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### Section 3 Field Tests

#### 6-301 General

The resident engineer must make sure that materials incorporated into the project comply with specifications. Refer to Section 3-609, "Testing by Caltrans," of this manual.

Perform field inspection of material and testing in accordance with the guidelines in this chapter. Sampling and testing frequencies for materials acceptance are shown in the tables included in Section 6-107, "Materials Acceptance Sampling and Testing," of this manual. Maintain a record of field tests and material inspected and released on the job as described in Section 5-102, "Organization of Project Documents," of this manual.

#### 6-301A References

Unless specified, references are Caltrans guides and manuals.

California Test guidance, Materials Engineering and Testing Services (METS):

<https://dot.ca.gov/programs/engineering-services/california-test-methods>

American Association of State Highway and Transportation Officials (AASHTO), American Society for Testing and Materials International (ASTM), and other test methods are available at the IHS Markit Standards Store website, which is accessible to Caltrans staff who click on the Material Standards (ASTM/AASHTO) link after pasting the following link into their browser for this Caltrans-only web page:

<http://des.onramp.dot.ca.gov/materials-engineering-and-testing-services-mets>

*Material Plant Quality Program (MPQP)*, Division of Construction:

<https://dot.ca.gov/programs/construction/publications>

*Laboratory Safety Manual*, paste the following link into your browser:

<http://des.onramp.dot.ca.gov/des-safety-meeting-information>

#### 6-302 Field Inspection and Release of Materials

When materials or products listed in Table 6-2.3., "Materials Accepted by Certificate of Compliance," of this manual arrive on the job site, or where METS assigns inspection of products for which they normally have responsibility back to the resident engineer, use the following procedure:

- Verify that METS has sent Form TL-0028, "Notice of Materials to Be Inspected at Job Site." If a material does not have a corresponding TL-0028, contact the project's structural materials representative.
- Verify that the material meets the requirements of the specification and is undamaged by shipping and handling.

- When required by the specifications, verify that the material has a certificate of compliance from the supplier stating that the material meets all required specifications for the contract.
- Check that the appropriate documentation is included for materials covered by the Buy America requirements. Refer to Section 3-604, “Buy America,” of this manual for Build America, Buy America Act information.
- Verify that the environmental product declaration is provided for materials subject to Buy Clean California Act requirements. Refer to Section 3-606, “Buy Clean California Act,” of this manual for information.
- Complete Form CEM-4102, “Material Inspected and Released on Job.”

### **6-303 Field Laboratory**

Suitable laboratories and equipment are necessary to perform proper field testing. When economically feasible, a field laboratory should be established to assess multiple construction projects in the immediate area.

Field laboratories must comply with the *Laboratory Safety Manual*. The *Laboratory Safety Manual* is required under California Code of Regulations Title 8, Section 5191 (8 CCR 5191), “Occupational Exposure to Hazardous Chemicals in Laboratories.” The *Laboratory Safety Manual* guidelines and procedures must be implemented and enforced at all materials testing laboratories in Caltrans, including field construction laboratories.

Most laboratories have water, gas, and electricity. Field laboratory facilities are provided by any of the methods covered under Sections 1-4, “Facilities and Equipment,” and 1-5, “Field Expenses and Purchases,” of this manual.

The resident engineer should coordinate with the district materials engineer to establish a field laboratory.

### **6-304 Field Testing Equipment**

Each district materials engineer must have an effective calibration program for equipment used for materials acceptance testing. Testing equipment must be in proper operating condition and calibrated within prescribed tolerances for accuracy.

Standards for calibration of testing equipment are described in the appropriate California Tests for calibration and manufacturer’s instructions.

District materials laboratories perform periodic reconditioning and calibration of field laboratory testing equipment. The use of decals attached to testing equipment showing date of last calibration, name of calibrator, the district, and date that the next calibration is due, is a requirement for all testing items listed in this section. Acceptance samplers and testers should verify that field testing equipment is in good condition and check the date of last calibration on the decal.

Any testing equipment that does not meet calibration requirements is to be recalibrated or replaced without delay. Each piece of equipment should be recalibrated and reconditioned in accordance with the frequencies listed in the appropriate

California Test. More frequent calibration may be required depending on use of equipment and on moving and handling practices.

While the maximum interval between calibrations may be as long as a year, equipment should be calibrated any time there is reason to believe it has been damaged or affected in any way that would alter calibration.

#### 6-304A Scales and Balances

All scales and balances used in field testing must be periodically recalibrated. The district materials engineer can use a service contract to use technicians from private industry to perform the recalibration. Recalibration of this equipment must be performed at least once each year. New scales and balances must be calibrated before use.

In the interest of standardization, the following types of scales are recommended for field use:

- A 20-kilogram balance equipped with graduated bars on the beam to give readings less than 1,000 grams without recourse to loose weights.
- A 6-kilogram trip scale equipped with agate bearings and double beam. The upper beam should be graduated to 100-gram units, making a range of 1,100 grams directly on the beam without recourse to loose weights. The equipment should include one 1-kilogram and two 2-kilogram weights with scoop and scoop tare, all to provide a full capacity of 6 kilograms.
- A torsion balance of 500-gram capacity, accurate to 0.10 gram.

When the volume of work is large, an automatic digital scale can be used instead of the 20-kilogram and 6-kilogram scales.

#### 6-304B Screens and Sieves

Examine all screens and sieves before performing grading tests. Inspection includes examination for broken wires, distortions and sags, and removal of particles stuck in the mesh, all as instructed in California Test 202, "Method of Test for Sieve Analysis of Fine and Coarse Aggregates."

#### 6-304C Portland Cement Concrete Air Meters

Data sheets accompanying newly purchased meters contain operation and calibration information. Supplemental sheets are available through METS.

California Test 504, "Method of Test for Determining Air Content of Freshly Mixed Concrete by the Pressure Method," covers the procedure for operation of the two most common brands in use by Caltrans. California Test 115, "Method of Calibration of Pressure Type Air Meters," covers calibration of these two meters.

#### 6-304D Compaction Tubes

California Test 110, "Method of Calibration of Compaction Test Equipment," outlines the procedure for both calibration and repair.

### 6-304E Cement-Treated Base Compressive Strength Apparatus

District materials laboratories can check the calibration of the hydraulic jacks used with the apparatus. If a jack requires repair, contact the METS machine shop in Sacramento to make arrangements for repair.

### **6-305 Test Methods**

Whenever a reference is made in the specifications to a test method by number, it means the test in effect on the day the “Notice to Bidders” for the work is dated. This means that the test methods for each project are fixed and are not necessarily the latest revisions.

Field personnel who perform tests for compliance with the specifications must be qualified to conduct the proper tests methods as indicated by the contract. The resident engineer must make sure that the correct versions of test methods are used. The latest revisions of the test methods are available on the METS website:

<https://dot.ca.gov/programs/engineering-services/california-test-methods>

Use the following guidelines for some of the tests performed in the field.

### 6-305A Method of Determining Approximate Grading of Mineral Aggregate by Dry Sieve Analysis

California Test 202, “Method of Test for Sieve Analysis of Fine and Coarse Aggregates,” requires that fine aggregate is subjected to a prescribed washing procedure before performing the sieve analysis. However, when large numbers of sieve analyses are performed on material from a given source, the tester may use the “Approximate Sieve Analysis of Processed Fine Aggregate” method in Appendix E of California Test 202. Any material subject to rejection because of excessive material retained on any sieve by the approximate method must be retested using the basic California Test 202.

### 6-305B Fabrication of Cement Treated Base Specimens

Test specimens are fabricated in the field. When compressive strength tests are desired, the specimens are cured, tested in the field, or shipped to the district materials laboratory for testing in accordance with applicable portions of California Test 312, “Design and Testing of Classes ‘A’ and ‘B’ Cement Treated Bases.”

### 6-305C Determination of Cement or Lime Content

Refer to California Test 338, “Method of Test for Cement or Lime Content in Treated Aggregate by the Titration Method,” for instructions. The acid-base titration and constant neutralization titration tests are used to determine the percentage of portland cement or lime in aggregates that have been treated.

The resident engineer must devise and perform a cement-determination test program geared to the contractor’s mixing and spreading operation. Increase testing frequency when mixing or spreading equipment is changed or altered or production rates are increased.

## 6-305D Portland Cement Concrete

Concrete samples are taken in accordance with California Test 539, "Method of Test for Sampling Freshly Mixed Concrete."

For penetration, test in accordance with California Test 533, "Method of Test for Ball Penetration in Fresh Portland Cement Concrete," each batch of concrete from which strength specimens are made.

For slump, test in accordance with ASTM C143, "Standard Test Method for Slump of Hydraulic-Cement Concrete," each batch of concrete from which strength specimens are made.

If air-entrained concrete is used, test the concrete using California Test 504, "Method of Test for Determining Air Content of Freshly Mixed Concrete by the Pressure Method," on each batch of concrete from which strength specimens are made. If concrete contains lightweight aggregate, air content is determined in accordance with California Test 543, "Method of Test for Air Content of Freshly Mixed Concrete by the Volumetric Method."

If the cement content is being checked by California Test 518, "Method of Test for Density (Unit Weight) of Fresh Concrete," determine the cement content for each batch from which strength tests are made.

Review California Test 540, "Method of Test for Making, Handling, and Storing Concrete Compressive Test Specimens in the Field," to determine the maximum size of coarse aggregate to be incorporated in the test specimen. Be sure to note removal of any oversize aggregate on the sample identification card.

California Test 540 covers the molding, transportation, curing, and storage of concrete cylinders.

### *6-305D (1) Number of Cylinders and Beams Required for a Test*

Each compressive strength test of structural concrete is determined to be the average strength of two 6- by 12-inch cylinders or three 4- by 8-inch cylinders. For pavement, the compressive strength test of concrete is determined to be the average strength of three 6- by 12-inch cylinders or three 4- by 8-inch cylinders. District Materials Lab, Southern Regional Lab, or METS performs California Test 521, "Method of Test for Compressive Strength of Cylindrical Concrete Specimens," ASTM C39, "Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens," or California Test 523, "Method of Test for Flexural Strength of Concrete (Modulus of Rupture)," and reports results to the resident engineer. The resident engineer evaluates the test results for compliance with the contract specifications.

Trial batching of structural concrete requires the average compressive strength of five 6- by 12-inch cylinders or five 4- by 8-inch cylinders. For pavement, trial batching of concrete requires the average modulus of rupture of three 6- by 6- by 20-inch beams and the average compressive strength of three 6- by 12-inch cylinders or three 4- by 8-inch cylinders at 3, 7, 14, 21, 28, and 42 days. The 42-day compressive strength acceptance value is correlated to the 42-day modulus of rupture of 650 psi.

#### *6-305D (2) Trial Batches*

Specifications state that for structural concrete designated by compressive strength greater than 3,600 pounds per square inch, or if prequalification is specified, the concrete must be prequalified by trial batches or certified test data before it is placed.

Make and test cylinders to prequalify the structural concrete. The test results must meet the contract specifications before the structural concrete designated by compressive strength may be considered as prequalified by trial batch. For pavement, the compressive strength of cylinders and the modulus of rupture of beams are used to prequalify the concrete by trial batch.

Concrete for trial batches must be designed, produced, and tested by the contractor or its supplier, and a certified trial batch test report must be obtained before use of such concrete. The resident engineer must make sure the certified trial batch test report contains all of the specified data.

The resident engineer must determine whether testing of trial batches will be performed during the life of the contract. Caltrans personnel must witness trial batch testing.

#### 6-305E Relative Compaction Using Nuclear Gauges

California Test 231, "Method of Test for Relative Compaction of Untreated and Treated Soils and Aggregates Using Nuclear Gages," provides the procedures for determining relative compaction by using nuclear gauges.

In addition to California Test 231, use of nuclear gauges is contained in California Test 121, "Administrative Instructions for Use of Nuclear Gages," as well as the manufacturer's manual pertaining to the gauge being used. A copy of these documents must be kept with each gauge. California Test 121 includes supervision and operator requirements for nuclear gauges, as well as requirements for nuclear gauge storage and transportation. For nuclear gauges, refer to the district radiation safety officer for any questions concerning operation, storage, and administrative requirements.

The person responsible for general inspection of the work and the person performing the test measurements are both involved in performing the complete test. The progressive steps are:

1. Designating the test area
2. Selecting test sites within the test area
3. Taking physical measurements



4. Determining test maximum value for comparison with the average in-place density (California Test 231 only)
5. Evaluation

### **6-306 Material Plants**

Determining the accuracy and suitability of scales and meters used to proportion materials in material processing plants is important to assure uniformity and quality of materials. Plants producing construction materials for Caltrans must be approved under the *MPQP*. Material plants used for producing materials under Sections 27, “Cement Treated Bases”; 28, “Concrete Bases”; 30, “Recycled Pavement”; 37, “Seal Coats”; 39-2, “Hot Mix Asphalt”; 60-3.04 “Deck Overlays”; and 90, “Concrete,” of the *Standard Specifications* must comply with the *MPQP*. Refer to Section 3-9, “Payment,” of this manual for weighing and metering procedures.

The *MPQP* covers these topics for materials plant weighing and measuring devices: inspection, calibration, dynamic testing, and approval. Section 2, “Equipment Requirements for Material Plants,” of the *MPQP*, is directed to the material producer and specifies the equipment requirements for material plants. Section 3, “Material Plant Calibration and Dynamic Testing,” is directed to the user of the calibration and approval process and specifies the calibration and approval of plant proportioning systems.

The plant approval process must be performed when weighing or measuring devices are newly installed, repaired, or adjusted, or when the plant is relocated. The resident engineer may order that the approval process be performed to assure accurate proportioning at any time on any type of plant. The maximum interval for retesting proportioning equipment is as follows:

- Hot mix asphalt and portland cement concrete batch plants—1 year
- Hot mix asphalt continuous mixing plants—6 months
- Slurry seal mixer-spreader trucks—6 months or when aggregate sources are changed
- Concrete volumetric mixers—every 30 days for pavement and 90 days for structures or when there is any change in ingredient sources

The district weights and measures coordinator is responsible for material plant approval based on:

- Plant equipment safety inspection.
- Type approval of measurement elements, except continuous conveyor scales, by the California Department of Food and Agriculture, Division of Measurement Standards.
- Type approval of measurement elements outside the Division of Measurement Standards area of responsibility by the district weights and measures coordinator.
- Device calibration.
- Dynamic testing of the plant during operation.

Do not allow material production for Caltrans projects until plant approval is received. The district weights and measures coordinator maintains a list of approved material plants and equipment currently in compliance with the *MPQP*.