STATE OF CALIFORNIA—BUSINESS, TRANSPORTATION AND HOUSING AGENCY

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**DIVISION OF ENGINEERING SERVICES**
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# METHOD OF TEST FOR THE EFFECT OF WATER-REDUCING AND SET-RETARDING ADMIXTURES ON THE DRYING SHRINKAGE OF CONCRETE

## A. SCOPE

This test method describes the procedure for determining the effect of water-reducing and set-retarding admixtures on the drying shrinkage of concrete. This test method is a modification of ASTM C157/C157M and is intended to provide a standardized procedure.

## B. REFERENCES

ASTM C157/C157M - Length Change of Hardened Hydraulic-Cement Mortar and Concrete

## C. APPARATUS

1. The measuring instrument, tamper, tamping rod, and molds shall conform to ASTM C157/C157M, except that the width and depth of the molds shall be 3 in.

2. A drying room shall be equipped with suitable racks for storing test specimens. The racks shall be designed to permit free circulation of air around specimens except for necessary supports. The room shall be large enough to permit the use of a manually operated sling psychrometer. The temperature of the room shall be maintained at 73.4°F ± 3°F and the relative humidity at 50 % ± 4 %. Conditioned air shall be circulated continuously through the room at such a rate that evaporation of water from an atmometer[1] is maintained at 3 ml/hr ± 0.5 ml/hr. Circulation of air shall be controlled by deflectors, if necessary, to result in equal rates of evaporation from the atmometer placed adjacent to specimens at different locations on the storage racks. The temperature and relative humidity of the room shall be measured with a sling psychrometer at least twice daily. The room shall be equipped with means of measuring and recording wet and dry bulb temperatures continuously. The recorded data shall be checked against the sling psychrometer and the results of the latter shall govern.

3. Moist curing room:

   The moist curing room shall be maintained at 73.4°F ± 3°F and so operated that free water is maintained on the surface of specimens placed therein at all times.

[1] A working drawing of an atmometer used by the Transportation Laboratory is available on request.

## D. MATERIALS

1. The Type II modified portland cement used in the test shall conform to the requirements of the Caltrans Standard Specifications of the California Department of Transportation and be composed of a mixture of equal parts produced by the following mills:

   a. Lehigh Southwest Cement (Permanente), Cupertino, California.

   b. Lehigh Southwest Cement, Redding, California.

   c. CEMEX, Victorville, California.

   d. TXI Riverside Cement, Oro Grande, California.

   e. CalPortland Co., Mojave, California.

2. Aggregates:

   The aggregates used in the test shall consist substantially of alluvial, uncrushed sand and gravel obtained from commercial sources nearby the American River in the vicinity of Sacramento, California. The aggregates shall be separated on sieves and recombined to the following grading:

| Sieve Size | % Passing |
|---|---|
| 1 in. | 100 % |
| ¾ in. | 90 % |
| ⅜ in. | 63 % |
| No. 4 | 48 % |
| No. 8 | 39 % |
| No. 16 | 27 % |
| No. 30 | 18 % |
| No. 50 | 7 % |

## E. NUMBER OF BATCHES OF CONCRETE

1. Mix at least three rounds of concrete, each on a different day.

2. Each round shall consist of one batch of concrete containing each dosage of admixture plus one batch of control concrete containing no admixture.

3. Use at least two dosages of admixture, one of which shall be the maximum recommended by the manufacturer, and another to be one-half the maximum dosage recommended.

## F. MIXING CONCRETE

1. Proportion the portland cement to be 7.0 sacks ± 0.1 sacks of concrete.

2. Mix the concrete in batches of 0.3 $ft^3$ or larger.

3. Before mixing, bring all concrete ingredients to room temperature. After mixing, the

concrete shall be maintained at a temperature of 73°F ± 3°F.

4. Prepare the molds by coating their interior surfaces with a release agent. Then place the measuring studs in the end plates and use care to avoid getting any release agent on the studs.

5. Mix the concrete in an open-tub type mixer for 3 min followed by a rest period of 3 min, after which continue mixing for 2 min.

6. All aggregates and about two-thirds of the mixing water should be mixed briefly before the addition of the cement. The admixture, if used, should be added as a diluted solution made with part of the remaining mixing water. Finally, add the quantity of water required to produce a slump of 3½ in. ± ½ in.

7. After final mixing of the concrete, determine the slump, density, and air content. Take up excess water from the surface of the concrete in the air meter with a sponge.

8. Return the concrete used in the above tests to the mixer bowl and remix briefly.

## G. TEST SPECIMEN FABRICATION

1. Fabricate at least three test specimens from each batch in accordance with the procedure described in ASTM C157/C157M, except that in lieu of rodding and spading the mix into the molds, an external vibrator, such as a vibratory packer, may be used to compact the mix in two layers.

2. The first layer of concrete should just cover the top of the gage studs. While vibrating briefly, work the concrete into the corners and around the gage studs with the fingers; then fill the mold to slightly overflowing and vibrate again.

3. When placing the concrete, avoid over vibration.

4. When compaction is complete, strike off the top surface and finish with a steel straightedge.

5. Immediately after molding, release the gage stud holders.

## H. CURING AND DRYING SPECIMENS

1. After molding, cover specimens with wet mats. During the curing process, make sure the mats are wet at all times.

2. At an age of 24 hr ± 4 hr, remove the specimens from their molds and place them in the moist curing room.

3. At an age of seven days after molding, measure the specimens for length.

4. Store specimens on racks in the drying room, maintained at 73.4°F ± 3°F and 50 % ± 4 % relative humidity, for 14 days. During storage, maintain a minimum of 1 in. of clearance on all sides, except for necessary supports.

5. Measure the specimens again for length 21 days after molding (14 days of drying).

## I. CALCULATIONS

1. Compute the drying shrinkage for each condition (no admixture, and at least two dosages of admixture) to the nearest 0.001 %, based on the gage length of 10 in. The computed shrinkage must be the average of at least 7 specimens, the individual values of which do not depart from the average by more than 0.004 percentage points.

2. Compute the relative drying shrinkage of the concrete for each of the dosages, making the plain concrete shrinkage equal to 100 %. Plot the relative shrinkages on a graph to be used in determining the maximum permissible dosage of the admixture, depending on the class of work proposed.

## J. REPORTING OF RESULTS

1. Report drying shrinkage for each specimen as the length at 7 days minus the length at 21 days.

2. Include in the report, the average portland cement content, the average slump, and The average air content of the control mixture and similar data for concrete containing the admixture. Also, include the name and designation of the admixture being tested and the dosages used (per sack of portland cement).

## K. HEALTH AND SAFETY

It is the responsibility of the user of this test method to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. Prior to handling, testing or disposing of any materials, testers must be knowledgeable about safe laboratory practices, hazards and exposure, chemical procurement and storage, and personal protective apparel and equipment.

Caltrans Laboratory Safety Manual is available online at the Caltrans website.

http://www.dot.ca.gov/hq/esc/ctms/pdf/lab_safety_manual.pdf

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**(California Test 530 contains 4 pages)**