Prestressing Concrete

Revision and Approval

Revision	Date	Nature of Changes	Approved By
0	09-30-2022	Original Issue. Added BCM 50-1.01C, 50-1.01D(1-2), 50-1.01D(3), 50-1.02, 50-1.03A, and 50-1.03B	Richard Foley

Click here to request previous versions Contact SC Technical Team E for questions

Background

This process establishes Structure Construction (SC) responsibilities and procedures for the review and authorization of submittals and materials, quality assurance, construction, and payment for prestressing concrete as specified in the contract documents.

When working with precast concrete members additional requirements are detailed in the *Contract Specifications*:

- Section 51-4, *Concrete Structures – Precast Concrete Members*
- Section 90-4, *Concrete – Precast Concrete*

Before reviewing this Bridge Construction Memo (BCM), it is essential to review the *Contract Specifications*, Section 50*, Prestressing Concrete*, that this BCM is based on as identified in the title block above. The information in the *Contract Specifications* typically will not be repeated in the text of this BCM.

Process Inputs

1. Submittals:
   a. Prestressing shop drawings
   b. Test samples (strand, bar, anchor assembly, etc.)
   c. Grouting plan

d. Daily grouting reports
e. Alternative prestressing shop drawings

2. Materials:
   a. Prestress anchorage system
   b. Prestressing steel (strand and bar)
   c. Duct vents and ties
   d. Grout and grout caps
   e. Corrosion inhibitor
   f. Structural concrete
   g. Pretensioned precast member
3. Quality Control (QC)/Assurance (QA):
   a. CEM-3101, *Notice of Materials to be Used*
   b. Calibration of the hydraulic jacking equipment and pressure gauges with Materials and Engineering Testing Services Representative (METS Reps), scheduled by the Contractor
   c. Contractor provided calibration data for hydraulic jack and gauges
   d. Notification from the Contractor for pressure testing of prestressing ducts
   e. Notification from the Contractor to witness duct demonstrations
   f. Notification from the Contractor for duct void investigations
   g. Copy of certificate to verify technician is certified as a Level 2 Bonded Post-Tensioning Field Specialist
   h. Copy of certificate to verify technician is certified as a Grouting Technician under American Segmental Bridge Institute (ASBI).

Procedure

1. All work associated with this process should be charged to the Project Direct – Construction.
2. The inspection of field work for this process is:
   a. Benchmark inspection for prestressing bearing plate assembly, strand, duct, and duct tie installation.
   b. Continuous inspection for soffit, stem, and deck concrete placement near PS tendons to verify adequate concrete consolidation and prevent duct damage.
   c. Continuous inspection for duct demonstration, void investigation, pressure testing ducts, strand placement, stressing and grouting.

3. Before construction begins, the Structure Representative (SR) or delegate must:
    a. During submittal review:
        i. Verify project prestress (PS) shop drawings have been received by the SC Office Associates from the Contractor in accordance with *Contract Specifications*, Section 5-1.23B(2), *Control of Work – Submittals – Action Submittals – Shop Drawings*, in a timely manner to meet the critical path schedule. Note email address provided in step 3.a.xii.
            1. Coordinate and monitor the submittal process. Establish lines of communication regarding shop drawing reviews with Bridge Design (BD) Structure Project Engineer and METS Representative (METS Rep).
        ii. Review all contract documents pertaining to prestressing concrete.
        iii. Review the following references as required to develop an understanding of prestressing and grouting operations:
            1. Caltrans *Prestress Manual*
            2. Post-Tensioning Institute (PTI)
            3. American Segmental Bridge Institute (ASBI)
            4. Federal Highway Administration *Post-Tensioning Tendon Installation and Grouting Manual* (FHWA-PTTIGM)
            5. BCM 51-4, *Concrete Structures – Precast Concrete Members.*
        iv. Perform an initial review of shop drawings for the proposed prestressing system and review comments with the BD Structure Project Engineer according to:
            1. Caltrans *Prestress Manual*:
                a. Section 2, *Prestress Shop Drawings*
                b. Section 8*, Prestressing Operation.*
        v. Verify the PS system is on the Materials and Engineering Testing Services (METS) Authorized Materials List (AML). If the system is not listed on AML, notify the METS Rep and the Contractor immediately.
        vi. Verify BD Structure Project Engineer incorporates the Structure Representative's (SR) comments before completing shop drawing review.
        vii. Verify BD Structure Project Engineer authorizes the prestressing shop drawings, per Memo to Designers (MTD) 11-1*, Prestressed Concrete – Shop Drawing Review*.
        viii. Verify all reviewers from the SC staff and the Contractor have received all rejected or authorized shop drawings.
        ix. See *Contract Specifications*, Section 4-1.07B, *Scope of Work – Value Engineering − Value Engineering Change Proposal,* for alternative

prestressing system shop drawings which require a change order (CO). See *Prestress Manual*, Appendix A, *Prestressing Systems* for required information needed for approval by METS Rep for a new or modified prestress system.

x. Verify the METS Rep receives the test sample(s) and notifies of any noncompliance issues. Coordinate and monitor the test sample(s) submittal process.

xi. Review the grouting plan as part of the PS shop drawing or as a separate submittal. If received as a separate submittal, the plan must be reviewed and authorized.

xii. If prestressing materials are used in a precast (PC) concrete member, verify PS PC concrete member shop drawings are submitted to sc.office.associates@dot.ca.gov (formerly OSD Documents Unit, now SC Office Associates) as required per *Contract Specifications*, Section 51-4.01C(2), *Concrete Structures – Precast Concrete Members − General − Submittals − Shop Drawings*.

xiii. Verify receipt of the Precast Concrete Quality Control Plan in accordance with *Contract* Specifications, Section 90-4.01C(3), *Concrete – Precast Concrete − General − Submittals − Precast Concrete Quality Control Plan*.

xiv. Attend the Contractor's PC Concrete Quality Control Meeting in accordance with *Contract Specifications,* Section 90-4.01D(2)(b), *Concrete − Precast Concrete − General − Quality Assurance – Quality Control − Quality Control Meeting*. The METS Rep, SC staff, prime contractor, and fabricator will also attend.

xv. Check the Critical Path Method (CPM) schedule as related to prestressing operation activities. Meet with the Bridge Construction Engineer (BCE) to review submittal status updates as required by the project needs. Note that the BCE is also referred to as the SC Supervisor.

b. For materials:

i. Confirm authorized PS shop drawings have been received and distributed to the Contractor, METS Rep, and SC project field staff.

ii. Confirm that the Contractor has submitted Form CEM-3101, *Notice of Materials to Be Used*, for all related materials and all precast members.

iii. For the material's release procedure refer to the Caltrans *Construction Manual*:

1. Figure 6-2.1, *Inspection and Release Flowchart – Source Inspection.*
2. Figure 6-2.3, *Inspection and Release Flowchart – Inspection at Job Site.*

iv. Confirm the materials for which the METS Rep will issue Form TL-608, *Notice of Materials to be Furnished.*

v. Verify which materials will be field released using Form TL-28, *Notice of Materials to be Inspected at Job Site* and expect:

1. Materials typically not released by the METS Rep include ducts, vent tubes, trumpets, wedges, and grout materials.
2. Grout cement shall be field released with a Certificate of Compliance (COC).

vi. Verify the following were released by METS Rep with Form TL-0029, *Report of Inspection of Material*:

1. PS anchorage system components and strands.
2. PC concrete members (PC concrete pavement panels, deck panels, girders, etc.), the PC concrete members themselves will be released.

c. In preparation for safety issues:

i. Review the following documents:

1. Project specific or Division of Construction Code of Safe Practices (COSP)
2. Safety Data Sheets (SDSs) for grout components, corrosion inhibitor, etc.
3. *Prestress Manual*, Section 1, *Safety.*

ii. Verify all required Personal Protective Equipment (PPE) are obtained for SC project field staff which may include appropriate eye protection, gloves, and dust masks.

iii. Verify the Contractor provides safe access to the job site.

d. For quality assurance:

i. Review the following documents in addition to the *Prestress Manual*:

1. *Outline of Field Construction Practices Manual* for step-by-step procedures on construction of the prestress components.
2. METS *Quality Assurance and Source Inspection (QASI) Manual* for METS Rep responsibilities.

ii. Select field samples for couplers used to extend prestressing bars. Verify test results meet contract compliance.

iii. Verify SC project field staff are trained to perform American Society for Testing and Materials (ASTM) C939 or California Test 541, *Method for Flow of Grout Mixtures (Flow Cone Method)*.

iv. For precast members:

1. Verify shop drawing dimensions of PC concrete members match required field dimensions for proper fit.

2. Review the time between fabrication of the PC concrete member and proposed installation in the field. Excessive time may lead to undesired camber which needs to be mitigated before deck placement. Steps to be taken include:
    a. Discussing and coordinating scheduled installation of PC concrete girders with the Contractor and METS Rep during the PC Concrete Quality Control Meeting before the work begins per *Contract Specifications*, Section 90-4.01D(2)(b), *Precast Concrete − General − Quality Assurance – Quality Control − Quality Control Meeting.*
3. Verify METS Rep checks girder camber periodically while being stored at the fabricator's yard and again before shipping to the jobsite.

4. During construction, the SR or delegate must:
    a. For submittals:
        i. Use the authorized prestressing shop drawing to verify materials for contract acceptance.
        ii. Confirm any additional changes (layout of ducts, bearing plates, duct ties or rebar, etc.) are implemented to:
            1. The project plans by a change order, and/or
            2. The prestressing shop drawings by the Contractor submitting a revision to the prestressing shop drawing for authorization by BD Structure Project Engineer.
    b. For materials:
        i. Review all materials for conformance with the requirements of the contract documents. For additional information on inspecting prestressing materials, see the *Prestress Manual*:
            1. Section 3, *Prestressing Ducts*
            2. Section 4, *Prestressing Strands/ Bars*
            3. Section 5, *Anchorage Devices*
            4. Section 6, *Strand Wedges*
        ii. Verify field released materials listed in Form TL-28, *Notice of Materials to be Inspected at Job Site* are released using Form CEM-4102, *Material Inspected and Released on Job*.
        iii. Verify that materials which have been released by METS are physically identified with an attached Form TL-0624, *Inspection Release Tag* (orange release tag).
        iv. Record the area (A) and Young's Modulus (E) of the strand from the fabricator's tags for each individual strand pack on the daily report.
        v. Verify that the values on fabricator's tag and the COC agree.

vi. Collect the orange inspection release tag and verify the information matches with Form TL-0029, *Report of Inspection of Material.* Note the Lot Numbers, quantity, and date of release on the back of the orange release tag.

vii. Check condition of strand packs on delivery at job site and reject if not in contract compliance. Check storage site for adequate protection of packs and prestressing materials. Strands must be properly protected with wrappings until placement.

viii. Review condition of ducts for damage or blockage.

ix. Verify corrosion inhibitors meet contract requirements, and that product data sheet and a material SDS are provided. Determine if required rust inhibitor agent has been applied to prestressing steel.

x. Verify that the Contractor uses contract-specified mix proportions and follows manufacturer's recommendation for any admixtures before grouting operation.

xi. For precast members:

1. Verify all Form TL-0015, *Quality Assurance - Nonconformance Reports* (NCR) for PC concrete members are resolved before delivery to project site.
2. Inspect PC concrete members for damage upon delivery to the jobsite and notify the Contractor immediately if PC concrete members are unacceptable for installation.

c. For safety:

i. Verify all field work is performed safely according to:

1. CAL/OSHA *Construction Safety Orders*, Section 1711, *Reinforcing Steel and Post-Tensioning in Concrete Construction*
   a. Note that these safety orders are found in the *California Code of Regulations*, Title 8, Chapter 4, Subchapter 4
2. Contractor's Injury Illness Prevention Plan (IIPP)
3. Caltrans project specific COSP.

d. For quality assurance:

i. For bearing plates and trumpets:

1. Verify that block-outs are formed to the correct slope/batter and are perpendicular to the ducts as required by the contract documents.
2. Verify reinforcing steel behind bearing plates.
3. Verify anchor plates are the correct size.
4. Verify that the trumpets are properly secured to the bearing plates.

ii. During placement of rigid ducts:

1. Verify ducts and vents are placed in accordance with the requirements of authorized shop drawings and the contract documents.
2. Verify the adequacy of end anchorage formwork and the size of anchorage hardware. Plate should be fastened to the forms at the proper angle, sealed tight and secured.
3. Verify each girder contains the correct number of ducts and the correct size of ducts as called for on the shop drawings.
4. Verify duct joints for adequate grade of waterproof tape. Be sure that there are adequate ties to hold ducts from floating during placement of concrete. Stagger joints to maintain proper profile.
5. Verify final profile of rigid duct. Consider camber in forms when visually inspecting the tendon drape. The first 15 feet from the end anchorage should also be given special attention to eliminate severe angular changes. Structure cross slope and sloping exterior girders often require special attention to correctly measure the duct profile.
6. Verify installation of intermediate grout vents. Typically, grout vents are required at all high points when there is a change in profile of six inches or more.
7. Verify that snap ties, tie bolts, etc. have not been placed through or just above or below ducts, to avoid possible duct damage.
8. Discuss optional duct demonstration in the prestressing ducts with the Contractor prior to stem and soffit concrete placement. Duct demonstration requirements must follow the contract documents and include running an approved device, referred to as a torpedo, a rabbit, or a mandrel, through the ducts.
9. Verify all defects in ducts (breaks, crushed areas, etc.) have been repaired before concrete placement.
10. Verify duct tie size and spacing is in accordance with project plan and *Standard Plans*, Section B8-5, *Cast-In-Place Post-Tensioned Girder Details*.
11. Verify duct alignment and duct tie requirements at all exterior girder flares and on curved bridges; see *Bridge Design Memo,* BDM 5.27*, Curved Cast-In-Place Prestressed Box Girders*. If duct ties are not shown on project plans, and there is a significant change in horizontal alignment of duct, contact the BD Structure Project Engineer.
12. Verify the tendon openings are sealed to prevent water or debris from entering the duct.

iii. During stem and soffit concrete placement:

1. Verify that if possible, ducts are covered with an inch of concrete in the bent cap area but allow for cap rebar clearance.

2. Verify rock pockets are avoided by proper vibration of concrete, particularly around anchor plates and low areas of the duct's path.
3. Verify no impact loading on ducts nor dropping vibrator directly on ducts.
4. Verify prestressing system alignment to see that no unusual movement takes place during concrete placement.

iv. After stem and soffit concrete placement:

1. Prior to installation of the lost deck forms, verify the Contractor performs a duct demonstration to check for any blockages that occurred during stem and soffit concrete placement. The ends of the ducts must be covered after the ducts are checked and clear of blockages. All blockages must be resolved before deck concrete placement. Sources of blockage may include:
   a. Duct dented before or during concrete placement.
   b. Form ties placed through duct or duct crushed by rebar etc.
   c. Concrete leakage into duct during concrete placement.
   d. Separation of duct sections due to inadequate fabrication.
2. Inspect the area around the anchorages and all stems for rock pockets. Voids must be repaired. Epoxy concrete or other specialty concrete mixes should not be used for repairs behind bearing plate, whether before or after stressing. See Attachment 1*, Precautions During Prestressing Concrete Operations.*
3. Verify damaged ducts are repaired and the ends of the ducts must be covered.
4. Verify ducts are aligned with trumpets.

v. During deck concrete placement:

1. Verify vent pipes are protected from damage.
2. Verify vent locations are marked before deck placement.
3. Ensure sufficient concrete test cylinders are taken to verify required strength before tensioning.

vi. During fabrication and placement of tendons:

1. Verify the Contractor performs a duct demonstration to confirm the ducts are free of water, damage, and debris. Remove or fix blockages so strands can be pushed or pulled through ducts.
2. Verify that when a complete tendon is on the ground, the strands must be:
   a. Free of dirt and debris before inserting the tendon through the duct.
   b. Protected from scraping or wear when pulled over dunnage.

3. Verify the strands are adequately protected from contamination and damage during tendon installation.
4. Verify strands remain free from rust before installation and grouting. See *Prestress Manual*, Section 4, for rust inspection.
5. Verify unusual angle points are avoided when placing the tendons into ducts.
6. Verify correct tendon sizes and number of strands are installed in their proper locations.
7. Consider "rust free" period and possible need for corrosion inhibitor requirement once strands installed; refer to the manufacturer recommendation for dosage.
8. Verify tendons are protected from electric welding operations. Refer to Attachment 1, *Precautions During Prestressing Concrete Operations.*

vii. Before stressing:

1. Verify posting of restricted work area signs and delineations required during stressing operation. See Cal/OSHA *Construction Safety Orders,* Section 1711, *Reinforcing Steel and Post-Tensioning in Concrete Construction.*
2. Verify concrete strengths and age meet contract requirements.
3. Verify the Contractor's staff performing prestressing and grouting operation includes the following qualifications:
    a. For all prestressing operations, a technician that is certified as a Level 2 Bonded Post-Tensioning Field Specialist must supervise the work.
    b. For grouting only, a technician certified as a Grouting Technician through the ASBI is acceptable.
4. Verify prestressing equipment has been calibrated in accordance with the requirements of the contract documents. See METS' authorized jack calibration list.
5. Verify the Contractor has furnished the required calibration curves for specific jack/gauge combination.
6. Secure a SC strain indicator and pressure cell (SIPC) unit and a standby unit well in advance. Verify SIPC are in good working condition. Check with the BCE for availability.
7. Understand the operational procedure for the use of SIPC. Instructional videos are available on the SC Intranet in the Training tab.
8. Contact the SC Equipment Manager if repairs are needed.

9. Verify stressing preparation by prepopulating the appropriate section of Form SC-4301, *Post-Tensioning Field Monitoring Chart*, before field operations.
10. Verify the Contractor's theoretical prestressing steel elongations using the authorized shop drawings; refer to *Prestress Manual*, Appendix D, *Post-Tensioning Losses and Elongations*, and Appendix E, *Example Calculations*, for examples.
11. Verify theoretical elongations using the actual A and E values taken from the fabricator's material properties from each released strand pack (see step 4.b.iv.). Typically, COC values are used but need to be cross referenced with the strand pack tag numbers.
12. Prepare the following:
    a. Form SC-4302, *Prestress Calibration Monitoring Sheet*
    b. Form SC-4302A, *Prestress Calibration Gauge Pressure vs. Jacking Force*
13. Discuss potential problems with the prestressing operation with the Contractor, BCE, and experienced staff before start of work. This includes adverse weather forecast and expectations on the day of stressing.
14. Verify from the contract plan the stressing is from one end, from both ends, or simultaneously from both ends. Do not change this without the approval of the BD Structure Project Engineer as this may lead to unexpected girder loading.
15. Verify the stressing sequence shown on the shop drawings with the Contractor. Not following the sequence may result in damage to the structure and is not permitted.
16. Inspect the deck surface for compliance with *Contract Specifications*, Section 51-1.01D(3)(b)(iv), *Concrete Structures – General − Quality Assurance − Department Acceptance − Testing Concrete Surfaces − Crack Intensity*. Deck cracks shall be mapped before post tensioning for contract compliance.

viii. During stressing:

1. Verify the Contractor will:
    a. Paint strands on both ends to check for slippage or strand breakage.
    b. As a safety precaution, secure areas around the dead end and live end of the stressing operation for authorized personnel only.
2. Plot at least one calibration curve per structure frame.

3. Monitor the Contractor's jacks at the start of each day, but not necessarily while stressing every tendon. SR may require additional monitoring.
4. Verify Contractor's hydraulic jack and gauge using the Department's SIPC following procedures outlined in the *Prestress Manual*:
    a. Section 7, *Prestressing Jacks*
    b. Section 8, *Prestressing Operation*
    c. Appendix B, *Strain Indicator-Pressure Cell*
5. If unable to verify the Contractor's gauge pressure within the tolerances discussed in the *Prestress Manual,* then:
    a. The Contractor must verify the pressure gauge and jack are working correctly together using required backup gauge for comparison.
    b. If the SR or BCE allows work to proceed without the SIPC, elongation must be carefully compared between theoretical and actual.
6. When using the SIPC:
    a. Verify SIPC have been calibrated for the hydraulic jack and gauge onsite. If available, a second strain indicator may be used for comparison.
    b. Only turn the unit on while monitoring the Contractor's jack.
    c. Avoid damage to the strain indicator unit by unplugging and moving it away from the jacking equipment when not in use.
7. Discrepancies between theoretical and actual elongations that exceed 5 - 10% require the following actions:
    a. Notify the Contractor to not cut strand on any tendons.
    b. Compare elongations between adjacent tendons. Deviations exceeding 4% need an explanation.
    c. Verify theoretical elongations and compare to actual recorded elongations on Form SC-4301.
    d. Review *Prestress Manual*, Section 8, *Prestressing Operation – D. Elongation Measurements and Calculations,* for possible explanations/causes.
    e. Consult with the SR, BCE, and BD Structure Project Engineer as appropriate if source of discrepancies not found.
    f. Proceed only when discrepancy explained and determined acceptable by SR.
8. Continue completing the following forms, started before stressing:

a. Form SC-4301, *Post-Tensioning Field Monitoring Chart*
b. Form SC-4302, *Prestress Calibration Monitoring Sheet*
c. Form SC-4302A, *Prestress Calibration Gauge Pressure vs. Jacking Force*

9. Document all QA activities for stressing operation in the daily report.
10. If any anchorage hardware fails (even if the problem was corrected), call the BCE and the SC HQ Office Chief.
11. For strand breakage or slippage:
    a. Stop work and evaluate the capacity of the remaining strands.
    b. Contact the BD Structure Project Engineer to determine whether any broken or slipped strands in tendon need replacement.
    c. Contact BCE to determine if additional action is required.
    d. Discuss how to proceed with the Contractor.
12. Verify the final force in the prestressing tendons matches the force shown on the authorized shop drawings after seating, based on field monitoring and measurements. Do not over-tension the tendons or structural elements. Any variations in tendon loading from the authorized shop drawings must be approved by the BD Structure Project Engineer.
13. Allow the Contractor to cut excess strand only after tendons have been properly seated and accepted. If the Contractor cuts the strand without approval, stop work, and verify adequacy of the tendon prior to grouting.

ix. After stressing and before grouting:

1. Review authorized grouting plan along with *Prestress Manual*, Section 9, *Grouting Operation.*
2. Verify prestressing ducts meet pressure testing requirements of the contract documents.
3. Complete Form SC-4305, *Air Pressure Field Monitoring Chart*.
4. If air pressure test fails to meet contract requirements:
    a. Notify the Contractor of noncompliance.
    b. Require the Contractor to locate the cause of the pressure test failure.
    c. Require the Contractor to repair leaks with authorized methods.
    d. Retest ducts after repair.
5. Verify once again that the ducts are free of water just before grouting.

6. Verify grouting operation will take place within 10 days after strand installation unless corrosion inhibitor placed.
7. Verify that there are no missing strands before placing grout caps. Do not proceed if the correct number of strands are not present since this may be due to slippage or failure.
8. Calculate theoretical grout volume for each duct.
9. Discuss with the Contractor the requirement to:
    a. Discharge two gallons of grout at the last vent.
    b. Include concrete washouts or other suitable receptacles on and off the bridge.
    c. Collect the wasted grout and verify proper disposal.
10. Verify excessive Contractor-produced vibrations are not occurring within 100 ft of the frame in which grouting is taking place.

x. During grouting operation:

1. Verify the cement is the correct type per *Contract Specifications*, Section 90-1.02B(2), *Concrete − General − Materials – Cementitious Materials − Cement* and protected from adverse conditions such as excessive moisture. A COC is required for cement before placing the grout.
2. Verify water for the grout is not contaminated and complies with *Contract Specifications*, Section 90-1.02D, *Concrete − General − Materials – Water*.
3. Verify grouting equipment meets specifications and has adequate capacity for the job. Verify the Contractor has a standby grout mixer and pump.
4. Verify grout is flowable in extreme ambient conditions. Additional measures may be required if:
    a. Temperatures approach, or are below freezing.
    b. Ambient temperatures are above 100 degrees.
5. If grout temperatures are predicted to exceed 90 degrees:
    a. Adjust to maintain the temperatures of the grout ingredients and prevent grout from flash setting.
    b. Add ice to the water to reduce the temperature of grout.
    c. Do not use dry ice or liquid carbon dioxide (CO_2) as a cooling agent.
6. Verify pumping of grout starts within 30 minutes of mixing.

7. Verify the use of water/cement ratio not to exceed five gallons of water to one sack of cement or does not exceed manufacture's recommendation for prepackaged grout.
8. Verify any admixtures are authorized before use.
9. Perform California Test 541, *Method of Test for Flow of Grout Mixtures (Flow Cone Method)* or ASTM C939*,* at the point of introduction and discharge of grout from the duct. Test for grout efflux time. Document test results in the daily report.
10. Verify there is continuous agitation of grout during grouting.
11. Verify grout screen size of 1/16 inch or less.
12. Monitor the grouting pressure and check if pressure:
    a. Gradually increases as the duct is filled.
    b. Has a blockage which is indicated by:
        i. A sudden jump in pressure.
        ii. Excessive pressure that reaches 150 psi.
13. If there is a blockage, notify the Contractor to:
    a. Stop injecting grout and investigate blockage.
    b. Develop a repair action plan.
    c. Resolve blockage as required to prevent any voids in the tendon before continuing to grout.
14. Verify when grouting from a series of injection points, that the grout has flowed past the next point. This is to confirm grout is flowing in one direction, and not back towards previous injection point - otherwise there is risk of creating an air pocket.
15. Verify that the actual quantity of grout placed in each duct substantially agrees with theoretical grout volumes.
16. If grout leaks or cross-grouting are observed:
    a. Notify the Contractor to stop grouting and determine the sources of leak or cross-grouting.
    b. The Contractor may consider patching girder leak and continue grouting.
    c. For cross-grouting into adjacent tendon, notify the Contractor to stop pumping grout until an acceptable resolution can be agreed upon. Resolutions must result in no remaining voids in the affected tendons.
    d. Secondary grouting by vacuum grouting may be required for unresolved blockages or grout losses; see *Contract Specifications*, Section 50-1.03B(2)(d)(ix), *Prestressing Concrete − General −*

Construction – Prestressing − Post-Tensioned Members − Bonding and Grouting − Secondary Grouting.

17. Verify the consistency of the effluent grout through vents and grout caps is equivalent to the consistency of the injected grout.
18. Verify the Contractor closes the outlet valve before closing inlet valve.
19. Verify no grout leakage by briefly holding working grout pressure.
20. Verify the Contractor locks off at a minimum of 5-psi of grout pressure when the inlet valve is closed.
21. Verify excessive contractor produced vibrations are not occurring within 100 feet of the frame with grouted ducts for a period of 24 hours after grouting.
22. Verify void investigation of ducts is performed and completed 24 to 72 hours after grouting. See *Contract Specifications*, Section 50-1.101D(2)(e), *Prestressing Concrete − General − Quality Assurance − Quality Control − Void Investigation*. Voids are filled with secondary grout. Secondary grout must comply with ASTM C1107, *Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink),* and the *Contract Specifications*.
23. Verify cleanup and disposal is in accordance with the contract documents and authorized Water Pollution Control Program (WPCP)/Stormwater Pollution Prevention Plan (SWPPP).
24. Verify the Contractor submits completed daily grouting reports within 3 business days after grouting in accordance with *Contract Specifications*, Section 50-1.01C(7), *Prestressing Concrete − General − Submittals − Daily Grouting Report*. File reports in the prestress grout category contract file.

xi. For miscellaneous items:

1. Most of the preceding inspection suggestions are also applicable to post-tensioned ground anchors, transverse bridge deck or bent cap stressing, bridge strengthening applications and vertical tie-downs. However, there may be additional inspection items that are unique to these non-box-girder applications. Inspection guidelines for these applications shall be coordinated through SC HQ and referencing the appropriate subject BCM and technical manuals.
2. On rare occasions, usually due to unforeseen emergencies, the Contractor may desire to post-tension partially completed bridges. All requests to stress partially completed bridges shall be discussed with the BCE, Area Construction Manager (ACM), and BD Structure Project Engineer.

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

5. Following construction, the SR or delegate must:

   a. For submittals:

      i. Verify the Contractor submits electronic copies of the as-built shop drawings in accordance with the *Contract Specifications*, Section 5-1.23B(2), *Control of Work – Submittals – Action Submittals – Shop Drawings*. Drawings received by the SC Office Associates must be routed to the project field staff for review of accuracy and completeness.

         1. On externally financed projects that are not Department designed or administered, authorization of the shop drawings rests with the Local Agency Engineer or the Consultant Designer. The SC Oversight Engineer verifies as-built shop drawings are submitted to the SC Office Associates upon completion of the contract.

      ii. Document receipt of all as-built shop drawings in the final records section of the contract files.

   b. For materials:

      i. Verify payment:

         1. Refer to BCM C-9, *Preparation of Progress Payment Documents*, for monthly progress payments (partial payments for lump sum item).

         2. Take administration deduction for broken or slipped prestress strands.

      ii. Verify all prestress forms are accurately completed and filed in the appropriate categories of the project files in accordance with the *Construction Manual*.

   c. For quality assurance:

      i. Complete documentation of QA activities, which include METS sample testing, physical condition of prestressing steel, verification of prestressing forces, and grout testing.

      ii. After the prestressing operation is completed at each structure for a project:

         1. Verify all deviations from the project plans are noted on the project as-built plans, and the prestress shop drawings.

         2. Verify the prestressing material information and any problems with materials is entered on Form SC-6303, *Report of Completion – Bridges*.

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

Process Outputs

1. Authorized prestressing shop drawings
2. Authorized test samples
3. Authorized prestressing materials
4. Authorized grouting plan
5. Authorized daily grout reports
6. Completed daily reports
7. Completed Forms: CEM-4102, *Material Inspected and Released on Job*; SC-4301, *Post-Tensioning Field Monitoring Chart*; SC-4302, *Prestress Calibration Monitoring Sheet*; SC-4302A, *Prestress Calibration Gauge Pressure vs. Jacking Force;* and SC-4305*, Air Pressure Field Monitoring Chart*
8. Submitted electronic copies of the as-built shop drawings by the Contractor
9. Submitted electronic as-built shop drawings by Local Agency Engineer

Attachments

1. Attachment 1, *Precautions During Prestressing Concrete Operations*