
Standard Method of Test for

Protective Sealers for Portland Cement Concrete

AASHTO Designation: T 384-23¹

Technically Revised: 2023

Technical Subcommittee: 4c, Markings and Coatings



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1. SCOPE

- 1.1. This method covers test methods and selection criteria for prequalification of sealers for protecting new concrete or prolonging the life of sound in-service concrete used in highway structures. Sealer testing and evaluation for routine and job site product quality assurance, field performance, and re-application are provided in R 94.
- 1.2. Sealers are divided into two basic types: coatings, which remain on the surface; and penetrants, which penetrate into the concrete to some measurable depth and do not substantially change the appearance of the concrete.
- 1.3. The values stated in SI units are to be regarded as the standard.
- 1.4. *The quality of the results produced by this standard are dependent on the competence of the personnel performing the procedure and the capability, calibration, and maintenance of the equipment used. Agencies that meet the criteria of R 18 are generally considered capable of competent and objective testing/sampling/inspection/etc. Users of this standard are cautioned that compliance with R 18 alone does not completely assure reliable results. Reliable results depend on many factors; following the suggestions of R 18 or some similar acceptable guideline provides a means of evaluating and controlling some of those factors.*

2. REFERENCED DOCUMENTS

- 2.1. *AASHTO Standards:*
 - < M 6, Fine Aggregate for Hydraulic Cement Concrete
 - < M 80, Coarse Aggregate for Hydraulic Cement Concrete
 - < M 339M/M 339, Thermometers Used in the Testing of Construction Materials
 - < R 18, Establishing and Implementing a Quality Management System for Construction Materials Testing Laboratories
 - < R 94, Quality Assurance, Job Site Quality Control, and Reapplication of Protective Sealers for Portland Cement Concrete
 - < T 22M/T 22, Compressive Strength of Cylindrical Concrete Specimens
 - < T 160, Length Change of Hardened Hydraulic Cement Mortar and Concrete
 - < T 260, Sampling and Testing for Chloride Ion in Concrete and Concrete Raw Materials
 - < T 278, Surface Frictional Properties Using the British Pendulum Tester

2.2.

ASTM Standards:

- < C33/C33M, Standard Specification for Concrete Aggregates
- < C138/C138M, Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete
- < C143/C143M, Standard Test Method for Slump of Hydraulic-Cement Concrete
- < C157/C157M, Standard Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete
- < C192/C192M, Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory
- < C231/C231M, Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
- < C494/C494M, Standard Specification for Chemical Admixtures for Concrete
- < C496/C496M, Standard Test Method for Splitting Tensile Strength of Cylindrical Concrete Specimens
- < C511, Standard Specification for Mixing Rooms, Moist Cabinets, Moist Rooms, and Water Storage Tanks Used in the Testing of Hydraulic Cements and Concretes
- < C642, Standard Test Method for Density, Absorption, and Voids in Hardened Concrete
- < C666/C666M, Standard Test Method for Resistance of Concrete to Rapid Freezing and Thawing
- < C672/C672M, Standard Test Method for Scaling Resistance of Concrete Surfaces Exposed to Deicing Chemicals
- < C1064/C1064M, Standard Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete
- < C1152/C1152M, Standard Test Method for Acid-Soluble Chloride in Mortar and Concrete
- < C1315, Standard Specification for Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete
- < C1583/C1583M, Standard Test Method for Tensile Strength of Concrete Surfaces and the Bond Strength or Tensile Strength of Concrete Repair and Overlay Materials by Direct Tension (Pull-Off Method)
- < D891, Standard Test Methods for Specific Gravity, Apparent, of Liquid Industrial Chemicals
- < D2369, Standard Test Method for Volatile Content of Coatings
- < D4138, Standard Practices for Measurement of Dry Film Thickness of Protective Coating Systems by Destructive, Cross-Sectioning Means
- < D4541, Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers
- < D5095, Standard Test Method for Determination of the Nonvolatile Content in Silanes, Siloxanes and Silane-Siloxane Blends Used in Masonry Water Repellent Treatments
- < D6132, Standard Test Method for Nondestructive Measurement of Dry Film Thickness of Applied Organic Coatings Using an Ultrasonic Coating Thickness Gage
- < D6762, Standard Test Method for Determining the Hiding Power of Paint by Visual Evaluation of Spray Applied Coatings
- < D7089, Standard Practice for Determination of the Effectiveness of Anti-Graffiti Coating for Use on Concrete, Masonry and Natural Stone Surfaces by Pressure Washing
- < E1, Standard Specification for ASTM Liquid-in-Glass Thermometers
- < E230/E230M, Standard Specification for Temperature-Electromotive Force (emf) Tables for Standardized Thermocouples
- < E274/E274M, Standard Test Method for Skid Resistance of Paved Surfaces Using a Full-Scale Tire
- < E355, Standard Practice for Gas Chromatography Terms and Relationships



- < E879, Standard Specification for Thermistor Sensors for General Purpose and Laboratory Temperature Measurements
- < E1252, Standard Practice for General Techniques for Obtaining Infrared Spectra for Qualitative Analysis
- < E2877, Standard Guide for Digital Contact Thermometers

2.3. *International Electrotechnical Commission Standard:*

- < IEC 60584-1: 2013 Thermocouples - Part 1: EMF Specifications and Tolerances

2.4. *Other Reference:*

- < Pfeifer, D. W., and M. J. Scali. *National Cooperative Highway Research Program Report 244: Concrete Sealers for Protection of Bridge Structures*. National Academy Press, Washington, DC, 1981, 138 pp.

3. PREQUALIFICATION TESTS FOR UNIVERSAL PROPERTIES

3.1. *Test Overview*—This test procedure outlines the methods and requirements used for the testing of the universal properties of concrete sealers and includes batching, casting, and storing concrete test cubes for use in the testing of penetrating and film-forming sealers for use on concrete surfaces. These tests are used to prequalify all sealers to be used on highway structures. The properties evaluated include:

- < water vapor transmission,
- < saltwater absorption,
- < chloride permeability,
- < sealer penetration depth or coating thickness,
- < UV weathering and cyclic saltwater ponding, and
- < resistance to alkali.

Methods to characterize the sealer material are also provided and are used to ensure materials provided for project use are the same as the materials submitted and tested for prequalification. Figure A1.1 in Annex A is a flow chart showing the general progression of testing for each prequalification test procedure.

3.2. *Equipment:*

3.2.1. An electronic weigh scale having a capacity not less than 4000 g and a sensitivity of 0.1 g.

3.2.2. Conditioning chamber capable of maintaining 50 ± 4 percent RH at $23 \pm 1^\circ\text{C}$ (72 to 75°F), consistent with T 160. The thermometer for measuring the temperature of the chamber shall meet the requirements of M 339M/M 339 with a temperature range of at least 19 to 27°C (66.4 to 80.6°F) and an accuracy of $\pm 0.5^\circ\text{C}$ [$\pm 0.9^\circ\text{F}$] (see Note 1).

Note 1—Thermometer types suitable for use include ASTM E1 mercury thermometers; ASTM E2877 digital metal stem thermometer; ASTM E230/E230M thermocouple thermometer, Type T, Special; or IEC 60584 thermocouple thermometer, Type T, Class 1.

3.2.3. Thermostatically controlled oven(s), for drying samples shall be capable of operation at the temperatures required, between 50 to 100°C (122 to 212°F), accurate within $\pm 2^\circ\text{C}$ ($\pm 3.6^\circ\text{F}$), as corrected, if necessary, by calibration. More than one oven may be used, provided each is used within its proper operating temperature range. The thermometer for measuring the temperature of materials shall meet the requirements of M 339M/M 339 with a temperature range of at least 50 to 100°C (122 to 212°F), and an accuracy of $\pm 0.5^\circ\text{C}$ ($\pm 0.9^\circ\text{F}$) (see Note 2). When oven-drying is

called for, cool oven to lab temperature before samples are placed in it. Then increase the oven temperature to the specified drying temperature at the rate of no more than 20°C/h (36°F/h).

Note 2—Thermometer types suitable for use include ASTM E1 mercury thermometers; ASTM E2877 digital metal stem thermometer; ASTM E230/E230M thermocouple thermometer, Type T, Special Class; IEC 60584 thermocouple thermometer, Type T, Class 1; or ASTM E879 thermistor thermometer.

- 3.2.4. Moist cure room complying with ASTM C511.
- 3.2.5. Sandblasting equipment, including a steel plate shield with a 100-mm² opening and a steel plate shield with a 300-mm² opening.
- 3.2.6. Ultraviolet exposure chamber capable of producing 25 to 35 watts/m² of ultraviolet radiation over the surface of a 0.6-m² (6-ft²) area. Lamps should emit at 368 nm. GE F40BL (part number 10526) was used to achieve this irradiance level in NCHRP 244 testing.
- 3.2.7. Freezing-and-thawing apparatus and related testing equipment conforming to the requirements of ASTM C666/C666M, Method A.
- 3.3. *Screening Performance Cube Tests for Water Vapor Transmission, Saltwater Absorption, Chloride Permeability, and Sealer Penetration Depth or Coating Thickness:*
 - 3.3.1. *Test Overview*—This test procedure outlines the details to manufacture, store, and test cubes for testing water vapor transmission, saltwater absorption, chloride permeability, and depth of penetration or coating thickness of sealers.
 - 3.3.2. *Test Sample Preparation and Treatment:*
 - 3.3.2.1. *Casting and Storing Concrete Test Cube*—Select a representative and standard source of cement and aggregates. Use well-graded, normal density aggregates meeting the requirements of M 6 and M 80 (ASTM C33/C33M) and having a maximum nominal aggregate size of 13 mm to 19 mm ($\frac{1}{2}$ to $\frac{3}{4}$ in.). Use rigid molds to produce cubes of 100 ± 1.5 mm (4 ± 0.06 in.) on a side constructed of plastic-treated plywood or other nonabsorptive surface. Do not use form oils or release agents that could contaminate the concrete surfaces. The concrete mixture should have a water/cement ratio (w/c) of 0.50 and an air content of 5 to 7 percent. The plastic slump should be between 75 and 125 mm (3 and 5 in.). The concrete should be designed to have a 28-day compressive strength between 27 and 31 MPa (4000 and 4500 psi) but its value may vary depending on local materials and testing needs. Keep water/cement ratio, maximum aggregate size, and air content requirements fixed. Use a moderate cement content, preferably near 300 kg/m³ (505 lb/yd³). Do not use fly ash or other supplementary materials. Use a chloride-free, lignosulfonate water-reducing admixture to obtain the correct slump, if needed. Other ASTM C494/C494M Type A water-reducing admixtures may be used if they do not contain chloride or other material that may affect the pore structure. Do not use a superplasticizer (high-range water-reducing admixture). Use a Vinsol resin air-entraining admixture unless testing includes the effect of other air-entraining admixtures. Table 1 provides guidelines for a recommended mix design; however, other mix designs can be used if those designs are more typical of the concrete to be treated.

Table 1—Guidelines for a Recommended Mix Design

Constituents/Properties	Guideline
Water to cement ratio (w/c) ^a	0.5
Nominal maximum aggregate size ^a	13 to 19 mm ($\frac{1}{2}$ to $\frac{3}{4}$ in.)
28-day compressive strength (design)	27 to 31 MPa (4000 to 4500 psi)
Entrained air content ^a	5.0 to 7.0%
Slump	75 to 125 mm (3 to 5 in.)
Cement content	300 kg/m ³ (505 lb/yd ³)
Sand content, % total aggregate	40 to 42
Fineness modulus of sand	2.4 to 2.9
Air-entraining agent	Neutralized Vinsol resin or equivalent
Water-reducing agent	Lignosulfonates

^a Controlling guideline.

- 3.3.2.2. *Sample Fabrication*—Fabricate specimens in accordance with ASTM C192/C192M. Measure and account for aggregate moisture contents to ensure that the exact water to cement ratio (w/c) is used. Measure the concrete plastic properties including slump (ASTM C143/143M), air content (ASTM C231/C231M), temperature (ASTM C1064/C1064M), and unit weight (ASTM C138/138M). Consolidate cubes to minimize the amount of surface voids in the cubes and strike off flush with a wood or magnesium float. Do not use steel trowel or aluminum float. Cover with moist towels and plastic, such that the surfaces of the cubes are not marred or damaged but are kept moist. For each batch produced, cast a minimum of three 4-by-8-in. cylinders for compressive strength testing.

Identify the finished surface with a small felt-pen mark. Maintain this face in an upward facing orientation throughout the course of the testing unless otherwise noted. Re-mark the surface whenever it is removed by sandblasting or other procedures.

Demold specimens at the age of 24 ± 2 h and store samples in moist-curing room at $23 \pm 2^\circ\text{C}$ (70 to 77°F) with 100 percent relative humidity. Test specimens may be kept in storage for a maximum of 182 days before starting testing unless special curing requirements are being evaluated. Do not coat any samples until after a minimum of 42 days of moist curing, unless evaluating the effect of the sealer on new concrete.

Identify each cube to its batch. Prior to use, weigh, number, and label each cube for future identification. Label in a manner that does not affect the water absorption or the accuracy of weighing.

- 3.3.2.3. *Number of Samples*—For each sealer to be tested, select a minimum of 12 cube samples. A minimum of 6 of these cubes will serve as untreated control cubes. Conditioning of two additional samples is recommended in case alternate specimens are needed. Report the curing age of each cube sample used.

If the sealer is being tested for use on traffic-bearing surfaces, abrasion testing (Section 4.2) and time-to-cure (Section 4.4) testing are required. Abrasion testing will not require any additional samples, but for time-to-cure (Section 4.4) testing, four additional cubes are needed (two cubes for each temperature at which curing time is tested).

If the sealer is also being tested for cyclic freezing resistance according to Section 5.2, another 6 cubes are required.

If optional tests for the effect of wet (SSD) concrete surface condition at time of sealing (Section 6.3.1) or for performance at temperature extremes (Section 6.2) are being performed, additional sets of 6 cube samples are need for each test.

In addition, select a minimum of three cubes to be oven-dried for each concurrently conducted test program (i.e., only one set of cubes for oven drying is needed for each sealer evaluation program even if multiple sealers are tested).

It is suggested that additional cube samples be conditioned for sealing to account for cube variations or damage during the initial steps in the test program. These can then be returned to the moist-curing cabinet for reuse if they are not needed.

Note that six concrete test slabs 300 by 300 by 130 mm (12 by 12 by 5 in.) are required for each cyclic weathering test conducted according to Section 3.4.2. These slabs are cast from the same concrete used for the cubes.

Deicer scaling resistance is performed on three treated and three untreated ASTM C672/C672M test slabs manufactured with non-air-entrained concrete according to Section 5.3.

A summary of the cube samples required for the various tests is shown in Table 2.

Table 2—Cube Samples Required for Screening Performance Cube Tests

Test	Treated Cubes	Untreated Control Cubes
Moisture content	—	3
Basic prequalification	6 ^a	6
Time-to-cure	2 ^b	—
Cyclic freezing	3	3
Effect of wet (SSD) surface	6	—
Performance at temperature extremes	6	—

^a Plus two additional cubes recommended as alternates.
^b Number of cubes per temperature.

When all specimens are fabricated from the same batch of concrete, assign individual specimens randomly to each set. When the specimens are fabricated from more than one batch of concrete, distribute the individual specimens among each set so that, as close as is possible, an equal number of specimens in each set are taken from each batch.

Examine cubes and do not use cubes having large surface voids or poorly consolidated areas. Check cubes for surface voids and only use cubes with less than 3 percent of the surface area covered by voids (or 18 cm² [2.8 in.²] of void area). Do not include surface voids smaller than 10-mm (0.4-in.) diameter in this measurement. Cubes with more than 3 percent voids can be used as nontreated control samples.

Note 3—An acceptable estimate of the area of surface voids can be made by measuring the number and diameter of all voids greater than 10-mm (0.4-in.) diameter to the nearest millimeter and calculating the total area assuming each void is a perfect circle.

3.3.2.4. *Total Moisture Capacity of Cubes and Baseline Chloride Content*—After 35 days or more of wet curing, remove 3 cubes from the moist-curing room for determination of the total moisture content. The cubes should include at least 1 cube from each represented batch of concrete and no fewer than 3 cubes total. Determine the saturated surface-dry weight (*W_{ssd}*) by drying the surfaces of the cubes with a towel and weighing to the nearest 0.1 g. Oven dry cubes at 93 to 96°C (200 to 205°F) until they reach a constant weight (*W_{od}*), defined as the weight achieved with less than 1/2 percent change in 24 h per ASTM C642, Oven-Dry Mass. Calculate the total moisture capacity (*M_{ssd}*) in percent by weight as follows:

$$M_{ssd} = ((W_{ssd} - W_{od})/W_{od}) \times 100\% \text{ by weight} \tag{1}$$

Split the oven-dried cubes using the procedure outlined in Section 3.3.6. Pulverize one half of the split cube by crushing and grinding to a powder. All sawing or crushing shall be done dry (i.e., without water). All material shall pass a 0.300-mm (No. 50) sieve. All pulverizing tools and sieves shall be washed with alcohol or distilled water and shall be dry before use with each sample. Test this half of the split cube for acid-soluble chloride content in the same manner to be employed in Section 3.3.6.2; this is the baseline chloride content for the concrete.

Note 4—This chloride testing can be performed later in conjunction with chloride penetration testing on treated cubes to be performed in Section 3.3.6. The oven-dried cubes should be stored in sealed plastic bags if testing is to be delayed.

- 3.3.2.5. *Adjust Moisture Content of Cubes*—After 42 and before 182 days of curing, remove the required number of test cubes (at least 12 per sealer) from the moist-curing room, pat surfaces dry with clean, soft towel and weigh to determine the saturated surface-dry weight of these cubes (W_{ssd1}). Dry cubes in the conditioning chamber that conforms to ASTM C157/C157M at 50 percent RH and 23°C [73°F] with air circulation aided by fans to achieve a moisture condition in each cube representing 70 ± 2 percent of the mean total moisture capacity (M_{ssd-m}) estimated for these cubes in Section 3.3.2.4. Complete drying within 21 days. Adjust fans to change the rate of drying as needed to be consistent with this time constraint.

Calculate the estimated oven-dry weight of each test cube (W_{od1}) using the formula:

$$W_{od1} = W_{ssd1} / (1 + (M_{ssd-m} / 100)), \text{ in grams} \quad (2)$$

where:

M_{ssd-m} = the mean moisture capacity of the cubes from Section 3.3.2.4, in percent.

The target weight after drying for each test cube W_{t1} is 70 ± 2 percent of the mean total moisture capacity (M_{ssd-m}) calculated as follows:

$$W_{t1} = (0.70 \times (W_{ssd1} - W_{od1})) + W_{od1}, \text{ in grams} \quad (3)$$

The allowable difference from this target is:

$$\pm W_{t1-\text{tolerance}} = 0.02 \times (W_{ssd1} - W_{od1}), \text{ in grams} \quad (4)$$

Weigh test cubes daily until the required target weight is obtained. Select 6 cubes for sealer treatment and 6 cubes to serve as control cubes. These will be divided between chloride penetration and alkali resistance/abrasion test paths. The cubes should be selected so that the difference between the actual and target weights are minimized and to equally distribute different batches of concrete, if present. Extra cubes can be returned to the moist-curing room for future use after submerging for 48 h in water. (There will be 2 extra cubes if 14 cubes were selected for conditioning.)

Note 5—This drying process results in the surface being drier than the interior of the cubes. This simulates normal field conditions. Do not store test cubes in the adjusted relative moisture condition for later use.

- 3.3.2.6. *Specimen Preparation*—After conditioning and immediately prior to coating, lightly sandblast all surfaces of each cube to uniformly remove a total of 24.0 ± 2 g. Blast one face at a time to remove $4.0 \text{ g} \pm 0.5 \text{ g}$ per face. Use a steel plate shield with a 100-mm² opening to protect the sample edges.

Use sandblasting sand with the following gradation to produce surfaces that are uniform. Lightly brush or air-blow the samples with clean, dry air to remove sand or dust prior to weighing.

Table 3—Gradation Requirements for Sandblasting Sand

Nominal Opening		% Retained
Microns	U.S. Standard Sieve	
1180	No. 16	4–12
850	No. 20	8–15
600	No. 30	15–25
425	No. 40	35–45
300	No. 50	15–25
Pan	Pan	0–3

- 3.3.2.7. *Apply Sealer*—Apply sealer to cube surfaces according to the following procedures by immersion or by applying a known amount of sealer. Weigh cubes before and after treatment or measure the weight of sealer applied and record weights.

Use a maximum of two immersions or coats, unless otherwise directed. Alternate methods to treat samples are also acceptable as long as the cubes are treated uniformly and the application rate is accurately measured.

If the sealer is being tested for use on traffic-bearing surfaces, measure and record drying time and time to traffic per Section 4.4. Subsequent to treatment, maintain cubes in 50 percent RH and 23°C environment.

Calculate the weight of the sealer applied in g/m² and the surface coverage rate in ft²/gal based on the sealer specific gravity and cube surface area. Record the number of immersions or brushings, the drying time between coats, and the coverage rate.

Note 6—Manufacturers usually have a range of recommended application rates, since different surface conditions and concretes will absorb or require different amounts of sealer or coating. If the minimum recommended application rate is tested successfully, the sealer should perform well at higher application rates. However, the opposite may not be true. For prequalification testing, it is important to ensure that adequate material is applied so that the sealer has the best chance of success and is fairly evaluated. In all cases, it is important that the test results be reported in terms of the application rate used in the prequalification tests. Agencies can then specify that the tested rate will be the minimum applied rate in the field.

Note 7—Some sealers and coatings contain volatile components and should be applied in a fume hood. Keep air velocity to a minimum over the cube surfaces during curing.

- 3.3.2.7.1. *Penetrating Sealers Applied by Immersion*—Use the following treatment process for penetrating sealers unless otherwise directed.

Obtain a container to be used for the sealer, a grating that fits over the container, and tongs that can be used to handle the cubes. Fill the container with sufficient sealer and determine the combined weight of the sealer, container, grating, and tongs. Immerse the preweighed cube to be treated with the finished surface upward for 2 min so that the cube is covered with 10 to 15 mm of sealer. Remove the cube and place it on the grating so any excess sealer is allowed to drip back into the container. When no more sealer is dripping from the cubes and after a minimum of 5 min, remove the cube from the grating and determine the combined weight of the contents of the container, grating and tongs, to the nearest 0.1 g. The difference in weights is the weight of applied sealer. Apply a second coat after the first coat visibly dries and between 2 and 24 h after the first coat (unless otherwise directed), if needed to achieve the minimum manufacturer's recommended application rate. Record the time at which the sealer is applied. Measure the weight of the second coat in the same manner. Record total weight of sealer applied wet (W_{sw}).

- 3.3.2.7.2. *Film Forming Sealers Applied by Application Rate*—Apply film forming materials uniformly using a brush or small roller and measure the amount of sealer applied to the nearest 0.1 g, accounting for any sealer remaining on the brush or roller. Support cubes on glass rods or pins during curing such that the coating is not damaged. This may require one face to be coated at a slightly later age to avoid damage to the freshly treated surfaces.

- 3.3.3. *Moisture Vapor Transmission Test*—The moisture vapor transmission is determined gravimetrically. Starting 24 ± 2 h after the sealer treatment is complete, weigh cubes and maintain cubes in standard ASTM C157/C157M laboratory at 50 percent RH, 23°C environment without fans for 14 days. Measure the cube weights at 0 (W_0), 7 (W_7), and 14 (W_{14}) days after treatment to the nearest 0.1 g.

Determine the water loss due to vapor transmission as the weight loss between the 7th and 14th day of drying for the treated (VT_{treated}) and untreated ($VT_{\text{untreated}}$) cubes as follows.

$$VT_{\text{treated}} \text{ or } VT_{\text{untreated}} = (W_7 - W_{14}) / (168 \text{ h} \times 0.062 \text{ m}^2), \text{ in g}/(\text{m}^2 \times \text{h}) \quad (5)$$

Calculate the mean vapor transmission $VT_{\text{treated-m}}$ and $VT_{\text{untreated-m}}$ for the treated and untreated cubes, respectively.

Calculate the mean Drying Rate Coefficient (DRC) as follows:

$$DRC = VT_{\text{treated-m}}/VT_{\text{untreated-m}} \times 100, \text{ in percent (\%)} \quad (6)$$

Note 8—The calculation of vapor transmission between 7 and 14 days is based on the assumption that all evaporation of the sealer itself takes place during the initial 7-day drying period and that only the solid (nonvolatile) components of the sealer remain after that period. Therefore, any additional weight loss is due solely to water vapor transmission.

- 3.3.4. *Waterproofing Performance by Saltwater Immersion Test:*

- 3.3.4.1. *Test Overview*—The same samples used in the vapor transmission testing are used for measuring waterproofing performance. The treated cubes, which are expected to have retained more moisture during the 14-day vapor transmission test than the control cubes, are dried to achieve the same moisture content as the untreated control samples.

- 3.3.4.2. *Adjustment of Treated Cube Moisture Content*—Determine the weight of the cured sealer applied (W_{csa}) to the treated cubes as the product of the nonvolatile content (N_s) (determined in Section 3.5.4) and the wet-applied weight of sealer (W_{sw}) as follows:

$$W_{\text{csa}} = N_s \times W_{\text{sw}}, \text{ in grams} \quad (7)$$

Adjust the moisture content of the treated cubes to match the control cubes by the following process. Calculate the target weight of the treated cubes (W_{t2}). To do this, determine the moisture content of the untreated cubes after the vapor transmission testing, M_{cvt} , which is expected to be equal to or less than the moisture content of the treated cubes as:

$$M_{\text{cvt}} = ((W_{14\text{-untreated}} - W_{\text{od1}})/W_{\text{od1}}) \times 100, \text{ in percent (\%)} \quad (8)$$

where $W_{14\text{-untreated}}$ is the weight of the untreated cubes at the end of the vapor transmission test period and W_{od1} was estimated for each cube in Section 3.3.2.5.

Determine the mean moisture content in the control cubes ($M_{\text{cvt-m}}$) and use the values to determine the target weights for each of the treated cubes as:

$$W_{t2} = W_{\text{od1}} \times (1 + M_{\text{cvt-m}}/100) + W_{\text{csa}}, \text{ in grams} \quad (9)$$