



APPENDIX

# K Foundation Construction Checklists

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Note: Most SC forms for recording field data are located on the Intranet in either Excel, Word or PDF format:

[http://onramp.dot.ca.gov/hq/oscnet/sc\\_manuals/crp/vol\\_1/crp016.htm](http://onramp.dot.ca.gov/hq/oscnet/sc_manuals/crp/vol_1/crp016.htm)



## **K1. Driven Piling Construction Checklist**

### **General Overview**

In conjunction with Chapter 7, *Driven Piles*, a construction checklist for driven pile construction has been developed to assist field personnel in preparing documents and inspecting fieldwork to ensure compliance with contract requirements. It is important for Structure Representatives to review the contract plans and specifications, meet and go over them with Caltrans staff, conduct preconstruction meetings with the Contractor to lay out procedures, identify field problems, and other issues.

A driven pile foundation is another form of a deep foundation, typically using steel or concrete piles, driven into the ground using a hammer that produces a measured amount of energy.

The following checklist is intended to provide Caltrans personnel with a guide for the driven pile construction process. This checklist does not cover all situations of driven pile construction. If a problem does occur you are encouraged to contact your Senior Bridge Engineer, Division of Engineering Services (DES) Substructure Technical Committee or Structure Construction (SC) Substructure Technical Team.

### **I. Sources of Technical Information**

- A. Foundation Manual:
  - i. Chapter 7, *Driven Piles*.
  - ii. Appendix E, *Driven Piles*.
- B. SC Website: <http://onramp.dot.ca.gov/hq/oscnet/>
  - i. Various form downloads, pile blow count spreadsheet, etc.
- C. Various pile and hammer manufacturer web sites.
- D. Bridge Construction Records & Procedures Manual:
  - i. Chapter 130, *Foundations*.
  - ii. BCM 3-7, *Pile Records*.

### **II. Sources of Project Specific Information**

- A. Structures Pending File:
  - i. Designer Notes.
  - ii. Bidder Inquiries.
- B. Supplemental Project Information:
  - i. *Foundation Report*



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- Provides recommendations on construction methods.
- ii. Local, Regional, State, and Federal regulatory and permit specific requirements.

**III. Contractual Requirements**

A. Special Provisions:

B. Contract Plans:

- i. Pile Data Table.
- ii. *Log of Test Borings*.
- iii. Pile Layout information.
- iv. Utilities.
- v. Foundation Plans.

C. Standard Plans:

- i. B2-5 Pile Details, class 90 & 140.
- ii. B2-8 Pile Details, class 200.
- iii. B2-9 thru B2-11 Load Test Pile Details.

D. Standard Specifications:

- i. Precast Concrete Members<sup>1</sup>
- ii. Welding<sup>2</sup>
- iii. Water Pollution Control<sup>3</sup>
- iv. Environmental Stewardship<sup>4</sup>
- v. *Piling* (SS Section 49)

**IV. Job Books Setup**

A. Category 9 – Welding:

- i. Steel pile splicing submittals.
- ii. Welding inspection reports

B. Category 12 – Contractor’s Submittals:

- i. Driving System submittal.
- ii. Shop drawings for precast concrete piles. (concrete mix designs)
- iii. Blow Count Spreadsheet.
- iv. Pile Handling Plan

C. Category 41 – Report of Inspection of Material:

<sup>1</sup> 2010 SS, Section 90-4, *Precast Concrete*, or Special Provisions for contracts using 2006 SS.

<sup>2</sup> 2010 SS, Section 11-3, *Welding*, or Special Provisions for contracts using 2006 SS.

<sup>3</sup> 2010 SS, Section 13, *Water Pollution Control*, or Special Provisions for contracts using 2006 SS.

<sup>4</sup> 2010 SS, Section 14, *Environmental Stewardship*, or Special Provisions for contracts using 2006 SS.



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- i. Materials release summary.
  - ii. Orange tags for piles and attach to TL-29.
- D. Category 48 – Bid Item Quantity Documents:
- i. SC4803 – *Pile Quantity & Driving Record.*
  - ii. SC4805 – *Log Pile Sheet.*
  - iii. SC4806 – *Pile Layout Sheet.*

**V. Prejob Discussion with Design & Geotechnical Services**

- A. The following issues should be discussed with the Designer and Geoprofessional:
- i. Why this type of foundation?
  - ii. Review pile type, depth and drivability issues.
  - iii. What kind of driving is anticipated?
  - iv. What kinds of remedies might be available if problems are encountered?
  - v. Requirements for scheduling testing, (PDA, Static Load Test, etc).

**VI. Preconstruction Meeting with the Contractor**

- A. The following items should be discussed or reviewed with the Contractor at the preconstruction conference:
- i. Predrill elevations/depths.
  - ii. Jetting requirements, including depths and methods/equipment.
  - iii. Requirements for driving shoes, including installation requirements.
  - iv. The need for a full-length pile if piles are to be driven with a follower.
  - v. Specific pile material requirements for redundant vs. non-redundant piles.
  - vi. Specific WQCP requirements as they pertain to steel pile sections.
  - vii. Specific pile-splice requirements. (See WQCP requirements.)
  - viii. Discuss the potential for using pile lugs, including installation requirements.
  - ix. Cure time for precast piles.
  - x. Pile handling requirements (Structural and Safety).
  - xi. Specific pile testing requirements (PDA, Static Load Test, timing requirements).
  - xii. Submittal requirements.
  - xiii. SWPPP issues.

**VII. Submittal Reviews**

- A. Typical submittals might include the following:
- i. Pile handling plan, checked for both the structural stability of the pile as well as for site specific crane/leads placement including locations of known utilities if applicable.
  - ii. General safety around traffic.



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- iii. Hammer information. (Check for minimum Energy, per the contract specifications<sup>5</sup>.)
- iv. General Code of Safe Practices.
- v. Welding Quality Control Plan.
- vi. Driving System submittal. (When required by the contract specifications.)
- vii. Shop Drawings and concrete mix designs for precast concrete piles.

**VIII. Construction**

**A. Field Preparation:**

- i. Pile Inspections
  - Verify METS-release tags release pile, or cast date marked directly on precast concrete piles by METS.
  - Check pile lift ring removal and patching requirements per the contract specifications<sup>6</sup>.
  - Verify proper pile length, longer for battered pile.
  - Mark pile at 1-foot intervals for blow count.
  - Check pile conditions: crack, rust, rebars on top, etc.
  - Verify pile layout, batter requirements. Do not lay out piles for Contractor.
  - Check for welder certification requirements if applicable.
  - Verify existence of utilities and any conflicts. Contact utility company and verify overhead power line voltages. Know minimum clearances and verify Contractor has located and marked safe travel areas for crane.
  - Verify use of full-length pile as required, one per footing location, min.
- ii. Equipment/Site Inspections
  - Check horizontal and vertical clearance requirements.
  - Inspect lead for rust or anomalies.
  - Verify hammer type/model – same one as submitted.
  - Evaluate construction plan, access, obstacles, traffic, safety, handling, storage, etc.
  - Mark/verify the reference elevation. Create an offset elevation hub for backup.
  - Measure hammer for stroke length.

**B. Driving Piles:**

- i. Review Code of Safe Practices.
  - Check pile driving crane requirements (Cal-OSHA Title 8 Subchapter 7 Group 13 Art. 100 Section 5031).
  - Wear eye/hearing protection. Do not stand next to driving equipment.

<sup>5</sup> 2010 SS, Section 49-2.01C(2), *Driving Equipment*, or 2006 SS, Section 49-1.05, *Driving Equipment*.

<sup>6</sup> 2010 SS, Section 49-2.04B(2), *Fabrication*, or 2006 SS, Section 49-3.01, *Precast Prestressed Concrete Piles, Description*.



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- ii. Talk to foreman, contingency (e.g., which piles to leave “high” if soft driving is encountered).
  - iii. Verify construction sequence.
  - iv. Bring prepared forms for recording.
  - v. Verify pile location at the start of driving.
  - vi. Verify plumbness or batter of the pile at the start and during driving.
  - vii. Bring hammer energy chart, pile bearing curve/table.
  - viii. Monitor and log blow counts, stroke length, blow rate, and penetration. Compare blow counts with information from LTB/*Foundation Report*. Record any pile damages.
  - ix. Check the reference elevation daily. Verify proper pile cutoff after pile driving. Survey top of pile elevations for as-built plans.
- C. Problems and Solutions:
- i. Bearing value/penetration
    - Hard driving/obstructions
      - Predrilling, Spudding, Jetting, reinforced tips.
      - Wave Analysis of Piles (WEAP) predicts internal stresses of the pile that can be used to determine blow count upper limit.
      - Check foundation reports and other supplemental project information for refusal criteria. Specified tip elevation may be raised if compression is the controlling (deepest) design tip elevation (see Pile Design Data Table). Check with the geoprofessional.
      - Heavier pile section.
      - Ensure that the hammer and its associated equipment are in good working order and stroke length measurements are accurate.
    - Soft driving – restrike/retap
      - Retap 10% of piles or minimum two per footing. Check special provisions or supplemental project information for additional information.
      - Retap after 12 to 24 hours for “set up/take up”. (May take longer).
      - Count blows/inch (max. 3 to 6 inches).
      - Use “hot” hammer and verify stroke length.
      - Keep old pile cushion on.
  - ii. Cutoff
    - Verify top of pile elevation for proper pile embedment.
    - Check for maximum pile cutoff length.
  - iii. Misalignment
    - Notify Designer of any pile misalignments, may create unintended eccentricity in pile footing design.



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**IX. Project Completion/ As-Built**

- A. Final Record Keeping/Pay Quantities:
- i. Complete Forms (BCM 3-7.0, *Pile Records*).
  - ii. File Pile Quantity and Driving Records in Category 48.
  - iii. Send copies of Pile Quantity & Driving Record, Log Pile, and Pile Layout forms to SC HQ.
- B. Record Data to As-Built.
- i. See Foundation Manual, Chapter 3, *Contract Administration*, Section 3-5, *As-Built Drawings and Pile Records*.
  - ii. See BCM 9-1.0, *As-Built Plans*.
- C. Send all project completion records and As-Built to the appropriate Office Associate at the following address.

**Division of Engineering Services  
Structure Construction  
1801 30<sup>th</sup> Street, M.S. 9-2/11H  
Sacramento, CA 95816  
Email: SC Office Associates@DOT**

**X. Forms**

- A. Refer to the SC Intranet, BCRP Manual Section 16<sup>7</sup> for various updated forms relating to driven pile construction.
- i. SC-4805, *Log Pile Sheet*.

<sup>7</sup> [http://onramp.dot.ca.gov/hq/osnet/sc\\_manuals/crp/vol\\_1/crp016.htm](http://onramp.dot.ca.gov/hq/osnet/sc_manuals/crp/vol_1/crp016.htm)



## **K2. Cast-In-Drilled-Hole (CIDH) Pile Construction Checklist**

### **General Overview**

In conjunction with Chapters 6, *Cast-In-Drilled-Hole Piles*, and 9, *Slurry Displacement Piles*, a construction checklist for Cast-In-Drilled-Hole (CIDH) pile construction has been developed to assist field personnel in preparing documents and inspecting fieldwork to ensure compliance with contract requirements. It is important for Structure Representatives to review the contract plans and specifications, meet and go over them with Caltrans staff, conduct preconstruction meetings with the Contractor to lay out procedures, identify field problems, and other issues.

Cast-In-Drilled-Hole piles are reinforced concrete piles cast in holes drilled to predetermined elevations. The CIDH piling can be grouped in two categories: the first is CIDH piling without inspection pipes (dry method), and the second is CIDH piles with inspection pipes (wet method). Inspection pipes are also referred to as inspection tubes.

Inspection pipes and testing are required for all CIDH piling that are 24 inches in diameter or larger, except when holes are dry or when the holes are dewatered without the use of temporary casing to control groundwater.

The following checklist is intended to provide Caltrans personnel with a guide for the CIDH pile construction process. This checklist does not cover all situations of CIDH pile construction. If a problem does occur you are encouraged to contact your Senior Bridge Engineer, Division of Engineering Services (DES) Substructure Technical Committee, Structure Construction (SC) Substructure Technical Team or the DES CIDH Pile Mitigation Committee.

### **I. Sources of Technical Information**

#### **A. Foundation Manual:**

- i. Chapter 1, *Foundation Investigations*.
  - Provides information to interpret and effectively use the *Foundation Report* and *Log of Test Borings* during the administration of the project
- ii. Chapter 6, *Cast-In-Drilled-Hole Piles*.
  - Provides general information on equipment and construction
- iii. Chapter 9, *Slurry Displacement Piles*.
  - Provides extensive details on the use of slurry including general information on equipment, construction and contract administration when using slurry.
- iv. Appendix G, *Slurry Displacement Piles*.
  - Provides sample reports of gamma-gamma logging test results and combined gamma-gamma logging and cross-hole sonic logging test results.





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**B. Bridge Construction Records and Procedures Manual:**

- i. BCM 130-7, *CIDH Concrete Piling.*
  - Criteria for accepting dry method of CIDH pile construction when encountering a small amount of water and a chronological outline for contract administration of CIDH Piling.
- ii. BCM 130-8, *CIDH Pile Mitigation Committee.*
  - Contains information on the committee's role and contact information.
- iii. BCM 130-9, *CIDH Pile Installation Plan and Concrete Test Batch.*
  - See Sections VII and IX subsection A for details.
- iv. BCM 130-10, *Testing of CIDH Piling.*
  - Information on coordinating and scheduling with the Foundation Testing Branch (FTB) for testing a CIDH Pile.
  - Information on contract administration when a CIDH Pile is rejected, including a sample letters.
- v. BCM 130-11, *Simple Repair of CIDH Piling.*
- vi. BCM 130-12, *Mitigation of CIDH Piling.*
- vii. BCM 130-13, *CIDH Pile Information Submittal.*
- viii. BCM 130-14, *Slurry Test Kits For CIDH Piling.*
  - Information to obtain a Slurry Test Kit, general equipment and testing information.
- ix. BCM 130-15, *Approved Synthetic Drilling Slurries.*
- x. BCM 130-20, *CIDH Pile Preconstruction Meeting.*
- xi. BCM 130-21, *CIDH Pile Non-Standard Mitigation Meeting.*

**C. Geotechnical Services:**

- i. Caltrans Soil and Rock Logging, Classification, and Presentation Manual
  - Assists in interpreting the information in the *Log of Test Borings* and communicating with Geotechnical Services.

**D. Other:**

- i. The International Association of Foundation Drilling (ADSC-IAFD)<sup>8</sup>
  - Drilled Shaft Inspection Manual and other technical references.
- ii. FHWA:
  - Drilled Shafts: Construction Procedures and Design Methods.<sup>9</sup>

**II. Sources of Project Specific Information**

**A. Structures RE Pending File:**

- i. Designers Notes.
- ii. Bidders Questions.

<sup>8</sup> [www.adsc-iafd.com](http://www.adsc-iafd.com)

<sup>9</sup> [www.fhwa.dot.gov/engineering/geotech/library\\_listing.cfm](http://www.fhwa.dot.gov/engineering/geotech/library_listing.cfm)



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- B. Supplemental Project Information
- i. Foundation Report.
    - Provides recommendations on construction methods.
  - ii. Local, Regional, State, and Federal regulatory and permit specific requirements.

**III. Contractual Requirements**

- A. Special Provisions:
- B. Contract Plans:
- i. General Plan.
    - General layout and typical section.
  - ii. Index To Plans
    - Provides reinforced concrete strength and type limits.
    - Pile Data Table showing pile type (size), cut off elevation, specified tip elevation and nominal resistance.
  - iii. Foundation Plan.
    - Provides bottom of footing elevations and centerline bearing and stationing at abutments and bents.
  - iv. Abutment Layout.
    - Provides dimensions for pile layout with respect to centerline bearing of abutments and edge of footing.
  - v. CIDH Pile Details.
    - Provides reinforcement details and embedment length of column cage for Type II CIDH Piles.
  - vi. Log of Test Borings (LOTB).
    - Review *LOTB* with respect to CIDH Pile locations. Note where the groundwater elevation is and types of soil. Also note the time of year groundwater elevations were observed. Use when reviewing the Contractors Pile Installation Plan to ensure method is appropriate. Note that Contractors may contact the Transportation Laboratory to request viewing of the rock cores collected during the geotechnical investigation.
- C. Standard Specifications:
- i. Jobsite and Document Examination.<sup>10</sup>
    - The bidder is responsible to review the site of work, contract documents, and has access to Caltrans investigations of the site conditions including subsurface conditions in areas where work is to be performed.
    - This also includes prior construction project records within the project limits that have been used by or known to designers and administrators of the project.

<sup>10</sup> 2010 SS, Section 2-1.30, *Job Site and Document Examination*, or 2006 SS, Section 2-1.03, *Examination of Plans, Specifications, Contract, and Site of Work*.



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- ii. Water Pollution Control.<sup>11</sup>
- iii. Environmental Stewardship.<sup>12</sup>
- iv. Cast-In-Place Concrete Piles.<sup>13</sup>

**IV. Job Books Setup**

A. Category 12 – Contractor’s Submittals:

- i. CIDH Pile installation plan.

B. Category 41 – Report of Inspection of Material:

- i. Orange tags for the welded hoops and attach to TL-29.

C. Category 43 – Concrete and Reinforcing Steel:

- i. Mix design, certified test data, trial batch report and authorization letter sent to Contractor.

**V. Preconstruction Discussion with Design & Geotechnical Services**

A. Contact Structures Design and Geotechnical Services:

- i. Structures Design contacts:
  - Special provisions – at the beginning look for the RCE Stamp.
  - Contract plans – Engineer of Record is on the plans.
- ii. Geotechnical Services Contact:
  - Contact information is located in the *Foundation Report*.

B. Establish a relationship with Structures Design and Geotechnical Services:

- i. Structures Design:
  - Discuss the spacing of the reinforcement; if inspection pipes are required verify the clearances between inspection pipes and reinforcement meet the contract requirements for acceptance testing.
  - Discuss if Cal/OSHA Mining and Tunneling requirements apply:
    - If the CIDH Pile design provides for a construction joint at a depth greater than 20 feet, District and Structures Design should have coordinated to obtain a gaseous classification prior to PS&E.
    - If the Contractor plans to enter the shaft in a location greater than 20 feet in depth the shaft must have a gaseous classification and Cal/OSHA Mining and Tunneling requirements shall be adhered to.
    - If you have the above conditions and you do not have a gaseous classification, contact the Resident Engineer, the District Designer, and Structures Designer to obtain one.

<sup>11</sup> 2010 SS, Section 13, *Water Pollution Control*, Special Provisions for contracts using 2006 SS.

<sup>12</sup> 2010 SS, Section 14, *Environmental Stewardship*, or Special Provisions for contracts using 2006 SS.

<sup>13</sup> 2010 SS, Section 49-3, *Cast-in-Place Concrete Piling*, or 2006 SS, Section 49-4, *Cast-in-Place Concrete Piling*.



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- ii. Geotechnical Services:
  - Performed the foundation investigation, wrote the Foundation Report and developed the *LOTB*.
  - Should discuss the manner in which the pile was designed to transfer load (compressive, tensile and lateral) by end bearing or skin friction, most piles use skin friction.
  - Verify if slurry application is appropriate for your job specific geology or groundwater situation.
  - Discuss potential problem areas and risk in detail.
  - Discuss expected construction methods and tooling.

**VI. Preconstruction Meeting with the Contractor**

- A. Remind the Contractor of their responsibilities to submit a CIDH Pile installation plan per the requirements of the contract specifications and in a timely manner to allow sufficient time for review, comment and authorization by the Structure Representative.
- B. Discuss any “alternative” procedures the Contractor might propose. These are especially common when groundwater is present and the Contractor wants to avoid the “wet hole” requirements, i.e., overdrill shaft diameter, sand slurry backfill, and redrill to planned diameter.

**VII. Review of the CIDH Pile Installation Plan**

- A. Requirements to be included for all CIDH Pile installation plans:
  - i. Concrete mix design, certified test data, and trial batch reports.
  - ii. Drilling or coring methods and equipment.
    - Verify the proposed equipment is appropriate per the data provided in the *Log of Test Borings*.
    - Methods, equipment, and locations for stockpiling spoils prior to off-hauling.
    - Methods and equipment for containment, collection, removal, and disposal of groundwater.
  - iii. Proposed method for casing installation and removal when necessary.
  - iv. Methods for placing, positioning, and supporting bar reinforcement.
    - Review that the Contractor’s plans to assemble and install the pile reinforcement are appropriate.
    - Plan view drawing of pile showing reinforcement and inspection pipes, if required.
      - Verify that the number of inspection pipes and clearances between the pipes and reinforcement meet the contract requirements.



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- v. Methods and equipment for accurately determining the depth of concrete and actual and theoretical volume placed, including effects on volume of concrete when any casings are withdrawn.
- vi. Methods and equipment for verifying that the bottom of the drilled hole is clean prior to placing concrete.
- vii. Methods and equipment for preventing upward movement of reinforcement, including the Contractor's means of detecting and measuring upward movement during concrete placement operations.

**B. Additional requirements when concrete is placed under slurry:**

- i. Concrete batching, delivery, and placing systems, including time schedules and capacities. Time schedules shall include the time required for each concrete placing operation at each pile.
  - Procedure for re-inserting the concrete placement tube into the concrete if the tube is withdrawn and the 'seal' is broken during the pour. Note the contract specifications require an End Cap and do not mention using the moveable plug or 'pig'.
- ii. Concrete placing rate calculations. When requested by the Engineer, calculations shall be based on the initial pump pressures or static head on the concrete and losses throughout the placing system, including anticipated head of slurry and concrete to be displaced.
  - This is especially important for large deep piles to verify whether the proposed concrete delivery system has enough pressure to displace the anticipated head of slurry and placed concrete.
- iii. Suppliers' test reports on the physical and chemical properties of the slurry and any proposed slurry chemical additives, including Material Safety Data Sheet.
  - Verify slurry application is appropriate for your job specific geology or groundwater situation.
  - Verify Contractor's proposed slurry is Caltrans approved and is appropriate for the field conditions.
  - Review Contractors submitted Material Safety Data Sheets (MSDS) for all proposed drilling slurries and chemical additives.
- iv. Slurry testing equipment and procedures.
  - Refer to BCM 130-14.0, *Slurry Displacement*, for testing equipment and procedures.
- v. Methods of containment, collection, removal and disposal of slurry, and contaminated concrete, including removal rates.
  - Slurries should be disposed of in accordance with the contract specifications.<sup>14</sup>
- vi. Methods and equipment for slurry agitating, recirculating, and cleaning.

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<sup>14</sup> 2010 SS, Section 5-1.20B(4), *Contractor-Property Owner Agreement*, or 2006 SS, Section 7-1.13, *Disposal of Material Outside the Highway Right of Way*.



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**VIII. CIDH Pile Preconstruction Meeting (BCM 130-20.0)**

- A. Hold this preconstruction meeting within 5 days of receipt of the Contractor's Pile installation plan.
- B. Refer to BCM 130-20.0, *CIDH Pile Preconstruction Meeting*, for meeting agenda and topics to be discussed with the Contractor.
- C. Additional items to discuss:
  - i. Request the plan view of inspection pipes and reinforcement includes the location of the centralizers for Type II CIDH Pile designs.
    - This can prevent a false positive anomaly reading during testing.
  - ii. Procedure to prevent unintentional drop in slurry head during removal of Kelly Bar and drill tool.

**IX. Prior to Construction**

- A. BCM 130-9.0 CIDH Pile Installation Plan and Concrete Test Batch:
  - i. Notify the Contractor in writing whether the CIDH Pile installation plan is authorized or rejected.
  - ii. When depositing concrete under slurry a test batch is required.
  - iii. The Contractor shall submit CIDH Pile installation plan prior to producing the test batch and at least 15 working days prior to constructing piling
  - iv. Caltrans inspector shall witness the Contractor's test batch.
  - v. Receive the test batch results and review for performance and consistency with CIDH Pile installation plan. If the performance does not match the pile installation plan, then reject the plan in writing.
  - vi. Revise until plan and the test batch results are consistent. If mix design changes, a new test batch is required.
  - vii. For CIDH Piles with inspection pipes send an authorized CIDH Pile installation plan and authorized mix design (with batch test results) to the CIDH Pile Mitigation Committee chairperson.
- B. Safety:
  - i. Review SC Code of Safe Practices and Construction Safety Orders that pertain to this work.
  - ii. For CIDH Piles over 20 feet in depth, 30 inches in diameter and there is potential human entry, Cal/OSHA Mining and Tunneling Safety Orders apply.
  - iii. Conduct a tailgate safety meeting prior to CIDH Pile construction. Be sure to discuss the contents of the MSDS and how to adhere to the safety precautions.



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**X. Construction**

**A. Prior to CIDH Pile Installation:**

- i. Survey
  - The Contractor should submit survey request at least 2 days prior to drilling.
  - Inspectors review survey notes and field verify the stakes placed.
- ii. Utilities
  - The Contractor shall identify existing underground and overhead utilities
- iii. General
  - Field inspectors shall have an authorized copy of the Pile installation plan and concrete mix design.
  - Inspector sampling concrete shall be certified in California Test Methods 518, 533, 539, 540, 556, and 557.
- iv. Reinforcement
  - Check pile cage reinforcement and get inspection release tags for the hoops
  - Check mechanical couplers for no-splice zones and record type and location of couplers in the as-built plans.
  - Check if pile cage bracing will allow tremie to be installed.
  - If inspection pipes are required, verify they are installed per the Contractor's authorized plan view drawing of the pile showing reinforcement and inspection pipe clearances.
  - If stray current provisions are required, verify they are installed per the contract documents.
- v. Equipment / Tooling
  - Document and photograph all equipment and tooling on the job site.
  - Verify the equipment and tooling per the Contractor's CIDH Pile installation plan are on-site (e.g., core barrel, cleanout bucket).
  - Check Crane and Operator's Certification are current. See CalOSHA Title 8, Subchapter 7, Group 13, Article 99 Sections 5021(a) and 5025, and Article 98 Section 5006.1.
  - If using slurry, verify the Contractor has the proper testing equipment and sampling device seal properly prior to construction.
  - Verify the Contractor has an 'end cap' for the concrete placement tube, as required by the contract specifications<sup>15</sup>, in the event the tube must be removed during the pour and re-inserted into the concrete.

**B. CIDH Pile Installation:**

- i. Drilling, dry hole
  - Requires 100% inspection.

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<sup>15</sup> 2010 SS, Section 49-3.02C(8), *Placing Concrete Under Slurry*, or Special Provisions for contracts using 2006 SS.





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- Each day keep a chronological timeline of the construction on the CIDH Pile and Concrete Placement Log form.
  - Log all materials as they are removed from the hole and check if it conforms to the *Log of Test Borings*.
  - Log all equipment/tooling changes (date, time, depth and type).
  - Verify depth of the hole prior to setting the reinforcement.
  - Verify that the bottom of the drilled hole is clean prior to setting the reinforcement and then again prior to concrete placement.
  - Note that dewatered holes are not classified as dry holes. If a hole has been dewatered without the use of temporary casing, the requirements for dry hole inspection may be utilized, but identify the hole as dewatered, not dry. For an uncased hole to be classified as dewatered, the unaided inflow (seepage) rate of water into the hole must be less than 12 inches per hour. Additionally, the hole must have less than 3 inches of standing water at the initiation of the concrete pour. For dewatered holes, note these values in the inspector logs.
- ii. Drilling – Wet Hole (In addition to the above section i)
- Verify approved slurry is being used and the Contractor conducts testing per the contract specifications.
  - Slurry manufacturer’s representative is required to be on site until released by the Engineer.
  - Monitor slurry level and maintain slurry level at least 10 feet above the groundwater surface / piezometric level.
  - The Contractor shall test slurry during drilling, prior to final cleaning, after final cleaning and prior to concrete placement. Compare versus contract requirements and record results; if using synthetic slurry, record the results on the *Synthetic Slurry Test Record* form.
- iii. Drilling – Temporarily Cased (In addition to the above section i, if dewatered. If slurry is used, also consider section ii.)
- Verify dimensions of the casing and its ability to fit within any permanent casing and fit the reinforcement cage within the temporary casing. Note any protrusions on the temporary casing.
  - If the casing is being used to facilitate drilling, verify with the Geoprofessional any detrimental effect the use of temporary casings may have on the geotechnical capacity of the pile. This is especially pertinent with rock sockets.
  - When a Contractor is excavating within temporary casing, check to see if the hole is advanced beyond the tip of the casing.
  - Consider the hydraulic balance of water outside the casing versus slurry and/or concrete head inside of the casing. Consider both during drilling and during concrete placement.
  - If the hole is dewatered using temporary casing, inspection pipes are still required.
- iv. Reinforcement/Inspection Pipes





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- Compare depth of drilled hole measured in the field versus measured length of CIDH reinforcement prior to setting reinforcement.
  - Verify the Contractor’s method for placing, positioning and supporting the reinforcement is per the authorized Pile installation plan.
  - Make sure the Contractor ties all PVC inspection pipes securely and the dobies are in place and secure per the authorized Pile Placement Plan.
  - Make sure the Contractor has logged the location of PVC couplers and any other non-uniformity within the rebar cage.
  - If Type II design with inspection pipes, verify the centralizers between CIDH Pile and Column reinforcement have sufficient clearance to the inspection pipes during GGL Testing.
- v. Concrete Placement – Dry Hole
- Check concrete ticket for authorized mix design.
  - Sample concrete for compressive strength per the contract specifications.
  - Concrete shall not be permitted to fall from a height greater than 8 feet without the use of adjustable length pipes or tubes unless the flow is directed into the center of the hole using a hopper and not allowed to strike the reinforcement or reinforcement bracing.
- vi. Concrete Placement – Wet Hole
- Check concrete ticket for authorized mix design.
  - Sample concrete for compressive strength per the contract specifications.
  - Verify that a stand-by pump is on site.
  - Verify Contractor is prepared to record a log of concrete placement.
  - Monitor slurry level and maintain slurry level at least 10 feet above the groundwater surface/piezometric level.
  - Inspect the tremie tube for a backflow prevention device (PIG) to prevent slurry from entering the tube.
  - Until at least 10 feet of concrete has been placed, the tip of the tremie shall be within 6 inches of the bottom of the drilled hole, and then the embedment of the tremie shall be maintained at least 10 feet below top of concrete.
- Concrete should be placed well past the top of pile to prevent slurry contaminated concrete at the top of the pile.
- C. Testing:
- i. Pretest Verification
- The Contractor checks accessibility of the inspection pipes by passing a rigid test probe 1.25 inches in diameter and 4.5 feet long through the entire length of all inspection pipes. Witness the entire probe check of the inspection pipes. Record results on the GGL Inspection Tube Verification form.
  - If test probe fails to pass through an inspection pipe, contact the FTB immediately.



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- The inspection pipes must be completely dry or completely filled with water at the time of testing. Notify FTB in advance whether the inspection pipes are wet or dry so they can calibrate the test probe accordingly.
- ii. Acceptance Test Request
  - Fill out the *CIDH Pile Acceptance Test Request Form*<sup>16</sup> and submit to the FTB.
  - Coordinate with the Contractor that no work will be performed within 25 feet of FTB personnel during gamma-gamma logging.
  - Send to the FTB the pile survey data, coupler logs and concrete placement logs.
- iii. Pile Acceptance or Rejection
  - Send a letter to the Contractor either accepting or rejecting a pile based on the FTB recommendation (See Attachment 1 of BCM 130-10.0, *Testing of CIDH Piling*, for sample letter).
  - Complete payment for accepted piling. Do not pay for rejected piling and continue with the following steps.

**XI. Pile Mitigation Plan**

A. Suspend pile construction:

- i. Contractor submits revised pile installation plan to correct methods that resulted in anomalies.
- ii. Review revised pile installation plan.
- iii. Notify the Contractor when the revised pile installation plan is authorized and slurry work can resume.

B. Simple Repair:

- i. If the anomaly within the rejected pile is candidate for a “simple repair” as defined in BCM 130-11.0, *Simple Repair of CIDH Piling*; follow mitigation procedures presented in BCM 130-11.0.

C. Pile Design Data Form:

- i. Consult with the Designer, the Geoprofessional, and the corrosion specialist and complete the *Pile Design Data Form* (PDDF) included in the FTB test report.
- ii. Determine whether the rejected pile requires repair and if so, the feasibility of repairing the rejected pile.
- iii. Send a copy of the completed PDDF to the members in the CIDH Pile Mitigation Committee (refer to BCM 130-8.0, *CIDH Pile Mitigation Committee*) and allow 2 working days for a cursory check.
- iv. If the rejected pile does not require repair (consensus with the CIDH Pile Mitigation Committee is required) the Contractor can make these repairs for

<sup>16</sup> [http://www.dot.ca.gov/hq/esc/geotech/client\\_requests/reqts.html](http://www.dot.ca.gov/hq/esc/geotech/client_requests/reqts.html)



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- full payment or forgo repairs and accept an administrative deduction per the contract specifications<sup>17</sup>.
- v. Unless otherwise stated in the contract specifications, the Engineer has 30 days to determine whether the pile requires mitigation and provide information to the Contractor. Day 1 of the 30 days shall be the first day after access has been provided to the Engineer to perform acceptance testing. If the Engineer acquires additional information that modifies the size, shape, or nature of the anomaly, the Contractor shall allow 20 additional days for the subsequent analysis.
  - vi. Should the Engineer determine non-standard mitigation is required, skip to Step (E).
- D. Standard Mitigation Plan (BCM 130-12.0, *Mitigation of CIDH Piling*):
- If the anomaly can be mitigated by basic repair or pressure grouting, refer to CT/ADSC Standard CIDH Pile Mitigation Plan. The most recent version of the plan is available at the FTB website: <http://www.dot.ca.gov/hq/esc/geotech/ft/adscmitplan.htm>
  - ii. Send an appropriate letter and information to the Contractor (refer to Attachments 3 & 4 of BCM 130-10.0, *Testing of CIDH Piling*, for sample letters).
- E. Non-Standard Mitigation Meeting (BCM 130-21.0, *CIDH Pile Non-Standard Mitigation Meeting*):
- i. In accordance with BCM 130-21.0, conduct meeting with the Contractor and discuss the following:
    - Pile replacement (if necessary).
    - Pile supplementation (if necessary).
    - Structural bridging (if appropriate).
  - ii. Following the meeting, send an appropriate letter and information to the Contractor (refer to Attachments 3 & 4 of BCM 130-10.0, *Testing of CIDH Piling*, for sample letters).
- F. Pile Mitigation Plan:
- i. Contractor submits Pile mitigation plan. The plan should include the following, subject to the requirements of the contract specifications:
    - The designation and location of the pile addressed by the mitigation plan.
    - A review of the structural, geotechnical, and corrosion design requirements of the rejected pile.
    - A step-by-step description of the mitigation work to be performed, including drawings if necessary.
    - An assessment of how the proposed mitigation work will address the structural, geotechnical, and corrosion design requirements of the rejected pile.

<sup>17</sup> 2010 SS, Section 49-3.02A(4)(d)(iv), *Rejected Piles*, or Special Provisions for contracts using 2006 SS.



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- Methods for preservation or restoration of existing earthen materials.
  - A list of affected facilities, if any, with methods and equipment for protection of these facilities during mitigation.
  - The Caltrans contract number, bridge number, full name of the structure as shown on the contract plans, and the Contractor's (and subcontractor's if applicable) name on each sheet.
  - A list of materials with quantity estimates and personnel, with qualifications, to be used to perform the mitigation work.
  - The seal and signature of an engineer who is licensed as a Civil Engineer by the State of California. This requirement is waived for Plan 'A' (Basic Repair) of CT/ADSC Standard CIDH Pile Mitigation Plan. It is also waived for Plan 'B' (Grouting Repair) of the Standard Pile Mitigation Plan if the Engineer has determined that the pile does not require mitigation and the Contractor elects to repair the pile.
- ii. For rejected piles to be repaired, the Contractor shall submit a Pile Mitigation Plan that contains the following additional information:
- An assessment of the nature and size of the anomalies in the rejected pile.
  - Provisions for access for additional pile testing if required by the Engineer.
- iii. For rejected piles to be replaced or supplemented, the Contractor shall submit a Pile mitigation plan that contains the following additional information:
- The proposed location and size of additional piling.
  - Structural details and calculations for any modification to the structure to accommodate the replacement or supplemental piling.
- iv. Unless otherwise stated in the contract specifications, the Engineer has 15 days to review the Pile mitigation plan after complete submittal has been received.
- Directly review the Pile mitigation plan if it is for simple repairs.
  - Coordinate review with CIDH Pile Mitigation Committee for non-simple mitigation by sending a copy of the proposed Pile mitigation plan to FTB and the CIDH Pile Mitigation Committee Chairperson.
  - Get consensus with CIDH Pile Mitigation Committee.
  - Review and respond to the Contractor until the plan can be authorized.

**XII. Pile Mitigation Work and Acceptance**

- A. Contractor performs pile mitigation work in conformance with the authorized Pile mitigation plan.
- B. For piles that are repaired, the Contractor submits a Mitigation report within 10 days of completion of repair.
- i. The Engineer reviews the Mitigation report to verify the work performed is in conformance with the work described in the Pile mitigation plan.



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- Send a copy of the Mitigation report to the CIDH Pile Mitigation Committee and reach a consensus of how to proceed.
  - Retest the mitigated pile if required in the Pile mitigation plan.
  - Accept the mitigated pile if consensus is reached with the CIDH Pile Mitigation Committee.
  - Require additional pile mitigation if that consensus is reached with the CIDH Pile Mitigation Committee.
- C. For piles that are supplemented or replaced, proceed with acceptance testing of the supplemental or replacement piling.
  - i. Mitigate or accept supplemental or replacement piling based on the acceptance test results.

**XIII. Complete Payment**

- A. The Contractor shall provide a written request for an Administrative Deduction as described in the contract specifications<sup>18</sup> in lieu of repairing anomalies that do not require mitigation.
- B. Payment is made for piles described in the contract documents or as modified by CCO. Do not pay for supplemental or replacement piling.

**XIV. Project Completion / As-Builts**

- A. On As-Built plans show:
  - i. CIDH Pile tip elevation.
  - ii. Type and location of couplers.
  - iii. The percent of mineral admixture on the “Concrete Strength and Type Limits” per BCM 9-1.0, *As-Built Plans* (add a separate line for CIDH piles).
- B. CIDH Pile Information form (BCM 130-13.0, *CIDH Pile Information Submittal*):
  - i. Required for all CIDH piles when acceptance testing is performed.
    - When all CIDH Piles are complete for a given contract, complete one “CIDH Pile Information” form, include all of the CIDH Piles final results and submit to the CIDH Pile Mitigation Committee Chairperson.
- C. Send all project completion records and As-Builts to the appropriate SC Office Associate at the following address.

<sup>18</sup> 2010 SS, Section 49-3.02A(4)(d)(iv) or Special Provisions for contracts using 2006 SS.



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**Division of Engineering Services  
Structure Construction  
1801 30<sup>th</sup> Street, M.S. 9-2/11H  
Sacramento, CA 95816  
Email: SC Office Associates@DOT**

**XV. Forms**

- A. Refer to the SC Intranet, BCRP Manual Section 16 for various updated forms relating to CIDH Pile construction:
- i. [http://onramp.dot.ca.gov/hq/oscnet/sc\\_manuals/crp/vol\\_1/crp016.htm](http://onramp.dot.ca.gov/hq/oscnet/sc_manuals/crp/vol_1/crp016.htm)
  - ii. CIDH Drilling & Concrete Placement Form OSC-CIDH01<sup>19</sup>
  - iii. Synthetic Slurry Test Record Form OSC-SLR01<sup>20</sup>
  - iv. GGL Inspection Tube Verification Form OSC-GGL<sup>21</sup>

<sup>19</sup> BCM 130-20.0, Attachment 1.3, [http://onramp.dot.ca.gov/hq/oscnet/sc\\_manuals/crp/vol\\_2/crp130.htm](http://onramp.dot.ca.gov/hq/oscnet/sc_manuals/crp/vol_2/crp130.htm)

<sup>20</sup> BCM 130-20.0, Attachment 1.4, [http://onramp.dot.ca.gov/hq/oscnet/sc\\_manuals/crp/vol\\_2/crp130.htm](http://onramp.dot.ca.gov/hq/oscnet/sc_manuals/crp/vol_2/crp130.htm)

<sup>21</sup> BCM 130-20.0, Attachment 1.6, [http://onramp.dot.ca.gov/hq/oscnet/sc\\_manuals/crp/vol\\_2/crp130.htm](http://onramp.dot.ca.gov/hq/oscnet/sc_manuals/crp/vol_2/crp130.htm)



### **K3. Cofferdam and Seal Course Construction Checklist**

#### **General Overview**

In conjunction with Chapter 12, *Cofferdam and Seal Courses*, a construction checklist for Cofferdam and Seal Course construction has been developed to assist field personnel in preparing documents and inspecting fieldwork to ensure compliance with contract requirements. It is important for Structure Representatives to review the contract plans and specifications, meet and go over them with Caltrans staff, conduct preconstruction meetings with the Contractor to lay out procedures, identify field problems, and other issues.

The Contractor shall comply with the *CalOSHA Construction Safety Orders* and the authorized *Storm Water Pollution Prevention Plan* to reduce potential impacts to the project area.

Structure Representatives are encouraged to employ the following checklist for Cofferdam or Seal Course installations. Contact Structure Construction (SC) Earth Retaining Systems Technical Committee member listed on the SC website for additional assistance.

#### **I. Sources of Technical Information**

A. Foundation Manual:

- i. Chapter 12, *Cofferdams and Seal Courses*, and Appendix I, *Cofferdams and Seal Courses*.

B. Bridge Construction Records and Procedures Manual:

- i. BCM 2-9.0, *Footing and Seal Course Revisions*.
- ii. BCM 9-1.0, *As-Built Plans*.
- iii. BCM 122-1.0, *Submitting Shoring Plans*.
- iv. BCM 130-22.0, *Seal Courses*.

C. Bridge Design Aids:

- i. Sections 2.6 and 2.7, 11-46 and 11-53.

D. Bridge Design Details:

- i. Section 7-20.1, Footings w/ Seal Course.

#### **II. Sources of Project Specific Information**

A. Structures Pending File:

- i. Designers Notes.



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- ii. Engineers Estimate.

**B. Supplemental Project Information:**

- i. *Foundation Report(s)*
- ii. Review regulatory agency permit requirements:
  - Department of Fish and Game, Regional Water Quality Board.
  - Army Corps of Engineers, Forest Service, Flood Control District.

**III. Contractual Requirements**

**A. Special Provisions**

**B. Contract Plans**

**C. Standard Specifications**

- i. Job Site and Document Examination<sup>22</sup>
- ii. Submittals<sup>23</sup>
- iii. *Legal Relations and Responsibility to the Public* (SS, Section 7)
- iv. Water Pollution Control<sup>24</sup>
- v. Environmental Stewardship<sup>25</sup>
- vi. Structure Excavation and Backfill (SS, Section 19-3)
- vii. Cofferdams<sup>26</sup>
- viii. Water Control and Foundation Treatment<sup>27</sup>
- ix. Concrete Placed Under Water<sup>28</sup>

**IV. Job Books Setup**

**A. Contractor's Submittals:**

- i. Seal Course/Cofferdam working drawings (Category 12).
- ii. Earthwork submittal, concrete mix design (Category 37).
- iii. SWPPP, dewatering plan, water treatment (Category 20).

**B. Water Quality Testing Results, (Category 20).**

**C. Contractor's Code of Safe Practice (Category 6).**

<sup>22</sup> 2010 SS, Section 2-1.30, *Job Site and Document Examination*, or 2006 SS, Section 2-1.03, *Examination of Plans, Specifications, Contract, and Site of Work*.

<sup>23</sup> 2010 SS, Section 5-1.23, *Submittals* or 2006 SS, Section 5-1.02, *Plans and Working Drawings*.

<sup>24</sup> 2010 SS, Section 13, *Water Pollution Control*, Special Provisions for contracts using 2006 SS.

<sup>25</sup> 2010 SS, Section 14, *Environmental Stewardship*, or Special Provisions for contracts using 2006 SS.

<sup>26</sup> 2010 SS, Sections 19-3.01A(2)(b), *Cofferdams & 19-3.03B(4)*, or 2006 SS, Section 19-3.03, *Cofferdams*.

<sup>27</sup> 2010 SS, Section 19-3.03D, *Water Control and Foundation Treatment*, or 2006 SS, Section 19-3.04, *Water Control and Foundation Treatment*.

<sup>28</sup> 2010 SS, Section 51-1.03D(3), *Concrete Placed Under Water*, or 2006 SS, Section 51-1.10, *Concrete Deposited Under Water*.





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**V. Preconstruction Discussion with Design & Geotechnical Services**

- A. Review the *Foundation Report(s)*, *Log of Test Borings*, As Built Plans, and Supplemental Project Information for information regarding soil conditions.
- B. Discuss geotechnical design issues relative to cofferdam construction with the Geoprofessional and the Designer.

**VI. Preconstruction Meeting with the Contractor**

- A. Discuss proposed construction methods for cofferdam and seal course with the Contractor.
- B. Remind the Contractor of his responsibility to submit cofferdam shoring drawings, earthwork/excavation plan, notice of material sources and concrete mix designs.
- C. Discuss the excavated material requirements and the necessity of water testing.
- D. Discuss the locations of survey stakes and elevation control points to be provided by surveys for the Contractor.
- E. Clarify that cofferdam plans and methods comply with local agency or permit procedures.
- F. Review proposed cofferdam shoring plans and construction methods, review seal course concrete placement procedures.
- G. Discuss the excavated material requirements and need for water testing.

**VII. Submittal Reviews**

- A. Cofferdam Shoring Construction and work sequencing:
  - i. Review shoring design according to excavation shoring/falsework requirements
- B. Contractor's Water Pollution Control and Dewatering Plan:
  - i. Review water discharge and testing according to local agency requirements.

**VIII. Construction**

- A. Inspection, Cofferdam:
  - i. During the sheet pile shoring installation work, verify the details of the shoring plan are complied with and are consistent with the authorized plans.



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- ii. Ensure that the submitted Earthwork/Excavation plan working drawing proposes a realistic and detailed construction sequence that includes measures to ensure shoring and foundation stability, during all stages of excavation.
- iii. Ensure the Contractor's ability to maintain the correct pile placement. Template or survey control references should be easy for the Contractor and inspector to verify. Vertical control references are necessary to measure and determine pile lengths and pile cut off elevations.
- iv. During foundation pile installation, ensure that stable excavation conditions are being maintained. Periodic checks for verification of bottom of footing elevation or bottom of seal course elevation are important to control soil loss or accumulation within the footing, due to dewatering activities and piping conditions or movement of the soil mass between the cofferdam sheet pile tips and the bottom of excavation. Changes to excavated depth should be investigated immediately to determine the cause. Dewatering prior to placement of the seal course should be kept to the minimum necessary for construction and to limit soil movement caused by pumping.
- v. At the conclusion of pile driving, determine if the bottom of excavation elevation has been maintained. Changes to excavated depth will need to be corrected by additional excavation or fill to match plan grades.

**B. Inspection, Seal Course Concrete:**

- i. Placement of concrete for the seal course should adhere to the details as specified in the contract specifications<sup>29</sup>.
- ii. Every effort should be made to achieve a monolithic slab.
- iii. Consistency of the seal course concrete requires a slump of 6 to 8 inches (ASTM C143), per the contract specifications<sup>30</sup>.
- iv. Cure period for seal course concrete should be a minimum of 5 days, dependant on air temperature, per the contract specifications<sup>31</sup>.
- v. The Contractor's dewatering shall be in accordance with the process specified in the authorized Water Pollution Control Plan, Dewatering Plan and local water quality agency standards. Verify the methods to determine water quality and characteristics prior to discharge are being used and water quality is within allowable limits.
- vi. The seepage of water through the cofferdam should be limited by sealing joints and gaps in shoring material. The top surface of the seal course should be prepared to achieve a level and sound surface, at the plan specified bottom of footing elevation.

<sup>29</sup> 2010 SS, Section 51-1.03D(3), *Concrete Placed Under Water*, or 2006 SS, Section 51-1.10, *Concrete Deposited Under Water*.

<sup>30</sup> 2010 SS, Section 90-1.02G(6), *Quantity of Water and Penetration or Slump*, or 2006 SS, Section 90-6.06, *Amount of Water and Penetration*.

<sup>31</sup> 2010 SS, Section 51-1.03D(3), *Concrete Placed Under Water*, or 2006 SS, Section 51-1.10, *Concrete Deposited Under Water*.



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C. Safety:

- i. Reference California Code of Regulations, Construction Safety Orders, Article 6, *Excavations*.
- ii. Reference SC Code of Safe Practices XVII, *Project Specific Requirements – Confined Spaces*.
- iii. Verify the constructed cofferdam has the necessary means for proper access and egress, as shown in the Contractor’s shoring submittal. The contract specifications<sup>32</sup> require SAFE work site access.
- iv. The Construction Safety Orders requires posting of warning signs for evacuation. Ensure that all workers have the requisite training to comply with CalOSHA guidelines.
- v. Make certain that railing, tie off devices, ladders and safety equipment is functional and is being used by work area employees.
- vi. If over topping by high water is possible, means shall be provided for controlled flooding of the work area. Sump pumps, well points etc.
- vii. Cofferdams in a navigable shipping channel shall be designed to be protected from vessels in transit.

**IX. Project Completion / As-Builts**

- A. On the General Plan sheet, indicate horizontal dimensions and bottom elevation of seal courses. If the seal course is omitted at any particular location, it should be noted on the general plan sheet. Reference BCM 9-1.0, *As-Built Plans*, and BCM 130-22.0, *Seal Courses*.
- B. Note any unusual conditions encountered and the corrective methods taken for specific locations for future consideration. Reference BCM 9-4.0, *Report of Completion of Structures*.
- C. Send all project completion records and As-Builts to the appropriate Office Associate at the following address.

**Division of Engineering Services  
Structure Construction  
1801 30<sup>th</sup> Street, M.S. 9-2/11H  
Sacramento, CA 95816  
Email: SC Office Associates@DOT**

<sup>32</sup> 2010 SS, Section 5-1.01, *Control of Work, General*, or 2006 SS, Section 5-1.08, *Inspection*.



## **K4. Footing Foundation Construction Checklist**

### **General Overview**

In conjunction with Chapter 4, *Footing Foundations*, a construction checklist for Footing Foundation construction has been developed to assist field personnel in preparing documents and inspecting fieldwork to ensure compliance with contract requirements. It is important for Structure Representatives to review the contract plans and specifications, meet and go over them with Caltrans staff, conduct preconstruction meetings with the Contractor to lay out procedures, identify field problems, and other issues.

Footing foundations, also known as spread, combined or mat footings, transmit design loads into the underlying soil mass through direct contact with the soil immediately beneath the footing.

Each individual footing foundation must be sized so that the maximum soil bearing pressure does not exceed the allowable soil bearing capacity of the underlying soil mass. In addition to bearing capacity consideration, footing settlement must also be considered and must not exceed tolerable limits established for differential and total settlement. Each footing foundation must also be structurally capable of spreading design loads laterally over the entire footing area.

Footing foundations can be classified into two general categories: (1) footings that support a single structural member; frequently referred to as “spread footings” and (2) footings that support two or more structural members; referred to as “combined footings”. Footing foundations encountered in bridge construction almost always support a single structural member (abutment, column, pier or wall) and are invariably referred to as spread footings.

The following checklist is intended to serve as a stand-alone reference related solely for the spread footings construction process. If a problem or situation is encountered that is not addressed by this checklist, you are encouraged to contact your Senior Bridge Engineer, the SC Substructure Technical Team or Division of Engineering Services (DES) Substructure Technical Committee.

### **I. Sources of Technical Information**

- A. Bridge Construction Record and Procedures Manual:
- i. BCM 2-2.0, *Pre-Job Discussion with Design, Architecture and Geology*.
    - General information on the need of preconstruction discussion with all designers to clear up any problem areas prior to start of construction.
  - ii. BCM 2-9.0, *Footing and Seal Course Revisions*.
    - Directs the Structure Representative to write a letter to the Contractor, prior to start of foundation excavation, to eliminate possible



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misunderstanding about field revision of the elevation of spread footings and the revision or elimination of the seal course.

B. Foundation Manual:

- i. Chapter 1, *Foundation Investigations*.
  - Provides information to interpret and effectively use the *Foundation Report* and *Log of Test Borings* during the administration of the project.
- ii. Chapter 2, *Type Selection* .
  - Provides general overview of suitability of the different types of foundations including footing foundations.
- iii. Chapter 3, *Contract Administration*.
  - Guidance on the key actions required by the Engineer to ensure completion of the contract in accordance with all terms of the contract.
- iv. Chapter 4, *Footing Foundations*.
  - Covers various aspects of footing foundation construction including types, bearing capacity, settlement, construction inspection, safety and problems and solutions.

C. Outline of Field Construction Practice:

- i. Chapters 1, 2, 3, 6, 8 & 10 provide simple and brief description of the key field duties required during construction of footing foundation.

D. Caltrans Soil and Rock Logging, Classification, and Presentation Manual:

- i. Assists in interpreting the information in the *Log of Test Borings* and communication with Geotechnical Services.

E. Construction Manual:

- i. Chapter 3, *General Provisions*.
  - Section 3-5, *Control of Work*.
  - Section 3-6, *Control of Material*.
  - Section 3-404, *Differing Site Conditions*.
- ii. Chapter 4, *Construction Details*.
  - Section 4-51, *Concrete Structures*.
  - Section 4-52, *Reinforcement*.
  - Section 4-90, *Concrete*.
- iii. Chapter 5, *Contract Administration*.
  - Section 5-1, *Project Records and Reports*.
  - Section 5-3, *Change Orders*.
- iv. Chapter 6, *Sampling and Testing*.
  - Section 6-3, *Field Tests*.

F. Bridge Memo to Designer:

- i. Section 4, *Footings*:



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- Clarifies terms and design methodology for spread footing and spread footing data table.

**II. Source of Project Specific Information**

A. Structures RE Pending File:

- i. Designers notes.
- ii. Bidder inquiries.
- iii. As Builts.
- iv. Constructability review comments from the Designer.
- v. Preliminary report.

B. Supplemental Project Information:

- i. *Foundation Report*
  - Review Spread Footing Data Table and compare with the one shown on the contract plans.
  - Note any comments concerning anticipated constructability problems.
  - Verify that Foundation report comments regarding specifications or construction issues are incorporated into the contract documents.
- ii. Local, Regional, State, and Federal regulatory and permit specific requirements.

**III. Contractual Requirements**

A. Special Provisions:

B. Contract Plans:

- i. General Plan:
  - General layout and typical section.
- ii. Index To Plans:
  - Provides the spread footing data table and reinforced concrete strength requirements.
- iii. Foundation Plan:
  - Provides the spread footing location and bottom elevation.
- iv. Abutment Details:
  - Provides footing dimensions and reinforcement details.
- v. Bent Details:
  - Provides footing dimensions and reinforcement details.
- vi. Log of Test Borings (*LOTB*):
  - Review *LOTB* with respect to spread footing location and elevation. Note groundwater elevations if applicable and date/season elevations were measured.

C. Standard Specifications:



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- i. Job Site and Document Examination.<sup>33</sup>
  - The bidder is responsible to review the site of work, contract documents, and has access to Caltrans investigations of the site conditions including subsurface conditions in areas where work is to be performed.
  - This also includes prior construction project records within the project limits that have been used by or known to designers and administrators of the project.
- ii. Water Pollution Control.<sup>34</sup>
- iii. Environmental Stewardship.<sup>35</sup>
- iv. Earthwork:
  - Unsuitable Material.<sup>36</sup>
  - Water Control and Foundation Treatment.<sup>37</sup>
  - Structure Backfill.<sup>38</sup>
  - Payment.<sup>39</sup>
  - Compaction.<sup>40</sup>
  - Embankment Construction.<sup>41</sup>
  - Settlement Period.<sup>42</sup>
- v. Concrete Structures:
  - Depth of Footing.<sup>43</sup>
  - Pumping.<sup>44</sup>
  - Placing Concrete.<sup>45</sup>
- vi. Reinforcement (SS, Section 52, *Reinforcement*).
- vii. Concrete (SS, Section 90, *Concrete*).

**IV. Job Books Setup**

A. Category 6 – Safety.

B. Category 11 - Information Furnished at Start of Project:

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<sup>33</sup> 2010 SS, Section 2-1.30, *Jobsite and Document Examination*, or 2006 SS, Section 2-1.03, *Examination of Plans, Specification, Contract, and Site of Work*.

<sup>34</sup> 2010 SS, Section 13, *Water Pollution Control*, or 2006 Special Provisions.

<sup>35</sup> 2010 SS, Section 14, *Environmental Stewardship*, or 2006 Special Provisions.

<sup>36</sup> 2010 SS, Sections 19-1.01B, *Earthwork, Definitions & 19-1.03B, Unsuitable Material*, or 2006 SS, Section 19-2.02, *Unsuitable Material*.

<sup>37</sup> Standard Special Provisions (SSP), Section 49-5.01C(3), *Shop Drawings and Calculations*, or 2006 SS, Section 19-3.04, *Water Control and Foundation Treatment*.

<sup>38</sup> 2010 SS, Section 19-3.03E, *Structure Backfill*, or 2006 SS, Section 19-3.06, *Structure Backfill*.

<sup>39</sup> 2010 SS, Section 19-3.04, *Payment*, or 2006 SS, Section 19-3.07, *Measurement*.

<sup>40</sup> 2010 SS, Section 19-5, *Compaction*, or 2006 SS, Section 19-5.03, *Relative Compaction (95%)*.

<sup>41</sup> 2010 SS & 2006 SS Section 19-6, *Embankment Construction*.

<sup>42</sup> 2010 SS, Section 19-6.03D, *Settlement Periods and Surcharges*, or 2006 SS, Section 19-6.025, *Settlement Period*.

<sup>43</sup> 2010 SS, Section 51-1.03C(1), *Preparation, General*, or 2006 SS, Section 51-1.03, *Depth of Footings*.

<sup>44</sup> 2010 SS, Section 51-1.03C(1), *Preparation, General*, or 2006 SS, Section 51-1.04, *Pumping*.

<sup>45</sup> 2010 SS, Section 51-1.03D, *Placing Concrete*, or 2006 SS, Section 51-1.09, *Placing Concrete*.



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- i. Environmental permits.
- C. Category 12 - Contractor's Submittals:
- i. Worker Protection Plan per the contract specifications<sup>46</sup> for excavations 5 feet or more in depth.
- D. Category 14 - Photograph Records.
- E. Category 20 – Water Pollution Control Plan or Stormwater Pollution Prevention Plan.
- F. Category 37 - Initial Tests and Acceptance Tests.
- G. Category 41 - Report of Inspection of Material.
- H. Category 43 - Concrete and Reinforcing Steel.
- i. Mix design, certified test data, trial batch report and authorization letter sent to Contractor.
- I. Category 48 - Bid Item Quantity Documents.
- V. Preconstruction Discussion with Design & Geotechnical Services**
- A. Contact Structures Design and Geotechnical Services:
- i. Structure Design Contacts:
    - Contract Plans: Engineer of Record is listed on the plans.
    - Sometimes you may want to contact the specifications writer: Look for the RCE Stamp at the beginning of the special provisions for the specification writer.
  - ii. Geotechnical Services Contact:
    - Contact information is located on the *Foundation Report* and the *LOTB*.
- B. Establish a relationship with Structures Design and Geotechnical Services:
- i. Structure Design:
    - Clarify and resolve any question or concerns developed during review of the contract plans and specifications.
  - ii. Geotechnical Services:
    - Performed the foundation investigation, wrote the *Foundation Report* and developed the *LOTB*.
    - Discuss foundation bearing material and ground water issues.
    - Discuss potential problem areas and risk in detail.
    - Discuss expected construction methods and tooling.

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<sup>46</sup> 2010 SS, Section 7-1.02K(6)(b), *Excavation Safety*, or 2006 SS, Section 5-1.02A, *Excavation Safety Plans*.





## **VI. Preconstruction Meeting with Contractor**

- A. Safety, per the contract specifications<sup>47</sup>. Remind the Contractor of their responsibilities to submit an excavation safety plan for excavations 5 feet or more in depth per the requirements of the contract documents and in a timely manner to allow sufficient time for review/comment/approval by the Structure Representative.
- B. Utilities:
  - i. Protection of utilities, per the contract specifications<sup>48</sup>.
- C. Environmental considerations.
- D. Foundation Work:
  - i. Footing and seal course revisions, BCM 2-9.0, *Footing and Seal Course Revisions*.
  - ii. Constructability issues: Check special provisions and *Foundation Report*.
  - iii. Required submittals.
  - iv. Staking request, per the contract specifications<sup>49</sup>.
  - v. Stockpiling, reuse within project limits, and/or off hauling of excavated materials.

## **VII. Submittal Review**

- A. Excavation Safety/Shoring Plan, per the contract specifications<sup>50</sup>. The Engineer should refer to the Caltrans *Trenching and Shoring Manual* or go directly to Cal-OSHA website<sup>51</sup> (when reviewing a Contractor's excavation safety plan for compliance with Construction Safety Order Section 1541.1).
- B. Contractor's Water Pollution Control Program, per the contract specifications<sup>52</sup>:
  - i. District responsibility to authorize with Structures review/comment.
  - ii. Verify regulatory/agency permit requirements are addressed.

## **VIII. CONSTRUCTION**

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<sup>47</sup> 2010 SS, Section 7-1.02K(6)(b), *Tunnel Safety*, or 2006 SS, Sections 5-1.02A, *Excavation Safety Plans*, and 7-1.01E, *Trench Safety*.

<sup>48</sup> 2010 SS, Section 5-1.36D, *Nonhighway Facilities*, or 2006 SS, Section 8-1.10, *Utility and Non-Highway Facilities*.

<sup>49</sup> 2010 SS, Section 5-1.26, *Construction Surveys*, or 2006 SS, Section 5-1.07, *Lines and Grades*.

<sup>50</sup> 2010 SS, Section 7-1.02K(6)(b), *Tunnel Safety*, or 2006 SS, Sections 5-1.02A, *Excavation Safety Plans*, and 7-1.01E, *Trench Safety*.

<sup>51</sup> <http://www.dir.ca.gov/samples/search/query.htm>

<sup>52</sup> 2010 SS, Section 13, *Water Pollution Control*, or 2006 SS, Section 7-1.01G, *Water Pollution*.



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A. Inspection:

- i. Survey:
  - Contractor shall submit survey request per the contract specifications<sup>53</sup>.
  - Inspectors review survey notes and field verify the stakes placed.
- ii. Utilities: Contractor shall identify existing underground and overhead utilities.
- iii. Witness the excavated material and compare with Contractor's assumed soil properties per the Excavation Safety Plan and the *LOTBs*.
- iv. Buried man-made object/differing site conditions, per the contract specifications<sup>54</sup>.
- v. Groundwater, per the contract specifications<sup>55</sup>, which describes methods to be utilized when water is encountered in excavation and seal course are not shown on plan.
- vi. Stability of slopes and excavation noting changes in soil properties with respect to the depth of the excavation and time exposed.
- vii. Proximity to existing structures.
- viii. Conformity of foundation material, per the contract specifications<sup>56</sup>, the Contractor shall notify the Engineer when the excavation is substantially complete and is ready for inspection. No concrete shall be placed until the Engineer has authorized the foundation.
- ix. Foundation bearing surface must be undisturbed soil or authorized alternative.
- x. Forms conform to layout before and after placement of bar reinforcement.
- xi. Reinforcement steel firmly and securely tied in place with adequate concrete cover. Re-check clearances and foundation bearing surfaces for potential loose soil caused by ironworker crews.
- xii. Shear steel hooked top and bottom and securely tied.
- xiii. Proper concrete cover over top of rebar mat.
- xiv. Concrete Placement:
  - Check concrete ticket for authorized mix design.
  - Check truck revolutions and time since mix was batched.
  - Check truck backup alarms are working properly on all concrete mix trucks.
  - Check concrete temperature.
  - Be aware of load restrictions for concrete mix trucks on existing structures.
  - Wet down rebar forms and subgrade.
  - Do not allow concrete to drop over 8 feet.

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<sup>53</sup> 2010 SS, Section 5-1.26, *Construction Surveys*, or 2006 SS, Section 5-1.07, *Lines and Grades*.

<sup>54</sup> 2010 SS, Section 4-1.06, *Differing Site Conditions*, or 2006 SS, Section 5-1.116, *Differing Site Conditions*.

<sup>55</sup> 2010 SS, Section 19-3.03B(5), *Water Control and Foundation Treatment*, or 2006 SS, Section 19-3.04, *Water Control and Foundation Treatment*.

<sup>56</sup> 2010 SS, Section 19-3.03B(1), *Structure Excavation, General*, or 2006 SS, Section 19-3.05, *Inspection*.



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- Monitor formwork for signs of excess deflection and/or failure due to freshly placed concrete loads.
  - Sample concrete for compressive strength per the contract requirements
  - Reconsolidate concrete greater than 2.5 feet thick per the contract specifications<sup>57</sup>.
  - Verify concrete wash out is being done according to authorized SWPPP.
  - Concrete curing per the contract specifications<sup>58</sup>.
- xv. Backfill inspection: 95% relative compaction per the contract specifications<sup>59</sup>.

**B. Safety:**

- i. Safe and authorized excavation/shoring plan for excavation over 5 feet in depth per the contract specifications<sup>60</sup>.
- ii. Verify Contractor's excavation permit.
- iii. Daily inspections by the Contractor's competent person.
- iv. Protective barrier around the excavation perimeter as required.
- v. Spoil piles must be greater than 2 feet away from the excavation lip for excavations greater than 5 feet deep.
- vi. Excavations may fall under the CalOSHA requirements for confined spaces.
- vii. Protection against the hazards of impalement on the exposed ends of rebar.

**C. Problems and solutions:**

- i. Addressing suitable material that has been disturbed or water damaged is the responsibility of the Contractor while unsuitable material is the responsibility of Caltrans.
- ii. All disturbed or water damaged material must be removed or restored at the Contractor's expense, to a condition at least equal to the undisturbed foundation as determined by the Engineer. To avoid or minimize the disturbance and/or water damage of the foundation surface:
  - Under-excavate with mechanical equipment and excavate to bottom of footing by hand or by using a cleanup bucket.
  - Divert surface water away from the excavation.
  - Minimize exposure of the foundation material to the elements by constructing footings as soon as possible after excavation.
- iii. Unsuitable material is defined in the contract specifications<sup>61</sup> as incapable of being compacted; too wet to be properly compacted; or otherwise unsuitable

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<sup>57</sup> 2010 SS, Section 51-1.03D(1), *Placing Concrete, General*, or 2006 SS, Section 51-1.09, *Placing Concrete*.

<sup>58</sup> 2010 SS, Section 90-1.03B, *Curing Concrete*, or 2006 SS, Section 90-7.03, *Curing Structures*.

<sup>59</sup> 2010 SS, Section 19-3.03E(1), *Structure Backfill, General*, or 2006 SS, Section 19-3.06, *Structure Backfill*.

<sup>60</sup> 2010 SS, Section 7-1.02K(6)(b), *Excavation Safety*, or 2006 SS, Section 5-1.02A, *Excavation Safety Plans*.

<sup>61</sup> 2010 SS, Section 19-1.01B, *Definitions*, or 2006 SS, Section 19-2.02, *Unsuitable Material*.



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for the planned use. The Engineer is responsible for determining the suitability of the foundation as it relates to the design intent.

- Contact Geotechnical Services.
  - Review of *LOTB*.
  - Anticipated suitable material may be just below the excavated surface.
  - Field tests to verify unsuitable material.
- iv. Footing modifications: Corrective action is required whenever changes in the bottom of footing elevation are made to address disturbed, water damaged or unsuitable material. They fall into two categories: replacement of the original foundation material to achieve the original bottom of footing elevation; or revisions to the structure to address a different bottom of footing elevation.
- Excavate to a stratum with sufficient bearing capacity and replace removed material with suitable foundation materials (i.e. concrete, lean concrete, aggregate base, structure backfill etc...) based on the recommendations of the Geoprofessional and Designer.
  - Lower the footing to a stratum with sufficient bearing capacity and increase the height of column or wall. This option may not be acceptable if the increase in height necessitates redesign of the column or wall.
  - Increase the footing size. Settlement can't exceed tolerable limits. Check with the Designer.
  - Footing revisions due to unsuitable material will require a change order per the contract specifications<sup>62</sup>. Impact to the construction schedule must be considered.

**IX. Project Completion / As-Builts**

- A. As Built drawings (BCM 9-1.0, *As-Built Plans*):
- i. Changes to footing elevations.
  - ii. Location of relocation of new/existing/abandoned utilities.
  - iii. Footing formed, or excavated neat (against undisturbed ground). Only note on As-Builts if placed neat.
  - iv. Gravel placement to control high ground water.
  - v. Concrete overpours.
- B. Send all project completion records and As-Builts to the appropriate Office Associate at the following address.

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<sup>62</sup> 2010 SS, Section 19-3.03B(5), *Water Control and Foundation Treatment*, or 2006 SS, Section 19-3.07, *Measurement*.



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## **K5. Micropile Construction Checklist**

### **General Overview**

In conjunction with Chapter 13, *Micropiles*, a construction checklist for Micropile construction has been developed to assist field personnel in preparing documents and inspecting fieldwork to ensure compliance with contract requirements. It is important for Structure Representatives to review the contract plans and specifications, meet and go over them with Caltrans staff, conduct preconstruction meetings with the Contractor to lay out procedures, identify field problems, and other issues.

Micropiles are a small diameter (typically less than 1 foot), drilled and grouted replacement pile that is typically reinforced. A micropile is constructed by drilling a borehole, placing reinforcement, and grouting the hole. Contractors who specialize in ground anchors and soil nails also construct micropiles since similar equipment and techniques are used.

Micropiles can withstand axial (compression and tension) loads and some lateral loads. Caltrans limits the use of micropiles due to the lateral demand requirements. Caltrans is currently using micropiles for seismic retrofits, earth retention, and foundations for new structures (retaining/sound walls).

The following checklist is intended to provide Caltrans personnel with a guide for the micropile construction process. This checklist will not cover all situations of micropile construction. Be sure to check your special provisions for additional requirements. If a problem does occur you are encouraged to contact your Senior Bridge Engineer, Division of Engineering Services (DES) Substructure Technical Committee or the Foundation Testing Branch.

### **I. Source of Technical Information**

#### **A. Foundation Manual:**

- i. Chapter 13, *Micropiles*.
  - Provides micropile definition and descriptions, Caltrans application, construction and contract administration.

#### **B. Micropile Design and Construction Guidelines Implementation Manual, Publication No. FHWA-SA-97-070<sup>63</sup>:**

- i. A comprehensive review of current design and construction methods.
- ii. The presenting the guideline procedure is to help ensure that agencies adopting use of micropile technology follow a safe, rational procedure from site investigation through construction.

<sup>63</sup> [http://www.fhwa.dot.gov/engineering/geotech/library\\_listing.cfm](http://www.fhwa.dot.gov/engineering/geotech/library_listing.cfm)



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C. Geotechnical Services:

- i. *Caltrans Soil and Rock Logging, Classification, and Presentation Manual*.<sup>64</sup>
  - Assist in interpreting the information in the *Log of Test Borings* and communicating with Geotechnical Services.

**II. Source of Project Specific Information**

A. Structures Pending File:

- i. Designer's Notes

B. Supplemental Project Information:

- i. *Foundation Report*
  - Provides recommendations on construction and grouting methods.
- ii. Local, Regional, State, and Federal regulatory and permit specific requirements.

**III. Contractual Requirements**

A. Special Provisions:

- i. Micropiling:
  - Caltrans provides design parameters for the micropiles in the contract plans, Contractor submits shop drawings, and the Office of Structures Design has 30 days to review the shop drawings<sup>65</sup>. Verification and proof testing requirements are detailed in the contract specifications<sup>66</sup>.
- ii. Alternative Piling:
  - There are currently no alternative piling systems authorized for use on Caltrans projects.

B. Contract Plans

- i. General Plan
  - General layout and typical section.
- ii. Index To Plans, Foundation Plan and Micropile Details
  - What you are constructing (seismic retrofit, retaining wall and sound wall) determines where you find the information regarding grout strength, pile data table, layout, reinforcement and required loads.
- iii. *Log of Test Borings (LOTB)*
  - When reviewing the Contractor's shop drawings for the micropile system, verify that the proposed equipment will work in the soil conditions provided in the *LOTB*.

C. Standard Specifications:

<sup>64</sup> [http://www.dot.ca.gov/hq/esc/geotech/sr\\_logging\\_manual/page/Logging\\_Manual\\_2010.pdf](http://www.dot.ca.gov/hq/esc/geotech/sr_logging_manual/page/Logging_Manual_2010.pdf)

<sup>65</sup> Standard Special Provisions (SSP), Section 49-5.01C(3), *Shop Drawings and Calculations*. or Standard Provisions for contracts using 2006 SS.

<sup>66</sup> 2010 SSP, Section 49-5.01D(5), *Load Testing*, or Standard Provisions for contracts using 2006 SS.



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- i. Job Site and Document Examination.<sup>67</sup>
  - The bidder is responsible to review the site of work and contract documents, has access to Caltrans investigations of the site conditions including subsurface conditions in areas where work is to be performed.
  - This also includes prior construction project records within the project limits that have been used by or known to designers and administrators of the project.
- ii. Contractor – Property Owner Agreement.<sup>68</sup>
  - Material resulting from grouting micropiles shall be disposed of properly.
- iii. Water Pollution Control.<sup>69</sup>
- iv. Environmental Stewardship.<sup>70</sup>
- v. *Piling* (SS, Section 49).
- vi. Bonding and Grouting.<sup>71</sup>
  - Reference specifications for cement, water and admixtures.
  - Grout shall meet the requirements of California Test 541.
- vii. *Reinforcement* (SS, Section 52).

**IV. Job Books Setup**

- A. Category 12 – Contractor’s Submittals:
  - i. Micropile shop drawings.
- B. Category 41 – Report of Inspection of Material:
  - i. Welding, reinforcement and couplers.
  - ii. Certificate of compliance for grout.

**V. Preconstruction Discussion with Structures & Geotechnical Design**

- A. Structures and Geotechnical Design:
  - i. Discuss potential problem areas and risk in detail.
  - ii. Discuss expected construction methods and tooling.
    - Method of grouting (gravity grout, pressure grout, multiple stage grouting).
    - Method of construction (open hole, temporary cased, partial permanently cased, permanently cased).
    - This is very important because micropiles can be constructed in all types of soil and by various methods. You want to ensure the Contractor is providing the product the Designer intended.

<sup>67</sup> 2010 SS, Section 2-1.07, *Job Site and Document Examination*, or 2006 SS, Section 2-1.03, *Examination of Plans, Specifications, Contract, and Site of Work*.

<sup>68</sup> 2010 SS, Section 5-1.20B(4), *Contractor-Property Owner Agreement*, or 2006 SS, Section 7-1.13, *Disposal of Material Outside the Highway Right of Way*.

<sup>69</sup> 2010 SS, Section 13, *Water Pollution Control*, or Standard Provisions for contracts using 2006 SS.

<sup>70</sup> 2010 SS, Section 14, *Environmental Stewardship*, or Standard Provisions for contracts using 2006 SS.

<sup>71</sup> 2010 SSP, Section 49-5.02D, *Grout*, or 2006 SS, Section 50-1.09, *Bonding and Grouting*.





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B. Foundation Testing Branch (FTB):

- i. The Foundation Testing Branch is a good source of information on construction methods and micropile testing since they have been involved in testing and accepting micropiles in the past.

**VI. Preconstruction Meeting with Contractor**

- A. Remind the Contractor of their responsibilities to submit shop drawings for the Micropile System to the Office of Structures Design per the requirements of the contract specifications and in a timely manner to allow sufficient time for review, comment and authorization.
- B. Remind the Contractor of their responsibilities to submit experience qualifications and the micropile installation plan per the requirements of the contract specifications and in a timely manner to allow sufficient time for review, comment and authorization.

**VII. Micropile Shop Drawings**

- A. Depending on the project location, design, and Contractor, different drilling and grouting techniques may be used. Review the contract specifications<sup>72</sup> for requirements to be included in the shop drawings. This also includes submittal review time, number of shop drawings and where to submit.

**VIII. Preconstruction Micropile Submittals**

- A. Experience Qualifications
  - i. Review and authorize the experience qualification information submitted by the Contractor.
  - ii. Keep in mind this submittal is post-award, so you can't simply reject the micropile contractor if they can't demonstrate compliance with the contract specifications<sup>73</sup>. However, you can require the Contractor bring in a work crew that does meet these requirements.
- B. Installation Plan
  - i. Review and authorize the micropile installation plan submitted by the Contractor. Coordinate this review with the Experience Qualifications submittal.
  - ii. Identify who will be performing load testing, the Contractor or a pile testing company. There are experience qualifications for load testing in the contract specifications<sup>74</sup>.

<sup>72</sup> 2010 SSP, Section 49-5.01C(3), *Shop Drawings and Calculations*, or Special Provisions for contracts using 2006 SS.

<sup>73</sup> 2010 SSP, Section 49-5.01C(2), *Experience Qualifications*, or Special Provisions for contracts using 2006 SS.

<sup>74</sup> 2010 SSP, Section 49-5.01D(2), *Experience Qualifications*, or Special Provisions for contracts using 2006 SS.



## **IX. Micropile Preconstruction Meeting**

- A. Hold this preconstruction meeting after 5 days of receipt of the Contractor's micropile shop drawings and installation plan.
- B. Refer to the contract specifications<sup>75</sup> for topics to be discussed with the Contractor.

## **X. Construction Inspection, Submittals & Quality Assurance**

### **A. Field Inspection:**

- i. Review the authorized shop drawings and be familiar with the construction sequence for your project-specific micropiling system.
- ii. Drilling mud or chemical stabilizers are not allowed.
- iii. Mill secondary steel reinforcing elements are no longer allowed.
- iv. Steel casing or bar reinforcement shall be installed with centralizers.
- v. Grout-ground bond is how micropiles transfer load which makes the inspection of the drilling and grouting procedure very important.

### **B. Submittals:**

- i. For each micropile, the Contractor is required to submit within 1 business day of completion for each micropile:
  - Micropile Installation Log<sup>76</sup>
  - Grout Test Results<sup>77</sup>
  - Load Test Data<sup>78</sup>
- ii. Submittals must be reviewed and authorized before each micropile can be accepted.

### **C. Testing:**

- i. Project-specific requirements depend on Geotechnical Control Zones.
- ii. The Contractor is required to perform and provide the equipment for the pile load tests. Verify requirements in the contract specifications<sup>79</sup>.
- iii. Verification Testing
  - Notify FTB in advance of verification testing and determine whether they will do additional testing on the verification load test micropile(s) to verify the test loads.

<sup>75</sup> 2010 SSP, Section 49-5.01D(3), *Preconstruction Meeting*, or Special Provisions for contracts using 2006 SS.

<sup>76</sup> 2010 SSP, Sections 49-5.01C(6), *Installation Log*, and 49-5.03H, *Installation Log*, or Special Provisions for contracts using 2006 SS.

<sup>77</sup> 2010 SSP, Sections 49-5.01C(7), *Grout Test Results*, and 49-5.01D(4), *Grout Testing*, Special Provisions for contracts using 2006 SS.

<sup>78</sup> 2010 SSP, Section 49-5.01C(8), *Load Test Data*, or Special Provisions for contracts using 2006 SS.

<sup>79</sup> 2010 SSP, Section 49-5.01D(5), *Load Testing*, or Special Provisions for contracts using 2006 SS.



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- Verification testing is performed for tension and compression using the load schedules and acceptance criteria in the contract specifications<sup>80</sup>. Verifies site-specific capacity for a given micropile type.
  - If a verification test micropile fails to meet acceptance criteria, contractors usually want to try post-grouting of the verification test micropile and retest before redesigning the micropiles. This is acceptable if the Contractor is willing to post-grout every production micropile in the wall zone represented by the verification test micropile.
- iv. Proof Testing
- Proof testing is performed for tension and compression using the load schedules and acceptance criteria in the contract specifications<sup>81</sup>. Serves as Quality Assurance for the project.
  - The contract specifications<sup>82</sup> specify how many micropiles are proof-tested.
  - Select randomly micropiles to be proof-tested, after installation, use engineering judgment.
  - If a micropile fails to meet proof testing acceptance criteria, the Contractor has two options for addressing the test failure. Both options involve suspending current micropile construction. Contractors tend to favor the post-grouting option.

**XI. Projection Completion / As-Builts**

A. As-Builts:

- i. Include authorized shop drawings.
- ii. Record all changes to the contract.
- iii. Note which micropiles were post-grouted.

- B. Send all project completion records and As-Builts to the appropriate Office Associate at the following address.

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<sup>80</sup> 2010 SSP, Section 49-5.01D(5)(b), *Verification Load Testing*, or Special Provisions for contracts using 2006 SS.

<sup>81</sup> 2010 SSP, Section 49-5.01D(5)(c), *Proof Load Testing*, or Special Provisions for contracts using 2006 SS.

<sup>82</sup> 2010 SSP, Section 49-5.01D(5)(c)(i), *General*, or Special Provisions for contracts using 2006 SS.



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## **K6. Ground Anchor Wall Construction Checklist**

### **General Overview**

In conjunction with Chapter 11, *Ground Anchors & Soil Nails*, a construction checklist for ground anchor wall construction has been developed to assist field personnel in preparing documents and inspecting fieldwork to ensure compliance with contract requirements. It is important for Structure Representatives to review the contract plans and specifications, meet and go over them with Caltrans staff, conduct preconstruction meetings with the Contractor to lay out procedures, identify field problems, and other issues.

The Contractor must comply with the CalOSHA Construction Safety Orders and Storm Water Pollution Prevention Plan to reduce potential impacts to the site.

Structure Representatives are encouraged to employ the following checklist for ground anchor wall construction. Contact the Earth Retaining Systems Specialist in the Office of Structure Design in Sacramento for additional assistance.

### **I. Sources of Technical Information**

- A. Foundation Manual:
  - i. Chapter 11, *Ground Anchors & Soil Nails*.
  - ii. Appendix H, *Ground Anchors & Soil Nails*.
- B. Bridge Construction Records and Procedures Manual:
  - i. Chapter 160, *Prestressed Concrete*.
- C. Recommendations for Prestressed Rock and Soil Anchors (Post-Tensioning Institute).

### **II. Sources of Project Specific Information**

- A. Structures Pending File.
  - i. Designers Notes.
- B. Supplemental Project Information.
  - i. *Foundation Report(s)*
  - ii. Local, Regional, State, and Federal regulatory and permit specific requirements.

### **III. Specification Requirements**

- A. Special Provisions.



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B. Contract Plans.

- i. General Plan and & Elevation
  - Check stationing, grades and bearings with District Plans.
- ii. Typical Section
  - Note ground anchor layout, spacing and inclination angles.
  - General notes.
  - Review ultimate bond stress for Test Load determination.
- iii. Structure Plans/Elevations
  - Verify wall grades, stationing and dimensions.
- iv. Foundation Plan
  - Review with respect to construction layouts, utility plans and drainage plans.
- v. Ground Anchor Details
  - Review ground anchor details for production and test assemblies, note total overall and bonded lengths.
  - Review drainage details for geotextile material placement.
- vi. Log of Test Borings
  - Review *LOTB*'s coring location with respect to wall layout and stationing.

C. Standard Specifications:

- i. Job Site and Document Examination<sup>83</sup>.
- ii. Submittals<sup>84</sup>.
- iii. Welding<sup>85</sup>.
- iv. Water Pollution Control<sup>86</sup>.
- v. Environmental Stewardship<sup>87</sup>.
- vi. Structure Excavation and Backfill<sup>88</sup>.
- vii. Slurry Cement Backfill<sup>89</sup>.
- viii. Ground Anchors<sup>90</sup>.
- ix. Prestressing<sup>91</sup>.
- x. Bonding and Grouting<sup>92</sup>.

<sup>83</sup> 2010 SS, Section 2-1.07, *Job Site and Document Examination*, or 2006 SS, Section 2-1.03, *Examination of Plans, Specifications, Contract, and Site of Work*.

<sup>84</sup> 2010 SS, Section 5-1.23, *Submittals*, or 2006 SS, Section 5-1.02, *Plans and Working Drawings*.

<sup>85</sup> 2010 SS, Section 11-3, *Welding*, or Special Provisions for contracts using 2006 SS.

<sup>86</sup> 2010 SS, Section 13, *Water Pollution Control*, or Special Provisions for contracts using 2006 SS.

<sup>87</sup> 2010 SS, Section 14, *Environmental Stewardship*, or Special Provisions for contracts using 2006 SS.

<sup>88</sup> 2010 SS, Sections 19-3.03B, *Structure Excavation*, & 19-3.03E, *Structure Backfill*, or 2006 SS, Section 19-3, *Structure Excavation and Backfill*.

<sup>89</sup> 2010 SS, Section 19-3.03F, *Slurry Cement Backfill*, or 2006 SS, Section 19-3.062, *Slurry Cement Backfill*.

<sup>90</sup> 2010 SS, Sections 46-1, *Ground Anchors and Soil Nails, General*, & 46-2, *Ground Anchors*, or Special Provisions for contracts using 2006 SS.

<sup>91</sup> 2010 SS, Section 50-1.03B, *Prestressing*, or 2006 SS, Section 50-1.08, *Prestressing*.

<sup>92</sup> 2010 SS, Section 50-1.03B(2)(d), *Bonding and Grouting*, or 2006 SS, Section 50-1.09, *Bonding and Grouting*.



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- xi. *Concrete Structures* (SS Section 51)
- xii. *Finishing Concrete*<sup>93</sup>.
- xiii. *Reinforcement* (SS Section 52).
- xiv. *Shotcrete* (SS Section 53).
- xv. *Materials*<sup>94</sup>.
- xvi. *Portland Cement Concrete* (SS Section 90, *Concrete*).

**IV. Job Books Setup**

- A. Contractor's code of safe practices (Category 6).
- B. Welding Quality Control Plan, Stud Welding (Category 9).
- C. Contractor's Submittals (Category 12):
  - i. Ground Anchor assembly working drawings.
  - ii. Earthwork submittal.
  - iii. Hydraulic jack calibration chart and date of calibration.
  - iv. Theoretical elongation calculations.
- D. Ground Anchor Proof and Performance testing results, and Earth Stability Report results (Category 37).
- E. Reports of Inspection of Materials (Category 41):
  - i. Prestress Tendon Steel.
  - ii. Sheathing (corrugated sheathing thickness.)
  - iii. Corrosion Inhibitors.
  - iv. Anchor assemblies (Anchor Heads, Bearing Plates, Trumpets, and Wedges).
  - v. Steel Soldier Piling.
  - vi. Treated Timber Lagging.
- F. Concrete Records (Category 43):
  - i. Grout, Shotcrete, and Structural Concrete Mix designs.

**V. Preconstruction Discussion with Design & Geotechnical Services**

- A. Review *Log of Test Borings* and other geotechnical information for soil conditions. Discuss geotechnical design issues with the Geoprofessional and the Designer.
- B. Discuss the possible need for use of a “grout sock” in case of drilling through unfavorable conditions such as shattered rock or fractured formation. A “grout sock” is a porous layer of filter fabric or equivalent that lines the wall of the hole. It is inserted into the hole or inside the temporary casing prior to the

<sup>93</sup> 2010 SS, Section 51-1.03F, *Finishing Concrete*, or 2006 SS, Section 51-1.18, *Surface Finishes*.

<sup>94</sup> 2010 SS, Section 55-1.02, *Materials*, or 2006 SS, Section 55-2, *Materials*.



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grout being pumped into the hole. This is to prevent the excessive loss of grout into cracks, fissures or voids in native materials that are encountered.

**VI. Preconstruction Meeting with Contractor**

- A. Remind the Contractor of his responsibility to submit Ground Anchor and/or Shoring working drawings, Earthwork/Excavation plan, notice of material sources, and grout, shotcrete, and structural concrete mix designs in a timely manner.
- B. Discuss the locations of survey stakes and reference points to be provided by the Engineer, and the requirements for filling out and submitting Survey Staking Requests.
- C. Discuss with the Contractor location of field storage of construction materials to prevent damage. Discuss methods to control grout and other SWPP issues.
- D. Discuss proposed drilling methods with Contractor, including the use of casing, grout socks, etc. Check for drilling conflicts. Is there enough horizontal clearance between the roadway and the drilling operation? Has the Contractor notified USA and checked for clearance between soldier piles, ground anchors and utilities?
- E. Discuss with the Contractor in detail how they will perform the Performance and Proof testing. For example, the use of a temporary stressing chair, use of shims, recording the elongation using a dial gage or caliper, etc. Emphasize the testing procedures as specified (for time and load) will be strictly enforced to accurately measure the creep in the system. No deviations are allowed for such testing.

**VII. Submittal Reviews**

- A. The Ground Anchor Assembly shop drawings and Earthwork/Excavation plan should be submitted to the Documents Unit. Ensure the Designer authorizes the plan submittals before any fieldwork begins.
- B. Review authorized shop drawings for bond length of ground anchors, drilled hole diameter, centralizer spacing/layout, and grouting procedures.
- C. Inspect site condition for equipment and crane setup. If a suspension platform is used for drilling, request and review information for load capacity requirements. Does the excavation plan work, or is a temporary shoring system necessary?

**VIII. Construction**





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A. Materials:

- i. Coordinate with METS and verify source inspection and release of materials.
- ii. Collect release tags on the ground anchor assemblies, bearing plates etc. and verify lot numbers with Form TL-29. Visually check all ground anchor assemblies and reinforcing steel for damage and defects upon delivery and prior to use.
- iii. Visually check encapsulated tendons for compliance with the specifications and for any damage to the corrosion protections.
- iv. Measure ground anchor assemblies and ensure centralizers are installed as per authorized shop drawings.
- v. Verify compliance of geocomposite drainage materials with the contract plans/specifications.
- vi. Take photos of stored materials.
- vii. Verify storage of materials such as treated timber lagging complies with SWPPP requirements.

B. Inspection: Earthwork:

- i. Prior to the start of any wall construction, check for any variance between the actual ground surface elevations along the wall line and those shown on the contract plans.
- ii. Use survey stakes and reference points to verify wall layout line. Work with the Contractor at the beginning of each shift to check wall layout and layout holes to be drilled for the day.
- iii. Ensure that the submitted Earthwork/Excavation plan proposes a realistic and detailed construction sequence that includes measures to ensure slope stability during all stages of excavation. The named competent person shall be on site at all times during excavation/earthwork.
- iv. Ensure the Contractor's stability analysis has been completed prior to production excavation as per the contract specifications<sup>95</sup>.
- v. Frequently ensure that stable excavation conditions are being maintained, both for general mass excavation and wall neat finish face excavation. Remind the Contractor that finish face excavation needs to be completed within the time limit shown in the project documents or authorized working drawings.
- vi. Work with Caltrans Surveys and the Contractor's grade setter to ensure the excavation is being performed within the specified tolerances for line and grade, and that overexcavation is not taking place.
- vii. Ensure that each preceding segment of the wall is structurally complete prior to performing excavation of the next lift.

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<sup>95</sup> 2010 SS, Section 19-3.01A(3)(b), *Stability Test for Ground Anchor and Soil Nail Walls*, or Special Provisions for contracts using 2006 SS.



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- viii. Ensure that no work takes place in different excavation zones, as listed in the contract specifications, until the required stability testing is complete.
- C. Inspection: Drilling holes and installing ground anchors:
- i. Discuss with the Contractor prior to start of drilling operation measures to control dust and drill cuttings forced out of hole during drilling, particularly operations adjacent to traffic.
  - ii. Discuss with the Contractor prior to start of drilling operation measures to control water used to flush cuttings out of drilled hole and grout expelled from drilled hole.
  - iii. Verify and record drilling methods, whether rotary or percussion, and drilling progress in length per time. If boulders or similar objects are encountered, the Contractor must provide measures to advance the hole to plan dimension.
  - iv. Verify and record whether casing will be used. If groundwater or soft soil is encountered, the Contractor is required to provide measures to protect holes from caving in, as well conform to the construction dewatering plan (part of excavation plan) to control water flow.
  - v. Verify and record drilling spoils using standard soil classifications throughout the drilling operation. Check in with the drilling foreman on a regular basis.
  - vi. Verify the diameter of the drilled hole by measuring the casing teeth and/or drill string bit.
  - vii. Verify the inside diameter of the casing to verify the ground anchor, with centralizers, will fit inside casing, if applicable.
  - viii. Ensure the vertical angle and drill diameter is in accordance with the authorized working drawings.
  - ix. Verify the drilled hole alignment is perpendicular to the layout line at each drilled hole location or matches plan requirement.
  - x. Ensure the hole is drilled to the specified depth and is clear prior to installation of the ground anchor. Adhere to project requirements regarding installation of ground anchor assemblies and maximum time permitted before grouting to ensure no caving between installation and grouting stages.
  - xi. Drilling, ground anchor installation and the grouting should be done in one shift to avoid caving of the soil.
  - xii. Check that centralizers are placed as per the authorized ground anchor shop drawings.
  - xiii. Verify the ground anchors are installed to the correct depth without excessive force.
  - xiv. Verify grout mix design proportions, test consistency, (CA Test 541). If sand is used in the grout mix design, check the penetration in accordance with CTM 533.
  - xv. Verify grouting sequence. For permanent ground anchors with full length corrugated sheathing (Alternative B), verify primary grouting on inside



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of sheathing before grouting of the drilled hole outside of sheathing. Primary (initial) grouting outside of sheathing is held to a minimum of 6 inches below the trumpet for holes equal or less than 6 inches in diameter.

- xvi. Following primary grouting and prior to installing trumpet, verify grout outside of sheathing is held sufficiently below trumpet.
- xvii. Verify secondary grouting following successful testing and lock-off of ground anchor.
- xviii. Verify final grouting takes place no earlier than 24 hours after secondary grouting.
- xix. Verify Contractor is recording grout volumes and pressures during grouting, including post-grouting.

**D. Ground Anchor Testing:**

- i. Request the jack number and corresponding gage numbers from the Contractor prior to the testing date – see SC website under Field Resources/OSM Prestress Calibration Charts for a current listing.
- ii. Verify stressing equipment meets specifications (jack “ram”, pump and pressure gages) and was calibrated by Caltrans METS within the last year. Verify the length of the ram extension (stroke) is sufficient for the calculated elongation of strand anchors. The combination of fewer strands and long unbonded lengths can produce large strand elongations during testing.
- iii. Review the *California Prestress Manual* and BCM 160-3.0, *Pressure Cells*, and verify equipment is working properly. Notify the Contractor that you will be monitoring loading using the pressure cell.
- iv. Verify the device proposed for measuring ground anchor movement meets the requirements of the contract specifications<sup>96</sup>.
- v. Verify the Contractor’s stressing chair is adequate for the proposed loads.
- vi. Verify the permanent lock-off materials (wedge plates, anchor heads, shims) are adequate for the lock-off load and the maximum test load. There may be a difference between stressing heads and permanent wedge plates.
- vii. Verify the Contractor is not using the ram extension for measuring ground anchor movement. The ram extension may include movement of the structure in response to the ground anchor load.
- viii. Review testing and lock-off procedures:
  - Identify specific ground anchors for Proof and Performance testing.
  - Verify adequate grout cure (and concrete whaler cure if the ground anchor is stressed against the concrete structure).
  - Verify ground anchor grouting is held a sufficient distance back from the wall.

<sup>96</sup> 2010 SS, Section 46-1.01D(2), *Load Testing*, or Special Provisions for contracts using 2006 SS.



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- Ensure proper arrangement of strands to achieve uniform loading of strands.
  - Thread anchor head on bar or place permanent wedge plate and wedges on strands.
  - Set stressing chair against bearing plate or whaler.
  - Place ram on stressing chair running bar or strands through ram center hole. Place stressing head or loading plate/wedges against ram cylinder.
  - Set up independent measuring device such as a tripod with dial gauge.
  - Align ram along axis of the ground anchor.
  - Apply alignment load to ram. Check for uniform bearing of anchor head on bearing plate and alignment of ram with strands.
  - Commence with testing.
- ix. Performance vs. Proof Tests:
- Performance Testing: Cyclic loading with incremental increase in maximum load for each cycle up to the factored test load shown.
  - Proof Testing: Single cycle of loading to the factored test load shown.
- x. Performance and Proof Tests:
- The contract plans specify which ground anchors to performance test.
  - All other ground anchors are proof-tested.
  - Loading:
    - Each loading increment applied within 1 minute.
    - Each loading increment held for no more than 2 minutes.
    - Movement for each load increment is noted and recorded.
    - Test load hold at the factored test load shown, held constant for 10 or 60 minutes
    - Loading schedules require a return to AL after achieving the Test Load for both proof and performance tests. Without returning to AL, the total elastic movement cannot be determined. Requirement to seat the wedges at the Test Load should not be inferred to mean that the wedges are seated after reaching the Test Load initially and prior to returning to the AL. The test should first be completed in its entirety, including returning to AL. Then the ground anchor should be stressed again to the Test Load and the wedges seated.
- xi. Test Acceptance Criteria:
- Elastic movement exceeds 80% of theoretical.
  - Movement at the factored test load hold is less than 0.04 inch after 10 minutes or 0.08 after 60 minutes.
- xii. Failed Tests:
- Elastic movement does not exceed 80% of theoretical. Possible causes:
    - Unbonded length insufficient – should be checked by visually inspecting prior to installation.



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- Insufficient loading is being applied to the strands by the testing mechanism – verify accuracy of gauge pressure with a properly calibrated pressure cell.
- Check load path from ram to strands for losses – check that wedges are properly seated within both the loading plate and permanent anchor head.
- Contact the Designer and Geoprofessional for further direction.
- Movement at test load hold exceeds 0.08 inches after 60 minute test load hold:
  - Ground anchor is rejected.
- xiii. Contractor’s responsibility to address failed ground anchors:
  - Elastic movement does not exceed 80% of theoretical:
    - If applied loading and load path are satisfactory, reject and replace ground anchor.
  - Movement at test load hold exceeds 0.08 inch:
    - Contractor normally repeats post grouting and retests after sufficient cure time.
- xiv. File all testing results within Category 37 for ground anchors.

E. Lock-Off:

- i. Lock-off results in relaxation of ground anchor force to the lock-off load shown:
  - The lock-off load is specified to achieve residual capacity within the ground anchors.
- ii. Lock-off conducted upon successful testing of ground anchors:
  - Ram is backed off anchor head.
  - Strands stressed to relax anchor head off shims.
  - Shims between anchor head and bearing plate removed.
  - Anchor head returned to bearing plate.
  - Perform Lift-off test.
  - For strand tendons, permanent wedges shall be fully set in the anchor head while the tendon is stressed to the factored test load shown and then locked off at the lock-off load shown.
- iii. Lift-off Test:
  - Verifies force in the ground anchor.
  - Load reapplied to strands until anchor head lifts off of bearing plate.
  - Pressure/load at lift-off noted, should be within 5% of required lock-off load shown.
  - Record final force in ground anchor on test sheets.
  - Potential Problems:
    - Actual lift-off force exceeds lock-off load shown in excess of 5% tolerance:
      - (i) Lock-off shim thickness used was too thin.
      - (ii) Back strand wedges out of anchor head.



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- (iii) Re-stress to the factored test load shown.
- (iv) Re-seat the wedges at the factored test load shown. (*Requires leaving teeth marks from wedges in Strand – Consult with Designer*).
- (v) Repeat lock-off & lift-off test.
- Actual lift-off force is less than the lock-off load shown in excess of 5% tolerance:
  - (i) Lock-off shim thickness used was too thin.
  - (ii) Install a permanent shim between anchor head and bearing plate.

**F. Testing / Stressing Summary:**

- i. Stressing / Testing requires full-time, attentive inspection.
- ii. Ensure residual force in each ground anchor is per contract documents within allowed tolerances.

**G. Safety:**

- i. Review *SC Code of Safe Practices*, Post Tensioning Operations.
- ii. Review *SC Code of Safe Practices*, Ground Anchors and Soil Nails:
  - Section IV Excavations.
  - Section XVII Earthwork.
- iii. Hold project-specific Safety Meeting prior to start of testing operation for all employees.
- iv. Review *Prestress Manual*<sup>97</sup>, Safety Topics.

**IX. Project Completion / As-Builts**

**A. Bridge Construction Memo 9-4.0, Report of Completion for Structures,**  
**applies:**

- i. Do not forward post-tensioning test results – maintain within the job files.
- ii. Note/draw any modifications on the As Built drawings on the number or location of ground anchors.

**B. Send all project completion records and As Builts to the appropriate Office Associate at the following address:**

**Division of Engineering Services  
Structure Construction  
1801 30<sup>th</sup> Street, M.S. 9-2/11H  
Sacramento, CA 95816  
Email: SC Office Associates@DOT**

<sup>97</sup> [http://www.dot.ca.gov/hq/esc/construction/manuals/OSCCCompleteManuals/PS\\_Terms.pdf](http://www.dot.ca.gov/hq/esc/construction/manuals/OSCCCompleteManuals/PS_Terms.pdf)



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**I. Forms**

- A. Refer to the SC Intranet, BCRP Manual Section 16<sup>98</sup>, *Forms*, for various updated forms relating to ground anchor construction:

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<sup>98</sup> [http://onramp.dot.ca.gov/hq/oscnet/sc\\_manuals/crp/vol\\_1/crp016.htm](http://onramp.dot.ca.gov/hq/oscnet/sc_manuals/crp/vol_1/crp016.htm).



## **K7. Soil Nail Wall Construction Checklist**

### **General Overview**

In conjunction with Chapter 11, *Ground Anchors & Soil Nails*, a construction checklist for soil nail wall construction has been developed to assist field personnel in preparing documents and inspecting fieldwork to ensure compliance with contract requirements. It is important for Structure Representatives to review the contract plans and specifications, meet and go over them with Caltrans staff, conduct preconstruction meetings with the Contractor to lay out procedures, identify field problems, and other issues.

The Contractor shall comply with the CalOSHA Construction Safety Orders and Storm Water Pollution Prevention Plan to reduce potential impacts to the site.

Structure Representatives are encouraged to employ the following checklist for soil nail wall construction. Contact the Earth Retaining Systems Specialist in the Office of Structure Design in Sacramento for additional assistance.

Soil nails provide a means to reinforce and strengthen an existing soil structure in order to achieve a slope face steeper than the natural angle of repose. Soil nails provide tensile reinforcement for soils which typically exhibit low tensile strength. They are termed “passive inclusions” as they are not pre-tensioned, but rather simply grouted in place along their full embedment into the ground. Soil nails are designed with sufficient embedment depths to adequately transfer the tensile stresses developed by the active soil mass pressures, back into stable soil structures behind the active failure planes.

### **I. Sources of Technical Information**

- A. Foundation Manual:
  - i. Chapter 11, *Ground Anchors & Soil Nails*.
  - ii. Appendix H, *Ground Anchors & Soil Nails*.
- B. Soil Nailing Field Inspectors Manual, FHWA Pub. SA-93-068.

### **II. Sources of Project Specific Information**

- A. Structures Pending File.
  - i. Designer’s notes
- B. Supplemental Project Information.
  - i. *Foundation Report(s)*
  - ii. Local, Regional, State, and Federal regulatory and permit specific requirements.





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**III. Contractual Requirements**

A. Special Provisions:

B. Contract plans:

- i. General Plan and & Elevation
  - Check stationing, grades and bearings with District Plans.
- ii. Typical Section
  - Note soil nail layout, spacing and inclination angles.
  - General notes.
  - Review ultimate bond stress for Test Load determination.
- iii. Structure Plans/Elevations
  - Verify wall grades, stationing and dimensions.
- iv. Foundation Plan
  - Review with respect to construction layouts, utility plans and drainage plans.
- v. Soil Nail Details
  - Review soil nail details for production and test assemblies, note total overall and bonded lengths.
  - Review drainage details for geotextile material placement.
- vi. Log of Test Borings
  - Review *LOTB*'s coring location with respect to wall layout and stationing.

C. Standard Specifications

- i. Job Site and Document Examination<sup>99</sup>.
- ii. Submittals<sup>100</sup>.
- iii. Welding<sup>101</sup>.
- iv. Water Pollution Control<sup>102</sup>.
- v. Environmental Stewardship<sup>103</sup>.
- vi. Structure Excavation and Backfill<sup>104</sup>.
- vii. Slurry Cement Backfill<sup>105</sup>.
- viii. Soil Nails<sup>106</sup>.

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<sup>99</sup> 2010 SS, Section 2-1.07, *Job Site and Document Examination*, or 2006 SS, Section 2-1.03, *Examination of Plans, Specifications, Contract, and Site of Work*.

<sup>100</sup> 2010 SS, Section 5-1.23, *Submittals*, or 2006 SS, Section 5-1.02, *Plans and Working Drawings*.

<sup>101</sup> 2010 SS, Section 11-3 or Special Provisions for contracts using 2006 SS.

<sup>102</sup> 2010 SS, Section 13 or Special Provisions for contracts using 2006 SS.

<sup>103</sup> 2010 SS, Section 14 or Special Provisions for contracts using 2006 SS.

<sup>104</sup> 2010 SS, Sections 19-3.03B, *Structure Excavation & 19-3.03E, Structure Backfill*, or 2006 SS, Section 19-3, *Structure Excavation and Backfill*.

<sup>105</sup> 2010 SS, Section 19-3.03F, *Slurry Cement Backfill*, or 2006 SS, Section 19-3.062, *Slurry Cement Backfill*.

<sup>106</sup> 2010 SS, Sections 46-1, *Ground Anchors and Soil Nails, General & 46-3, Soil Nails*, or Special Provisions for contracts using 2006 SS.



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- ix. Prestressing<sup>107</sup>.
- x. Bonding and Grouting<sup>108</sup>.
- xi. *Concrete Structures* (SS Section 51).
- xii. Finishing Concrete<sup>109</sup>.
- xiii. Reinforcement (SS Section 52).
- xiv. Shotcrete (SS Section 53).
- xv. Materials<sup>110</sup>.
- xvi. Geosynthetics (SS Section 88)
- xvii. Portland Cement Concrete (SS Section 90).

**IV. Job Books Setup**

- A. Contractor's Submittals (Category 12):
  - i. Soil Nail/Rock Anchor assembly shop drawings.
  - ii. Earthwork submittal.
  - iii. Hydraulic jack calibration chart and date of calibration.
  - iv. Theoretical elongation calculations.
  - v. Welding Quality Control Plan - onsite subassembly, stud weld (Category 9).
- B. Initial and Acceptance Tests (Category 37):
  - i. Soil Nail Verification, Proof and Supplemental test results, shotcrete tests and soil compressive test results.
- C. Reports of Inspection of Materials (Category 41):
  - i. High strength bars, Soil Nail assemblies.
  - ii. Geocomposite drainage materials.
  - iii. Bearing plates, couplers, Nelson studs.
  - iv. Bar reinforcing steel.
- D. Concrete (Category 43):
  - i. Shotcrete mix proportions and grout mix proportions.
  - ii. Plant inspection checklist.

**V. Preconstruction Discussion with Design & Geotechnical Services**

- A. Review *Log of Test Borings* and other geotechnical information for soil conditions.
- B. Discuss geotechnical design issues with the Geoprofessional and the Designer.

<sup>107</sup> 2010 SS, Section 50-1.03B, *Prestressing*, or 2006 SS, Section 50-1.08, *Prestressing*.

<sup>108</sup> 2010 SS, Section 50-1.03B(2)(d), *Bonding and Grouting*, or 2006 SS, Section 50-1.09, *Bonding and Grouting*.

<sup>109</sup> 2010 SS, Section 51-1.03F, *Finishing Concrete*, or 2006 SS, Section 51-1.18, *Surface Finishes*.

<sup>110</sup> 2010 SS, Section 55-1.02, *Materials*, or 2006 SS, Section 55-2, *Materials*.



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- C. Review authorized working drawings for bond length of test nails, drilled hole diameter, centralizer spacing/layout, and grouting procedures.
- D. Discuss any concerns developed during the review of project information or as a result of preliminary site reviews.

**VI. Preconstruction Meeting with Contractor**

- A. Discuss proposed drilling methods with Contractor.
- B. Remind the Contractor of his responsibility to submit Soil Nail working drawings, Earthwork/Excavation plan, notice of material sources, and grout and shotcrete mix designs in a timely manner.
- C. Discuss the locations of survey stakes and reference points to be provided.
- D. Discuss with the Contractor in detail how they will perform the verification, proof, and supplemental testing of soil nails.

**VII. Submittal Reviews**

- A. Review Contractor's earthwork submittal for excavation relative to the limitations of the site and construction safety requirements for earthwork.
- B. Review soil nail assembly shop drawing submittal for compliance with project plan requirements.
- C. Review Memo to Designers 5-14, *Review of Working Drawings for Ground Anchors*.
- D. Check the calibration dates of proposed test equipment.
- E. Verify test loads with contract specification<sup>111</sup> test requirements.
- F. Review bonded lengths for verification test assemblies.
- G. Check that concrete mix and grout proportions are consistent with the contract specifications.

**VIII. Construction**

- A. Materials:

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<sup>111</sup> 2010 SS, Section 46-3.01D(2), *Reinforced Concrete Crib Wall*. or Special Provisions for contracts using 2006 SS.



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- i. Collect release tags on the soil nail assemblies and bearing plates and verify lot numbers.
  - ii. Visually check all soil nail tendons and reinforcing steel for damage and defects upon delivery and prior to use.
  - iii. Visually check epoxy coated or encapsulated tendons for compliance with the contract specifications and for any damage to the corrosion protections.
  - iv. Measure soil nail assemblies and ensure centralizers are installed as per authorized shop drawings.
  - v. Verify compliance of geocomposite drainage materials with the contract plans/specifications.
- B. Inspection: Excavation and Drilling:**
- i. Prior to the start of any wall construction, check for any variance between the actual ground surface elevations along the wall line and those shown on the contract plans.
  - ii. Ensure that the submitted Earthwork/Excavation plan proposes a realistic and detailed construction sequence that includes measures to ensure slope stability during all stages of excavation. The named competent person shall be on site at all times during excavation/earthwork.
  - iii. Ensure the Contractor's stability testing has been completed prior to production excavation per the contract specifications<sup>112</sup>.
  - iv. Ensure that Verification testing has been completed prior to production excavation per the contract specifications<sup>113</sup>.
  - v. Frequently ensure that stable excavation conditions are being maintained, both for general mass excavation and wall neat finish face excavation. Work with Surveys and the Contractor's grade setter to ensure the excavation is being performed within the specified tolerances for line and grade, and that over-excavation is not taking place.
  - vi. Ensure that each preceding segment of the wall is structurally complete prior to performing excavation of the next lift.
  - vii. Use survey stakes and reference points to verify wall layout line. Work with the Contractor at the beginning of shift to check wall layout and layout holes to be drilled for the day.
  - viii. Verify drilling method, whether rotary or percussion. Vibration may cause unwanted settlement or raveling of the excavated face.
  - ix. Ensure the vertical angle and diameter of drilled holes is in accordance with the authorized shop drawings. Drilled hole alignment should be perpendicular to the layout line.
  - x. If groundwater or soft soil is encountered, the Contractor is required to provide measures to protect holes from caving in, as well conform to the construction dewatering plan to control water flow.

<sup>112</sup> 2010 SS, Section 19-3.01A(3)(b), *Stability Test for Ground Anchor and Soil Nail Walls*, or Special Provisions for contracts using 2006 SS.

<sup>113</sup> 2010 SS, Section 46-3.01D(2)(b)(ii), *Verification Test*, or Special Provisions for contracts using 2006 SS.



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- xi. Ensure the hole is drilled to the specified depth and is clean of debris prior to installation of the soil nail assembly.
  - xii. Drilling, insertion of soil nails and the grouting should be done in one shift to avoid caving of the soil.
  - xiii. The Contractor shall complete installation of soil nail assemblies, grouting, placing welded wire mesh and horizontal and/or vertical reinforcement steel, and primary shotcrete lift prior to performing excavation of adjacent area.
  - xiv. Check that centralizers are placed as per authorized soil nail assembly shop drawings.
  - xv. Make sure the soil nails are inserted to the correct depth without driving or forcing into the soil.
  - xvi. Verify grout consistency with flow cone (CA Test 541).
    - Grout tube must be inserted at the bottom of hole and gradually pulled up to reduce the formation of air pockets along the soil nail.
- C. Inspection: Drainage:
- i. Check the geocomposite drain strips and weephole outlet pipes are installed as specified.
  - ii. Check that drain elements are interconnected and provide continuous drainage paths.
  - iii. Check the reinforcing steel has been installed at the locations and to the dimensions specified.
- D. Testing:
- i. Check and calibrate the Caltrans pressure cell equipment using the appropriate calibration information supplied by the Contractor.
  - ii. Check the soil nail properties necessary to calculate elastic elongation, i.e. steel modulus, grade, cross-sectional area, and unbonded test length.
  - iii. Check the soil nail length is sufficient to accommodate all testing equipment.
  - iv. Check the installed test nail's drilled hole length and measure the unbonded length.
  - v. Check the Contractor's testing equipment and methods match the authorized soil nail shop drawings.
  - vi. Verify the minimum compressive strength of the shotcrete is attained prior to testing.
  - vii. Check that the displacement gauges are in proper working order and have an appropriate travel length.
  - viii. Make sure the calibration information for the jack and gauges being used matches the equipment on site. Verify that the jack and gauges have been calibrated within the last year.
  - ix. Check that the jack bearing pads will not interfere with the soil nail/grout column during testing.
  - x. Check that the jack is aligned correctly with the soil nail.



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- xi. Check that the displacement gauge is aligned with the axis of the soil nail and that gauges are mounted independent of the soil nail and testing apparatus.
  - xii. Check that the jack does not drop onto the soil nail or lie on it. This could cause bending or eccentric loading to the soil nail.
  - xiii. Check that the minimum alignment load is maintained at all times. Periodically check the jack alignment is maintained.
  - xiv. Check that constant load is maintained during the creep test.
  - xv. Check that load increments are applied and held within the specified time limits for the test.
- E. Safety:
- i. Review SC Code of Safe Practices, *Post Tensioning Operations*.
  - ii. Review SC Code of Safe Practices, *Ground Anchors and Soil Nails*.
    - Section XVII, *Earthwork and Excavation*.
  - iii. Hold project-specific Safety Meeting prior to start of testing operation for all employees.
  - iv. Review Prestress Manual<sup>114</sup>, *Safety*.

**IX. Project Completion / As-Builts**

- A. On the General Plan sheet, indicate any changed dimensions or obstructions. If any significant differences exist or differ from the contract plans at any particular location, it should be noted on the general plan sheet. Refer to BCM 9-1.0, *As-Built Plans*.
- B. Note any unusual conditions encountered and the corrective methods taken for specific locations for future consideration. Refer to BCM 9-4.0, *Report of Completion for Structures*.
- C. Send all project completion records and As-Builts to the appropriate Office Associate at the following address.

**Division of Engineering Services  
Structure Construction  
1801 30<sup>th</sup> Street, M.S. 9-2/11H  
Sacramento, CA 95816  
Email: SC Office Associates@DOT**

<sup>114</sup> [http://www.dot.ca.gov/hq/esc/construction/manuals/OSCCCompleteManuals/PS\\_Terms.pdf](http://www.dot.ca.gov/hq/esc/construction/manuals/OSCCCompleteManuals/PS_Terms.pdf)