Concrete – General

Revision and Approval

Revision	Date	Nature of Changes	Approved By
0	12-08-2022	Original Issue	Richard Foley

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Background

This process establishes Structure Construction (SC) responsibilities and procedures for the following:

1. Review and authorization of action submittals pertaining to concrete aggregate gradation, cementitious materials, admixtures, curing compounds, mix designs, delivery, testing, stationary mixer certification, concrete protection, quality control plan, concrete materials quality control summary report, and polymer fibers.
2. Quality assurance of the attributes of concrete, including cementitious material content, shrinkage limitations, uniformity of freshly mixed concrete, compressive strength, prequalification, and curing compounds.
3. Concrete material acceptance criteria when inspecting concrete deliveries and placement of concrete through verification of concrete batch proportioning, mixing, transporting, and concrete water content by penetration or slump testing.
4. Curing and protection of freshly placed concrete.

Prior to reviewing this Bridge Construction Memo (BCM), it is essential to review the *Contract Specifications*, Section 90-1, *Concrete – General*, 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. Concrete mix design and material submittals as required by the *Contract Specifications.*

Procedure

1. All work associated with this process is charged as Project Direct – Construction.
2. Inspection of field work for this process is:
   a. Benchmark for:
      i. Batch plant certifications
   b. Continuous for:
      i. Verification of concrete delivery, mixing, discharge, water content and curing operations
   c. Intermittent for:
      i. Material verification and authorization
3. Before construction begins the Structure Representative (SR) or delegate must:
   a. Review the following to gain familiarity with administration practices for concrete placement activities:
      i. Contract documents
      ii. *Construction Manual*, Chapter 6, *Sampling and Testing*, for concrete placement activities
      iii. *Concrete Technology Manual*
      iv. Relevant training such as a Winter Training presentation which covers Concrete Technology.
   b. Discuss and review concrete practices with other engineers and supervisor.
   c. Discuss upcoming material sampling and testing with the District Materials Engineer/ Field Tester and cover the following topics:
      i. Determine how much notice will be required for the District Materials Engineer to collect required concrete material samples and perform testing.
      ii. Determine how soon test results will be available after testing.
      iii. Determine which test equipment calibrations will be needed during the project. Reference Attachment 2, *Fresh Concrete Field Sampling and Testing Equipment List*, for a list of typical equipment required to perform routine fresh concrete sampling and testing.
      iv. Verify batch plant is in conformance according to California Test (CT) 109, *Method for Testing of Material Production Plants*.
   d. Review materials, submittals, and techniques with SC staff. Verify SC staff are familiar with inspecting concrete placement, performing required submittal

reviews, and have the required testing certifications. To follow are useful resources:

i. District Material Engineer for California Test certifications.

ii. The American Concrete Institute (ACI) - Certification - Certification Programs website to obtain information regarding certification as Concrete Field Testing Technician Grade 1. Note that this is found under the *Testing Programs – Field Concrete Testing* path.

1. Information on this topic can also be found at the SC intranet, ACI Field Training.

iii. Bridge Construction Engineer, to obtain or update the above certifications and to facilitate the training requirements.

e. Verify that SC staff have the required equipment for the necessary tests. The Resident Engineer (RE) may be able to provide standard concrete testing equipment from the District warehouse. The SC Equipment Manager may be contacted if additional test equipment is needed. Reference Attachment 2, *Fresh Concrete Field Sampling and Testing Equipment List*, for a list of equipment needed for typical ASTM/ CT concrete test procedures.

f. At the preconstruction conference discuss the following with the Contractor:

i. Concrete mix design submittal specification requirements and review times for each concrete mix design submittal. If the Contractor is submitting multiple mix designs, remind the Contractor to prioritize the review schedule. Refer the Contractor to the *Contract Specifications*, Section 5-1.23, *Control of Work – Submittals* for additional requirements.

ii. Unique specification requirements (corrosive environments, mass concrete, wet cast-in-drilled-hole concrete piling, etc.) that may require special attention in the concrete mix design submittal and review process.

iii. Prequalification requirements when specified, or when concrete has a described 28-day compressive strength greater than 3,600 psi.

iv. Quality assurance test requirements, such as concrete temperature, aggregate, admixture, air entrainment, concrete strength testing, and water content.

v. Expectations for timely pour notifications to allow coordination of staffing, batch plant inspection, and concrete sampling and testing.

vi. Any concrete placement submittal requirements.

vii. Methods for furnishing and protecting concrete.

viii. Limitations of concrete batch size based on manufacturer's guaranteed capacity, and the requirements for concrete trucks to have an electrically

or mechanically actuated revolution counter that readily allows verification of the number of revolutions of the drum or blades.

ix. The requirements of *Contract Specifications,* Section 90-1.02G(3), *Concrete – General – Materials – Mixing and Transporting Concrete – Transporting Mixed Concrete*, which stipulates the conditions under which concrete may be incorporated into the work.

g. Verify Form CEM-3101, *Notice of Materials to Be Used*, is received from the Contractor and then forward the form to Materials Engineering and Testing Services (METS).

h. Perform initial review of the concrete mix design submittal. Use Form SC-4303, *Concrete Mix Design Submittal Checklist*, as an initial acceptance tool to provide a comprehensive review of concrete mix design components and to point out gaps in the submittal. Verify the concrete mix design title block indicates the "intended use" (e.g., "CIDH," "stem and bent caps," "bridge deck," "abutment," "approach slab," "miscellaneous concrete") to ascertain cementitious requirements. When it is discovered that required components of the concrete mix design is not included in the submittal, stop the review, and promptly notify the Contractor in writing of the missing components. It is SC practice to expedite the authorization process by reviewing as much of the mix design as possible while waiting for the resubmission of missing components of the mix design, following the initial review.

i. Review and authorize each concrete mix design submittal in accordance with the *Contract Specifications* and the *Construction Manual*, Section 4-9001A(2), *Check of Mix Design*. Use SC Forms 4303B-E, *Concrete Mix Design Check Spreadsheet* or METS Concrete Mix Design Check application in METS J2 database to check mix design components. Refer to the *Concrete Technology Manual*, Chapter 3, *Review of Concrete Mix Designs,* for background information. Technical assistance during submittal reviews and construction may be provided by METS Contacts or the SC Concrete Material Technical Team B. The following concrete components and related items should be verified when reviewing a concrete mix design submittal:

   i. For cementitious materials perform the following steps as part of the mix design review process:

      1. Verify each proposed cementitious material is on the Authorized Materials List (AML).

      2. Review the submitted certificate of compliance for each cementitious material. Confirm that the cementitious classification, type, and chemical compositions meet the minimum contract requirements.

      3. Using Form SC-4303D, *Concrete Mix Design Check – SCM Evaluation*, in the *Concrete Mix Design Check Spreadsheet*:

a. Verify the mix design cementitious materials meet the mathematical requirements for minimum cementitious content.

b. Consider unique requirements of cementitious materials for corrosive environments, freeze-thaw areas, and deicing chemicals.

ii. For aggregates if the gradation specifications for minor concrete has been waived, advise the Contractor, and document that decision in writing. Perform the following steps as part of the concrete mix design review process:

1. Verify that the Contractor has submitted all required quality control (QC) test results of aggregates prior to starting the authorization analysis. If test results are not available, have the aggregates tested and obtain test results.

2. Review and authorize aggregate gradation (with X-values) submittal. Verify contract conformance by completing Form SC-4303B, *Concrete Mix Design Check -Aggregate Gradation*.

iii. For water, review water test results and authorize water for use.

iv. For admixtures refer to the *Concrete Technology Manual*, Chapter 2, *Concrete Construction Materials*; and Chapter 3, *Review of Concrete Mix Designs*. Perform the following steps as part of the concrete mix design review process:

1. Verify admixtures are on the AML.

2. Verify that the dosage amounts of admixtures are within the manufacturer's recommendations.

3. When multiple admixtures are used, verify the admixtures are compatible with each other per information provided in the manufacturer's recommendations.

v. For polymer fibers, review and approve polymer fiber submittals in accordance with contract documents.

vi. Review and verify shrinkage limitations are met when specified.

1. Refer to the *Concrete Technology Manual*, Chapter 2, *Concrete Construction Materials*, Chapter 3, *Review of Concrete Mix Designs* and Chapter 5, *Concrete Construction* for background information.

vii. Verify the concrete mix design compressive strength requirements are met when specified concrete strength at 28-days is 3,600 psi or greater.

viii. If the concrete has a described 28-day compressive strength greater than 3,600 psi, or if prequalification is specified, prequalify the materials, mix

proportions, mixing equipment, and procedures proposed for use in the work before placing the concrete, per contract requirements.

ix. For stationary mixer certification, review and authorize each Stationary Mixer Certification submittal in accordance with the contract documents. Refer to *Concrete Technology Manual*, Chapter 4, *Proportioning, Mixing and Transporting*, for additional guidance.

j. Notify the Contractor in writing of the authorization or rejection of each concrete submittal. Refer to the *Concrete Technology Manual*, Chapter 3, *Review of Concrete Mix Designs*, for review examples. For each authorized concrete mix design, send a courtesy copy to the METS Representative (METS Rep) and the District Materials Engineer. See Attachment 1, *Sample Letter to Authorize Concrete Mix Designs*.

k. Contact the District Materials Engineer to verify that the batch plant has been CT 109 certified before any production work starts.

l. Confirm that the METS Rep has tested and released the curing compound batch prior to authorizing the material. Authorize each curing compound submittal based on METS test reports and certificates of compliance.

m. Review concrete materials test results and quality control informational submittals in accordance with *Contract Specifications*, Section 5-1.23, *Control of Work – Submittals*. Inform the Contractor of unacceptable test results.

n. Print all concrete mix design check records and provide to field inspection staff. The concrete mix design checks produced by the *Concrete Mix Design Check Spreadsheet* are:

i. Form SC-4303B, *Concrete Mix Design Check- Aggregate Gradation*

ii. Form SC-4303C, *Concrete Mix Design Check- Batch Info*

iii. Form SC-4303D, *Concrete Mix Design Check- SCM Evaluation*

iv. Form SC-4303E, *Concrete Mix Design Check - Aggregate Gradation Chart*

o. Review concrete pour notification from the Contractor, which is typically received 24 hours and ideally 48 hours before the scheduled concrete pour.

i. After verifying the accuracy of the pour notification (correct mix design, item to be poured will be ready at intended time, etc.), coordinate adequate State staff for field inspection.

1. Schedule batch plant inspection and material sampling and testing for the time of the pour.

a. Consider the size of the concrete pour. For pours with anticipated quantities greater than 300 CY, more than one set of cylinder sampling will be required per the *Contract Specifications* and as

outlined in the *Construction Manual*, Table 6-1.17, *Materials Acceptance Sampling and Testing Requirements: Concrete.*

b. It is recommended that sampling concrete for compressive strength testing be performed when the concrete mix design is first used.

p. It is highly advisable to conduct a pre-pour meeting for concrete, grout, or mortar placement with the Contractor and District RE to:

i. Review authorized concrete submittals, concrete placement, logistical considerations, staff qualifications, expectations for timely pour notifications, assess potential risks, and schedule batch plant inspection services and testing requirements.

ii. Review the proposed concrete curing methods. Verify the curing compound has been tested and released.

iii. Review the proposed concrete protection methods when concrete materials, placement restrictions, weather conditions or other adverse conditions warrant extra precautions to protect fresh concrete.

1. Refer to *Concrete Technology Manual*, Chapter 5, *Concrete Construction,* for guidance.

iv. Review additional items such as site access, lane closures, flagging, and location of concrete washouts.

q. In preparation for checking concrete batch tickets before a pour, develop a spreadsheet that extrapolates the mix design quantities for the common delivery truck loads. The spreadsheet permits a quick review of load tickets at the job site to verify the mix design proportions for different size loads.

r. During trial batch and concrete placement operations, verify and document the following in daily reports:

i. The areas used for testing meet Stormwater Pollution Prevention Plan requirements.

ii. The concrete batch delivery matches the authorized concrete mix design.

iii. The unit weight for cementitious material content by:

1. Performing CT 518, *Method of Test for Density (Unit Weight) of Fresh Concrete*.

2. Completing Form SC-4304, *Worksheet for California Test 518 Unit Weight of Fresh Concrete*. Refer to the instruction tab for guidance, as well as the two Example tabs for completed forms.

iv. Compliance with the test frequency specified in the *Construction Manual*, Table 6-1.17.

v. The concrete uniformity. Perform at least two penetration (CT 533, *Method of Test for Ball Penetration in Fresh Portland Cement Concrete*) or slump (ASTM C143, *Standard Test Method for Slump of Hydraulic-Cement Concrete*) tests for each concrete placement operation in accordance with *Construction Manual* (Table 6-1.17). Reject concrete materials with failing tests and do not allow the material to be incorporated into the work.

vi. Fabrication of test cylinders for compressive strength tests per:

1. CT 539, *Method of Test for Sampling Freshly Mixed Concrete*
2. CT 540, *Method of Test for Making, Handling, and Storing Concrete Compressive Test Specimens in the Field*, which requires two test cylinders minimum, and should be performed at least once per significant concrete placement operation. The test frequency is specified in the *Construction Manual* (Table 6-1.17).

4. During Construction the SR or delegate must:

a. Collect and review concrete weighmaster batch tickets (for each truck) and a certificate of compliance, usually sent with the last concrete truck.

i. If concrete is rejected, note reasons for rejecting the concrete and the location of any concrete that was placed prior to the concrete being rejected.

ii. Assistant Structure Representative must notify the SR if there is a compliance issue; each weighmaster batch certificate (concrete ticket) must be verified for compliance with the authorized mix design in use.

iii. Refer to *Concrete Technology Manual*, Chapter 4, *Proportioning, Mixing and Transporting* for further guidance.

iv. After every concrete pour, all of the concrete batch tickets and the certificates of compliance should be assembled and used to complete form SC-4306, *Concrete Pour Record*.

1. This ongoing tracking of concrete pours is a useful tool when preparing monthly progress payments, as well as assisting with routine organization of paperwork.

b. Field verify application of concrete, grout or mortar curing method meets the requirements of the contract documents and conforms to the project plans as determined at the pre-pour meeting. Refer to BCM 51-1.03H, *Concrete Structures – General – Construction – Curing Concrete Structures*, for guidance.

i. For the water method verify water application for the required curing time period.

ii. For the curing compound method verify the curing compound is correct for the placement location. Verify curing compound mixing and application per the requirements of the contract documents.

iii. For the waterproof membrane method verify the waterproof membrane is suitable for use.

iv. For the forms-in-place method verify the forms remain in place for the required time period.

c. Field verify the concrete protection plan is followed, if required.

d. After the concrete pour, when the test cylinders have cured for the appropriate amount of time, coordinate compressive strength tests of the cylinders.

i. Fill out Form TL-0101, *Sample Identification Card,* to accompany the cylinders.

ii. Coordinate testing of the cylinders with the nearest Caltrans Materials Laboratory.

1. Testing is performed per CT 521, *Method of Test for Compressive Strength of Cylindrical Concrete Specimens*. Note that this test is performed by laboratory staff, not by SC staff.

iii. Obtain strength test results from the District Materials Engineer, or through the Data Interchange for Materials Engineering (DIME); note that an account login is required.

1. Note that *Construction Procedure Directive*, CPD 22-12, *DIME Statewide Implementation,* requires certain test results to be posted in DIME beginning in January 2023.

2. Review strength results and compare to contract requirements. Discuss any deficient results with the BCE and the Contractor and determine appropriate course of action (see additional guidance in Procedure step 4.h.).

e. Conduct post-pour review with the Contractor at the next scheduled meeting.

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

g. Prior to each progress payment complete quantity sheets and submit to the RE.

h. For measurement and payment, verify compliance with compressive strength requirements. If compressive strength requirements are non-compliant with

the contract requirements because of insufficient strength, take the following steps:

i. Reject the concrete represented by the failed test. Typically, the failed test represents a maximum of 300 cubic yards, but contract documents may modify the concrete volume represented by the cylinders.

1. Determine whether the concrete placed is structurally adequate to remain in place but with an administrative deduction. If in doubt, coordinate with the Bridge Design Structure Project Engineer.

2. If concrete is structurally adequate, ask the Contractor to elect between: replacing the rejected concrete, or accepting an administrative deduction for the concrete represented by the test in accordance with *Contract Specifications,* 90-1.01D (5)(a), *Concrete – General – General – Quality Assurance – Compressive Strength – General.*

5. Following Construction, the SR or delegate must:

   a. Update project records (SC-4306, *Concrete Pour Record*, SC-3701, *Test Result Summary*) as required. Review records for completion.

6. File all project documentation (correspondence, materials acceptance documentation, daily reports, concrete mix design check records, testing certifications, test equipment calibration records, 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 concrete submittals
2. Completed Form SC-4303, *Concrete Mix Design Submittal Checklist*
3. Completed SC Forms SC-4303B-4303E, *Concrete Mix Design Check Spreadsheet*
4. Concrete material testing records
5. Daily reports
6. Concrete pour records with batch tickets and certificates of compliance
7. Properly cured concrete
8. Properly protected concrete
9. Record of post-pour concrete review meeting

Attachments

Attachment 1: *Sample Letter to Authorize Concrete Mix Designs*

Attachment 2: *Fresh Concrete Field Sampling and Testing Equipment List*