

iv. Review the Code of Safe Practices (COSP) for personal protective equipment requirements and safety hazards associated with the pile driving operation.

v. Review the pile driving equipment and verify it matches the authorized DSS and/or Pile and Driving Data Form per the *Foundation Manual,* Section 7-6, *Preparing to Drive Piles* .

vi. If the pile driving crane is used for tasks other than pile driving, verify the operator certification meets the requirements of Title 8, Chapter 4, Subchapter 7, General Industry Safety Orders, § 5006.2, *Operator Training, Certification, and Evaluation for Cranes and Derricks in Construction*.

vii. Determine rejection criteria for piling driven "materially out of line". See *Foundation Manual*, Chapter 7, *Driven Piles*, Section 7-7.3, *Driving Challenges – Alignment of Piles*.

1. It is important for H Piles to be positioned correctly as shown on the plans with its strong axis parallel to the plane of the design forces.

viii. Confirm how the hammer stroke will be measured during driving.

ix. Verify pile lengths for the given location where piles are to be driven. See *Foundation Manual*, Section 7-6, *Preparing to Drive Piles*.

x. Verify the locations of reference staking hubs where piles are to be driven to provide pile cutoff elevations during driving. See *Foundation Manual*, Section 7-6, *Preparing to Drive Piles*, Table 7-11, *Field Preparation Tasks Prior to Driving Piles*.

xi. Verify pile marking at 1-foot intervals to measure penetration during driving. See *Foundation Manual*, Section 7-6, *Preparing to Drive Piles*.

xii. Check that the Contractor's pile layout meets contract requirements. See *Foundation Manual*, Section 7-6, *Preparing to Drive Piles*.

xiii. Review the driven piling training video (Driven Piling Placement).

4. During construction:

a. Inspect piling delivered to the job site, as follows:

i. Review materials as they are delivered to the job site:

1. Complete Form CEM-4101, *Materials Release Summary*, and Form CEM-4102, *Material Inspected and Released on Job*, for field-released materials.

ii. Reject damaged precast concrete piling per *Foundation Manual,* Chapter 7*, Driven Piles,* Section 7-6.2.1, *Preparing to Drive Piles – Materials Checklist – Precast Concrete Piles*.

b. Discuss driven piling operations in a tailgate safety meeting before field operations begin:

   i. Ensure personal protective equipment, including hearing protection and eye protection, is available and ready for use.

   ii. Ensure that the authorized pile handling work plan is implemented.

c. When predrilled holes are required through new embankments, verify the hole is at least 6 inches larger than the greatest pile dimension.

d. Use Form SC-4806, *Pile Layout Sheet*, to verify the pile location and number at the start of driving.

e. Verify the vertical alignment (plumb or battered) of the pile at the start, and during driving.

f. Monitor and log the pile number, blow count, hammer stroke, any predrilling completed, vibratory hammer usage, driving stoppages, cushion changes, and pile penetration during driving on Form SC-4803, *Pile Quantity and Driving Record (Driven Piles)* and Form SC-4805, *Log Pile Sheet*. See *Foundation Manual*, Section 7-6, *Preparing to Drive Piles*.

   i. Apply corrections for battered piling. See *Foundation Manual*, Chapter 7, *Driven Piles*, Section 7-5.4, *Nominal Resistance/Bearing Capacity, – Battered Piles,* and the appropriate Appendix for driven piles.

   ii. Form SC-4805 is prepared for **every driven pile**. At least one pile per individual footing is logged in its entirety. Additional piles within an individual footing are logged in their entirety when significant changes in the driving conditions are encountered.

g. Monitor at the start and periodically check the noise and vibration due to pile driving to ensure compliance with the requirements of the contract documents.

h. Monitor the hammer performance during driving to verify it is operating as anticipated.

i. For double-acting pile driving hammers or other hammer types where the ram stroke cannot be visually observed:

   i. Receive the printed readout of hammer energy for each pile during driving operations from the Contractor.

   ii. Determine pile acceptance using the printed readout of hammer energy delivered at the pile specified tip elevation.

j. Verify piles are driven to the correct position and alignment. See *Foundation Manual*, Chapter 7, *Driven Piles,* Section 7-7.3, *Driving Challenges – Alignment of Piles*.

k. If hard driving is encountered, address the Contractor's request for use of driving aids such as drilling, spudding, jetting, or raising the specified tip elevation. See *Foundation Manual*, Section 7-7, *Driving Challenges*.

   i. Consult with the GS Geoprofessional before authorizing the Contractor's requests.

   ii. Consider the possibility that the hammer is not operating properly. Consult with FTI.

   iii. After conferring with the GS Geoprofessional, if deemed appropriate, the Contractor may use a predrilled hole with diameter no larger than the minimum cross-sectional pile dimension: the exception to this is outlined in the preceding Step 4.c.

l. If soft driving is encountered, implement the use of pile lugs in accordance with Attachment 1, *Driven Piling – Steel H-Pile Lugs*, lower the specified tip elevation, or restrike the pile. See *Foundation Manual*, Chapter 7, *Driven Piles*, Section 7-7.2, *Driving Challenges – Soft Piles and Restrike*:

   i. Consult with the GS Geoprofessional before authorizing Contractor requests.

   ii. If restriking the pile is necessary, choose 10 percent (at least two piles) per footing to restrike in accordance with *Contract Specifications*, Section 49-2.01C(5), *Piling – Driven Piling – General – Construction – Driving.*

m. Check the reference staking hubs periodically to verify elevation is not changing due to soil heave during pile driving.

n. Confirm field welded splices meet the requirements of the contract documents:

   i. Coordinate inspection of field welded splices with the METS Rep as needed.

o. For rejected piling proposed for use, the Contractor must propose a repair plan in writing. Coordinate review of the repair plan with the Structural Designer and GS Geoprofessional.

p. Contact the Structural Designer and GS Geoprofessional for pile design revisions if needed, due to:

   i. Fabrication issues.

   ii. Proposals to raise or lower tip elevation.

   iii. Pile relocation.

   iv. Other unforeseen issues.

q. Use the pile driving acceptance criteria chart for the actual impact hammer used to determine whether each driven pile can be accepted for bearing.

r. Accept driven piling that is in the correct position and alignment and achieves proper bearing and specified tip. If specified tip elevation is not reached, the Structure Representative determines whether to accept or reject the pile, with concurrence from Geotechnical Services.

s. Keep accurate pile logs and field documentation to ensure:

   i. Good documentation for claim disputes and record audits.

   ii. Sufficient information for progress payments.

t. Document all inspection, construction, and quality assurance activities, pertinent to this BCM, in the daily reports per BCM C-7, *Daily and Weekly Reports.*

5. Measurement and Payment:

   a. Prior to each progress payment, compare materials on hand versus furnish piling requirements per Attachment 3, *Driven Piling – Measurement & Payment*.

   b. Prior to authorizing payment for furnish piling:

      i. Review Attachment 3, *Driven Piling – Measurement & Payment*.

      ii. Inspect piling delivered to the job site.

      iii. Reject damaged precast concrete piling per *Foundation Manual,* Chapter 7, *Driven Piles*, Section 7-6.2.1, *Preparing to Drive Piles – Materials Checklist – Precast Concrete Piles*.

   c. Prior to authorizing payment for "DRIVE PILE" item:

      i. Review Attachment 3, *Driven Piling – Measurement & Payment*.

      ii. Verify accurate completion of Form SC-4803, *Pile Quantity and Driving Record (Driven Piles),* and Form SC-4806, *Pile Layout Sheet.*

   d. After consulting with the Structural Designer and/or GS Geoprofessional, prepare change order(s) per BCM C-10, *Change Orders*, for piling driven beyond the specified tip elevation to achieve bearing, if applicable. If bearing is reached at specified tip, no payment is made for piling driven beyond specified tip elevation.

   e. File all payment records in the appropriate category in the project records as specified in the *Construction Manual*, Section 5-102, *Contract Administration – Project Records and Reports – Organization of Project Documents*.

6. Following construction:

   a. Assemble and verify completeness of applicable and previously referenced Forms SC-4803, SC-4805, and SC-4806.

b. File all project documentation (materials acceptance documentation, correspondence, daily reports, etc.) in the appropriate category in the project records as specified in the *Construction Manual,* Section 5-102, *Contract Administration – Project Records and Reports – Organization of Project Documents*.

Process Outputs

1. Submittals:
   a. Authorized Pile and Driving Data Forms
   b. Authorized driving system submittal, if applicable
   c. Authorized pile submittals for steel pipe piling, structural shape steel piling, precast prestressed concrete piling, and steel sheet piling
2. Materials:
   a. Form TL-0029, *Report of Inspection of Material*, and matching orange tags
   b. Completed Form CEM-4101, *Materials Release Summary*, and Form CEM-4102, *Material Inspected and Released on Job*
3. Construction:
   a. Completed pile driving acceptance criteria charts
   b. Completed Forms SC-4803, SC-4805, and SC-4806
   c. Daily reports

Attachments

Attachment 1: *Driven Piling – Steel H-Pile Lugs*

Attachment 2: *Driven Piling – Acceptance Criteria*

Attachment 3: *Driven Piling – Measurement & Payment*