

DEPARTMENT OF TRANSPORTATION
DIVISION OF ENGINEERING SERVICES
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METHOD OF TEST FOR THE DRYING SHRINKAGE OF LIGHTWEIGHT CONCRETE

A. SCOPE

This test method describes the standardized procedure for determining the drying shrinkage of lightweight concrete. It is a modification of ASTM C 157/C 157M.

B. REFERENCES

ASTM C 143/C 143M - Slump of Hydraulic-Cement Concrete
ASTM C 157/C 157M - Length Change of Hardened Hydraulic-Cement Mortar and Concrete
ASTM C 173/C 173M - Air Content of Freshly Mixed Concrete by the Volumetric Method
Caltrans Standard Specifications - Section 90 Concrete

C. APPARATUS

1. The length comparator instrument, tamping rod, and molds shall conform to ASTM C157/C 157M, except that the width and depth of the molds shall be 3 in.
2. Drying room: A room equipped with suitable racks for storing test specimens during drying. 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 $73^{\circ}\text{F} \pm 3^{\circ}\text{F}$, and the relative humidity at $50\% \pm 4\%$. Conditioned air shall be circulated continuously through the room at such a rate that evaporation of water from an atmometer¹ is maintained at $3\text{ mL/hr} \pm 0.5\text{ mL/hr}$. 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. These recorded data shall be checked against the sling psychrometer, but the results of the latter shall govern in cases of variance.
3. Moist curing room: The moist curing room shall be maintained at $73^{\circ}\text{F} \pm 3^{\circ}\text{F}$ and so operated that free water is maintained on the surface of specimens placed therein at all times.

D. CONCRETE MATERIALS AND PROPORTIONING

1. Unless otherwise specified, the cement, aggregates, and admixtures shall be from the sources designated by the Contractor and shall be of the brand and type proposed for use in the work.
2. The materials shall be combined in proportions according to the mix design submitted by the Contractor, except that the air entrainment shall be adjusted to

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

produce $4\% \pm \frac{1}{2}\%$ entrained air and the mixing water shall be adjusted to produce $3\text{ in.} \pm \frac{1}{2}\text{ in.}$ of slump.

3. Materials and the resulting mix design must conform with applicable provisions of the Caltrans Standard Specifications.

E. MIXING CONCRETE

1. Mix the concrete in batches of 0.6 ft^3 or larger.
2. Bring the materials used in the concrete to room temperature before mixing. After mixing, the concrete shall have a temperature of $73^\circ\text{F} \pm 3^\circ\text{F}$.
3. Prepare the molds by coating their interior surfaces with a release agent. After coating the molds with the release agent, place the measuring studs in the end plates, using care to avoid getting any release agent on the studs.
4. All aggregates and about two-thirds of the mixing water shall be mixed briefly in an open-tub type mixer and allowed to stand for 5 min before the addition of the cement.
5. After the soaking period specified above, the cement and an air entraining agent, added as a diluted solution made with part of the remaining mixing water, shall be added and the timer started. The remaining water required to produce a slump of $3\text{ in.} \pm \frac{1}{2}\text{ in.}$ shall be added in the first minute of mixing. Mixing shall be for 3 min followed by a rest period of 3 min, after which mixing shall continue for 2 min. Any adjustments in amount of mixing water to produce the desired slump shall be made during the first $\frac{1}{2}$ min of the second mixing period.
6. After mixing, determine the slump, density and air content. Determine the slump in accordance with ASTM C 143/C 143M. Determine the density in accordance with California Test 518. Determine the air content in accordance with ASTM C 173/C 173M.
7. Discard the concrete used in the determination of the air content. Return concrete used to determine slump and density to the mixer and remix briefly before fabrication of test specimens.

F. MOLDING OF TEST SPECIMENS

1. Mold at least three test specimens from each batch in accordance with the procedure described in ASTM C 157/C 157M, 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. Use only enough vibration to consolidate the concrete. Large aggregate protruding at the surface is an indication of over vibration.
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 compaction is complete, strike off the top surface and finish with a steel straightedge.

4. Immediately after molding, release the plates holding the gage pins.

G. CURING AND DRYING SPECIMENS

1. After molding, cover the specimens with wet mats. (Keep mats wet at all times.)
2. When specimens are 24 hr \pm 4 hr old, remove them from the molds and place them in the moist curing room.
3. At 7 d after molding, measure the specimens for length (initial length).
4. Store on racks in the drying room maintained at a temperature of 73°F \pm 3°F and a relative humidity of 50 % \pm 4 %. Store them with at least 1 in. clearance on all sides except for the necessary supports.
5. At 14, 21, and 35 d after molding (7, 14, 28 d of drying), measure the specimens again for length.

H. NUMBER OF BATCHES OF CONCRETE

Mix at least 3 rounds of concrete, each on a different day. Each round shall consist of one batch of concrete.

I. CALCULATIONS

Compute the drying shrinkage for each specimen to the nearest 0.001 percentage point, based on the gage length of 10 in. The reported 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 point.

J. REPORTING OF RESULTS

1. Report drying shrinkage for each specimen as the length at 7 d (initial length) minus the length at age 21 d (14 d of drying).
2. Include in the report the average cement content, the average slump, and the average air content of the mixture.

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 at:

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

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(California Test 537 contains 3 pages)