



Standard Test Method for Measurement of Mass Loss versus Time for One- Dimensional Drying of Saturated Concretes¹

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1. Scope

1.1 This test method determines the mass loss over time due to one-dimensional drying and moisture transport in an initially saturated cylindrical specimen with both ends exposed to constant temperature and relative humidity.

1.2 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 ASTM Standards:²

- C31/C31M Practice for Making and Curing Concrete Test Specimens in the Field
- C42/C42M Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
- C125 Terminology Relating to Concrete and Concrete Aggregates
- C157/C157M Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete
- C192/C192M Practice for Making and Curing Concrete Test Specimens in the Laboratory
- C511 Specification for Mixing Rooms, Moist Cabinets, Moist Rooms, and Water Storage Tanks Used in the Testing of Hydraulic Cements and Concretes
- C670 Practice for Preparing Precision and Bias Statements for Test Methods for Construction Materials
- C1005 Specification for Reference Masses and Devices for Determining Mass and Volume for Use in the Physical

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² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

Testing of Hydraulic Cements

E104 Practice for Maintaining Constant Relative Humidity by Means of Aqueous Solutions

3. Terminology

3.1 Definitions:

3.1.1 For definitions of terms used in this standard, refer to Terminology C125.

4. Summary of Test Method

4.1 Saturated cylindrical concrete specimens with sealed sides are prepared and the two ends are exposed to an environment at 23°C and 50 % relative humidity (RH), subjecting the specimen to one-dimensional drying. Their masses are measured periodically to establish a data set of average mass loss versus time.

5. Significance and Use

5.1 Drying behavior is related to the mass transport properties of concrete, such as liquid permeability and water diffusivity. It depends on a number of factors such as concrete mixture proportions, presence of admixtures and supplementary cementitious materials, composition and physical characteristics of the aggregates and cementitious materials, curing conditions, degree of hydration, and presence of microcracking. Drying behavior is also affected strongly by the degree of saturation and temperature of the concrete at the start of drying as well as the environmental conditions that exist during drying such as temperature, relative humidity, and air flow rate (wind speed).

5.2 This test method subjects initially saturated specimens of concrete to one-dimensional drying under controlled environmental conditions. The resulting mass loss versus time data can be used to estimate transport coefficients including liquid permeability³ and water diffusivity.⁴ These coefficients may be

³ Baroghel-Bouny, V., Thiery, M., Barberon, F., Coussy, O., and Villain, G., "Assessment of Transport Properties of Cementitious Materials: A Major Challenge as Regards Durability?," *European Reviews in Civil Engineering*, Vol 11, No. 6, 2007, pp. 671–696.

⁴ Samson, E., Maleki, K., Marchand, J., and Zhang, T., "Determination of the Water Diffusivity of Concrete Using Drying/Absorption Test Results," *Journal of ASTM International*, Vol 5, No. 7, 2008, pp. 1–12.

used in numerical models to estimate service life of concrete and reinforced concrete members exposed to different environmental conditions.^{5,6}

5.3 The test method provides instruction and a sequence of steps for measuring mass loss versus time. The preferred rate of this mass loss will depend on the application. For example, for interior commercial flooring applications, a mass loss that occurs quickly may be preferable, while for outdoor exposures in an aggressive environment, slower mass loss may be beneficial.

6. Apparatus

6.1 *Drying Chamber*, a temperature- and humidity-controlled chamber or room with temperature maintained constant at $23^{\circ}\text{C} \pm 2^{\circ}\text{C}$ and relative humidity at $50\% \pm 4\%$, such as the drying room specified in Test Method C157/C157M. The chamber shall have proper specimen supports to allow airflow around each concrete specimen (see Note 1). The chamber shall be of sufficient volume to hold at least three test specimens (see Note 2). The air movement around the specimens within the chamber shall result in an evaporation rate as required for the drying room described in Test Method C157/C157M.

NOTE 1—Rack shelving composed of metal, plastic, or composite materials will provide a convenient pathway for air circulation around each supported specimen.

NOTE 2—A walk-in chamber is preferable, so that the balance can be installed and maintained at constant conditions.

6.2 *Temperature and Relative Humidity Measuring Equipment*, of the digital type to be placed next to the specimens in the drying chamber and capable of measuring relative humidity with an accuracy of $\pm 3\%$ at a relative humidity of 50% and temperature with an accuracy of $\pm 0.5^{\circ}\text{C}$ at a temperature of 23°C . At least two separate measurements of both temperature and relative humidity are required for each drying chamber. Measurements shall be obtained at intervals of 15 min or less.

NOTE 3—The accuracy of the relative humidity measured by the equipment can be verified by measurement of relative humidity over aqueous solutions of various salts, as outlined in Practice E104.

6.3 *Absorbent Towels*, wetted thoroughly and wrung out, for blotting free water from specimen surfaces.

6.4 *Balance*, complying with Specification C1005 with a capacity of at least 1500 g, but with an index scale readable to at least 0.01 g.

6.5 *Water-Cooled Saw*, with diamond impregnated blade of adequate dimensions to cut test specimens from larger samples.

6.6 *Caliper*, to measure the specimen dimensions to the nearest 0.1 mm.

6.7 *Compressed Air*, source of compressed air at sufficient pressure to dry surfaces of specimens.

7. Materials

7.1 *Sealing Material*, strips of low permeability adhesive sheets, epoxy coating, or (paraffin) wax for sealing the side surfaces of test specimens. The hardening time of the sealing material shall not exceed 30 minutes. The adequacy of the sealing material is to be verified with respect to both drying and limewater immersion. Adequacy with respect to drying is to be verified by sealing a saturated specimen on all sides and storing it in the drying chamber for 3 days. The sealing material is adequate if the measured mass loss is less than 0.1 % of the original mass of the sealed specimen. The sealing material also must not gain mass or deteriorate when placed in a limewater solution. Adequacy with respect to limewater immersion is to be verified by sealing a saturated specimen on all sides and immersing it in limewater for 7 days. Visually examine the sealing material after immersion to detect any reaction with the limewater. The sealing material is adequate if the measured mass gain is less than 0.1 % of the original mass of the sealed specimen.

8. Sampling, Test Specimens, and Test Units

8.1 Three cylindrical sawcut specimens are to be prepared for each concrete mixture to be evaluated. Unless required otherwise by the specifier of the tests, specimen dimensions after cutting shall be a diameter of $100\text{ mm} \pm 5\text{ mm}$ and a length of $50\text{ mm} \pm 2\text{ mm}$. Specimens are cut to length, using a water-cooled saw (see 6.5), from either cylinders molded according to Practices C31/C31M or C192/C192M or cores drilled according to Test Method C42/C42M. The average diameters (see 9.3) of the end faces of a specimen shall not differ by more than 1 mm.

NOTE 4—While other specimen sizes may be employed, the minimum specimen dimension should exceed the nominal maximum aggregate size by a factor of two or more. Because the drying is one-dimensional through the exposed cylinder faces, a nominal diameter-length ratio of 2.0 does not have to be used if alternative specimen sizes are specified.

8.2 This test method may be applied to either specimens containing a cast or a finished wearing surface or those in which the cast or finished surface layer(s) of the concrete have been removed by sawing. In the latter case, the distances between the original exposed surface of the concrete and the end faces of replicate test specimens shall be within 5 mm of each other.

NOTE 5—An exterior surface of a concrete specimen seldom has the same porosity as the interior concrete. To reduce data scatter, measurements are made with the drying surfaces of replicate test specimens at the same distance from the original exposed surface of the concrete.

9. Sample Conditioning

9.1 Specimens are to be in a saturated condition at the start of the test. Cure molded concrete cylinders for at least 28 days in water storage tanks complying with the requirements of Specification C511. Condition cores in accordance with 9.7.

9.2 Seven days prior to the start of testing, cut test specimens to the necessary length and carry out steps 9.3–9.7.

⁵ Samson, E., and Marchand, J., “Modeling the Transport of Ions in Unsaturated Cement-Based Materials,” *Computers and Structures*, Vol 85, No. 23–24, 2007, pp. 1740–1756.

⁶ Henchi, K., Samson, E., Chapdelaine, F., and Marchand, J., “Advanced Finite-Element Predictive Model for the Service Life Prediction of Concrete Infrastructures in Support of Asset Management and Decision-Making,” *Computing in Civil Engineering*, 2007, pp. 870–880.