



Designation: D5860 – 95 (Reapproved 2022)

# Standard Test Method for Evaluation of the Effect of Water Repellent Treatments on Freeze-Thaw Resistance of Hydraulic Cement Mortar Specimens<sup>1</sup>

This standard is issued under the fixed designation D5860; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

## 1. Scope

1.1 This test method covers a procedure for determining the comparative effect of water repellent treatments on the freeze-thaw cycling of hydraulic cement mortar specimens.

1.2 This test method is designed to compare the effectiveness of water repellent treatments under conditions of freezing and thawing only. This test method is intended as a laboratory screening method for treatment selection and may not accurately reflect the performance of treated and untreated specimens in the field. This test method is not intended to duplicate field conditions.

1.3 The values stated in SI units are to be regarded as the standard. The values given in parentheses are for information only.

1.4 *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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.5 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

## 2. Referenced Documents

2.1 *ASTM Standards:*<sup>2</sup>

**C109/C109M Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50 mm] Cube Specimens)**

<sup>1</sup> This test method is under the jurisdiction of ASTM Committee D01 on Paint and Related Coatings, Materials, and Applications and is the direct responsibility of Subcommittee D01.47 on Concrete, Stone and Masonry Treatments.

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<sup>2</sup> For referenced ASTM standards, visit the ASTM website, [www.astm.org](http://www.astm.org), or contact ASTM Customer Service at [service@astm.org](mailto:service@astm.org). For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[D1193 Specification for Reagent Water](#)

[D1475 Test Method for Density of Liquid Coatings, Inks, and Related Products](#)

[E145 Specification for Gravity-Convection and Forced-Ventilation Ovens](#)

## 3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *water repellent treatment, n*—a transparent penetrating sealer or surface-applied treatment formulated for the purpose of protecting porous substrates by reducing the penetration of liquid water.

## 4. Summary of Test Method

4.1 Mortar specimens are treated with or immersed in a water repellent material, removed, and allowed to cure. After air drying, the treated specimens are weighed then subjected to various cycles of freezing and thawing. Periodic weighing and observations are made to determine weight loss and deleterious effects such as spalling and cracking.

## 5. Apparatus

5.1 *Balance*, having a capacity of not less than 400 g and a sensitivity of 0.1 g.

5.2 *Corrosion-resistant Metal Pan*, that is, aluminum, for immersion of substrates.

5.3 *Weight per Litre (Gallon) Cup*.

5.4 *Freezing Chamber*, capable of maintaining  $-19.2 \pm 1.4$  °C ( $-2.5 \pm 2.5$  °F).

5.5 *Forced Draft Oven*, capable of maintaining  $110 \pm 5$  °C ( $230 \pm 9$  °F).

5.6 *Stiff-nylon-bristled Brush*.

## 6. Test Materials

6.1 50-mm (2-in.) mortar cubes greater than 28-days old, and prepared in accordance with procedures outlined in Test Method **C109/C109M**, have been found suitable for this test method. These cubes should be brushed with a wire brush or lightly sand blasted to remove form oil or release agent before

using. Five test specimens will be used for each treatment, and five untreated controls shall also be included for each test. All cubes should come from the same lot of material.

NOTE 1—Preferably, rather than make each cube individually, a large cake can be made. 25-mm (1-in.) should be cut off each face of the cake to remove any residual form release oil. Cubes are cut from the cake to measure 50 by 50 by 50 mm (2 by 2 by 2 in.) to be used as mortar specimens.

## 6.2 Water repellent treatments.

## 7. Procedure

7.1 Dry the required number of specimens in a forced draft oven, as specified in Specification E145, for 24 h at 110 °C (230 °F) until 2 weighings at intervals of 2 h do not decrease in weight by more than 0.2 %. After drying, cool the test specimens at 23 ± 2 °C (73.5 ± 3.5 °F) and a relative humidity of 50 ± 5 % for 24 ± 4 h.

7.2 For the specimens to be treated, measure the surface area of each test specimen to the nearest 0.1-in.<sup>2</sup> and weigh to the nearest 0.1 g. Record the weight of the uncoated test specimens as  $W_1$ .

7.3 Coat five test specimens for each treatment being tested in accordance with manufacturer's instructions, or at a spreading rate of 3.06 ± 0.61 m<sup>2</sup>/L (125 ± 25 ft<sup>2</sup>/gal). The repellent(s) may be applied by brushing or immersion. Calculate the amount of material to be applied to obtain the specified coverage after determining the density as g/mL = Kg/L (weight/gal) in accordance with the Test Method D1475.

7.3.1 The weight of material needed for each cube can be calculated using the following equation:

$$G = \frac{454 \times D \times A}{144 \times \text{Spreading rate (125 ft}^2\text{/gal)}} \quad (1)$$

where:

$D$  = density of the test material lb/gal,

$A$  = area of the test specimen in.<sup>2</sup>, and

$G$  = weight of test material needed to obtain desired spreading rate, g.

7.4 Allow the treated test specimen to cure at 23 ± 2 °C (73.5 ± 3.5 °F) and a relative humidity of 50 ± 5 % for 7 days (or according to the manufacturer's recommendations) on a raised screen or rack to allow for sufficient ventilation around each specimen.

7.5 Weigh each treated and untreated specimen to 0.1 g and record the weight as  $W_2$ .

7.6 Place five treated specimens for each treatment and five untreated specimens in a metal tray then add reagent water to the tray to a depth of 12.7 mm (½ in.). Maintain at room temperature for 4 ± ½ h and then place the tray in the freezing chamber for 20 ± 1 h. Before placing in the freezing chamber, measure the water level, and, if necessary, add water to maintain the 12.7 mm (½ in.) depth. Reagent water used in this procedure shall be in accordance with Specification D1193.

**TABLE 1 Visual Rating System**

| Rating | Condition   |
|--------|---|
| 0      | No spalling   |
| 1      | Fine cracks (less than or equal to 0.004 in. (0.01 cm) in width) visible on surface |
| 2      | Heavy cracks (greater than 0.004 in. (0.01 cm) in width) visible on surface         |
| 3      | Heavy cracks visible on surface, with faces bulging                                 |
| 4      | Moderate spalling   |
| 5      | Severe spalling and loss in weight  |

7.7 Remove tray(s) from the freezing chamber and set the tray(s) in a thawing tank—containing water at room temperature—for 4 ± ½ h. Then remove the tray(s) and return to the freezing chamber for 20 ± ½ h. Make sure that the tray(s) are not completely immersed, but immersed enough to facilitate thawing. Always measure water level before returning the tray to the freezing chamber and, if necessary, add water to maintain the ½-in. water depth.

7.8 After the last freeze-thaw cycle of the normal work week, remove the specimens from the trays and store them over the weekend at room temperature. Following this period of air drying, brush specimens with the stiff brush to remove all loose material. Inspect the specimens for cracking and spalling, and record the rating (see Table 1, Visual Rating System). Weigh the specimens and record as  $W_3$ . Calculate the change in weight of each specimen as percent of the original weight of the dried specimen to 0.1 g as follows:

$$\% \text{ change in weight} = \frac{(W_2 - W_3)}{W_2} \times 100 \quad (2)$$

NOTE 2—An initial weight increase may be seen with some specimens before failure takes place.

7.9 Continue freeze-thaw cycling as outlined in 7.6 through 7.8 until completion of 50 cycles or complete failure, considered to be a weight loss of 25 % or more.

## 8. Report

8.1 Report the following information:

8.1.1 Type and size of specimen used,

8.1.2 Water repellent treatment used, spreading rate and method of application, or no treatment used (controls),

8.1.3 Mean average change in weight as a percentage, for each treatment and control group of five test specimens after 50 cycles or complete failure,

8.1.4 Description of any spalling, cracking or degradation in addition to using the Visual Rating System in Table 1,

8.1.5 Number of cycles completed, and

8.1.6 Any deviation from this procedure.

## 9. Precision and Bias

9.1 Precision and bias have not been developed on this test method at this time.

## 10. Keywords

10.1 freeze-thaw resistance; hydraulic cement mortar specimens; water repellent treatments