

SSPC: The Society for Protective Coatings

TECHNOLOGY GUIDE 23

Field Methods for the Determination of Moisture in Concrete and Masonry Walls and Ceilings, EIFS, and Stucco

1. Scope

1.1 This Guide describes common field methods for the determination of moisture content in painted and unpainted exterior concrete and masonry walls (CMU, brick, stone [manufactured and natural], poured-in-place, pre-cast, and tilt-up), Exterior Insulation Finishing Systems (EIFS), stucco, and concrete and masonry ceilings (panels, planks and cast-in-place). Many of the ASTM test methods cited in this Guide were developed for use on floors, but the methods are also suitable for use on walls and ceilings. References to relevant industry standards and recommendations for selecting test locations, frequency of testing, and acceptance criteria are provided. Methods other than those included here may also be suitable for use.

NOTE: The warnings and limitations of the various test methods described in this Guide are based on typical situations and may not reflect all field situations. The determination of moisture content can be very complex, and many unanticipated or unknown external factors can affect the results.

2. Description and Definitions

2.1 GENERAL: Coatings applied on surfaces exceeding a certain concentration of moisture can exhibit diminished performance. Excessive moisture in the substrate or on the surface at the time of painting can interfere with film formation, adhesion, and curing of the coating. Excessive moisture in the substrate during service can lead to blistering, peeling, discoloration, reductions in gloss, non-uniformity of color, efflorescence bleed, and other surface imperfections. This Guide is intended to assist the user in selecting specific procedures for performing qualitative and/or quantitative determinations of moisture in the substrate. It includes field and laboratory methods, test conditions, frequency of tests, and acceptance criteria.

NOTE: The methods in this Guide assess the presence of moisture in the substrate, but do not evaluate the transfer of moisture vapor through a wall or coating system.

2.2 UNITS OF MEASURE: This standard makes use of both the ASTM SI 10, "American National Standard for Metric Practice" International System Units (SI) and U.S. Customary units. The measurements are not exact equivalents; therefore, each system must be used independently of the other.

2.3. DEFINITIONS

Barrier Coating: This guide defines a barrier coating as a coating having a water vapor permeance of less than 57.5 nanograms per second per square meter per pascal ($57.5 \text{ ng} \cdot \text{s}^{-1} \cdot \text{m}^2 \cdot \text{Pa}^{-1}$) ($\approx 1 \text{ perm}$), unless the local code establishes a lower number such as $5.75 \text{ ng} \cdot \text{s}^{-1} \cdot \text{m}^2 \cdot \text{Pa}^{-1}$ ($\approx 0.1 \text{ perm}$), determined in accordance with ASTM D1653. Also see *Breathable Coating*, *Retarder Coating*.

Breathable Coating: A coating with a water vapor permeance greater than $575 \text{ ng} \cdot \text{s}^{-1} \cdot \text{m}^2 \cdot \text{Pa}^{-1}$ ($\approx 10 \text{ perms}$). Also see *Barrier Coating*, *Retarder Coating*.

Dew Point: Dew point temperature is the temperature at which condensation begins. It is the temperature at which air is cooled to saturation (assuming air pressure and moisture content are constant).

Moisture Content: The mass of moisture per unit mass of dry material. For example:

$$[(\text{wet weight} - \text{dry weight}) / \text{dry weight}] \times 100$$

Moisture Content Relative Scale (field test): An arbitrary scale (commonly 1 to 100) used to perform a qualitative survey to identify wet materials behind ceiling and wall finishes or coatings. Normally used for comparative purposes (e.g. compare readings from areas with similar materials that are known to be dry to those that are suspected to be wet).

Moisture Vapor Transmission: The steady water vapor flow in unit time through unit area of a body, normal to specific parallel surfaces, under specific conditions of temperature and humidity at each surface. For architectural components, it typically refers to the passage of water vapor through a ceiling or wall assembly.

Permeance Levels: Permeance is measured in perms. One U.S. perm is one grain of water vapor per hour flowing through one square foot of a layer, induced by a vapor pressure difference of one inch of mercury across the two surfaces. The SI measurement units are nanograms per second per square meter per pascal ($\text{ng} \cdot \text{s}^{-1} \cdot \text{m}^2 \cdot \text{Pa}^{-1}$). "Breathable" coatings have higher perm ratings and allow water vapor to pass through them more easily than coatings having lower perm ratings.

Relative Humidity: The ratio of the amount of water vapor actually in the air compared to the amount of water vapor required for saturation at that particular temperature and pressure, expressed as a percentage.

Retarder Coating: A coating with a water vapor permeance of approximately 57.4 to 574 ng•s¹•m²•Pa¹ (or 1 to 10 U.S. perms). Also see *Barrier Coating, Breathable Coating*

Substrate: In this Guide, “substrate” refers to the material below a ceiling or wall finish (e.g. on coated masonry walls, the masonry material is the substrate). **Water Vapor Permeability:** The time rate of water vapor transmission through unit area of flat material of unit thickness induced by unit vapor pressure difference between two specific surfaces, under specified temperature and humidity conditions

Water Vapor Permeance: The time rate of water vapor transmission through unit area of flat material or construction induced by unit vapor pressure difference between two specific surfaces, under specified temperature and humidity conditions

3. Referenced Standards

3.1 The date of the referenced standard in effect at the time of publication of this Guide was used in the development of the Guide unless otherwise noted.

3.2 ASTM INTERNATIONAL⁽¹⁾

C97/C97M	Standard Test Methods for Absorption and Bulk Specific Gravity of Dimension Stone
C1498	Standard Test Method for Hygroscopic Sorption Isotherms of Building Materials
D1653	Standard Test Methods for Water Vapor Transmission of Organic Coating Film
D4263	Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method
F710	Preparing Concrete Floors to Receive Resilient Flooring
F2170	Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using in situ Probes
F2659	Standard Guide for Preliminary Evaluation of Comparative Moisture Condition of Concrete, Gypsum Cement and Other Floor Slabs and Screeds Using Non-Destructive Electronic Moisture Meters

⁽¹⁾ ASTM International, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959. For referenced ASTM standards, visit the ASTM website <<http://www.astm.org>>. For Annual Book of ASTM Standards volume information, refer to the standard's Document Summary page on the ASTM website.

3.2. CEMENT CONCRETE & AGGREGATES AUSTRALIA (CCAA)⁽²⁾

Datasheet Moisture in Concrete and Moisture-Sensitive Finishes and Coatings

4. Test Methods

4.1. METHOD 1 – PLASTIC SHEET METHOD

4.1.1 Description: A non-destructive test to qualitatively determine if moisture is present within a cementitious substrate. The perimeter of a sheet of polyethylene 0.1 mm (4 mils) thick or heavier, measuring approximately 457 x 457 mm (18 x 18 inches), or equivalent minimum surface area, is firmly taped to the substrate and allowed to remain in place for a minimum of 16 hours. At the end of the exposure period, the underside of the sheet and surface of the concrete patch are visually examined for the presence of moisture.

4.1.2 Relevant Standards: ASTM D4263 and Appendix X2.2 of ASTM F710.

4.1.3. Test Conditions

4.1.3.1 The surface temperature and ambient conditions should be within the specified parameters for the application of the coating system. The test site should be out of direct sunlight or direct heat, and remain in place for a minimum of 16 hours (and ideally 22 to 26 hours from morning to morning).

4.1.3.2 Recent rain events (rain, snow, ice, or other form of precipitation) or morning dew can dampen the surface and provide misleading results. The length of drying time after rain or dew will vary depending on the condition of the substrate (coated, uncoated, degree of porosity, etc.), ambient conditions (hot, cool, windy, etc.), and duration and intensity of the rain event. Drying time after a rain event prior to installation of the plastic sheets may range from 2 to 24 hours. Plastic sheets should not be installed for a minimum of 4 hours after the visible evaporation of dew.

4.1.3.3 The preparation of the area beneath the tape is critical. Loose efflorescence, chalk, and dirt should be removed in order to achieve a good seal to the surface. The adhesive qualities of the tape should be sufficient to retain a complete seal for the duration of the test. ASTM D4263 suggests using duct tape 50 mm (2 inches) wide.

4.1.3.4 Rough surfaces, such as rough textured finishes or split-face block, will require a modification of the size and shape of the plastic to allow for the plastic to be sealed at a mortar joint. For example, in the case of block, the shape of the plastic sheet will be in a stair-step pattern.

⁽²⁾ Cement Concrete Aggregates Australia, P.O. Box 124 Mascot NSW 1460 Australia. Datasheet available online at <<http://www.ccaa.com.au>>

4.1.3.5 If the plastic sheet is damaged during the test or the perimeter of the sheet is not fully sealed to the surface, the results may not be reliable.

4.1.3.6 Coating on the surface may influence the results.

4.1.3.7 Cautions:

4.1.3.7.1 If the surface is previously coated with barrier or retarder coatings, the coating may prevent the evaporation of moisture, providing misleading results.

4.1.3.7.2 Results may be void if significant rainfall occurs during the test period.

4.1.3.7.3 Loss of adhesion of the tape will result in a poor seal and void the test.

4.1.4. Test Results

4.1.4.1 The presence of condensation on the back of the plastic, dampness on the surface of the substrate, or a darkening of the substrate indicates that the concrete contains moisture and may not be sufficiently dry for coating application. Note that while a lack of visible moisture is a positive indication of dryness, it is not a guarantee that the concrete is sufficiently dry for coating application. Combining the plastic sheet test with quantitative testing may provide more conclusive results.

4.1.4.2 The plastic sheet test can be combined with electronic instruments to improve the value of the plastic sheet test. This concept is briefly addressed in Appendix X2.4.4.3 of ASTM F710. Moisture readings with one or more of the instruments described in Methods 2, 3 or 4 are taken prior to the installation of the plastic, and again immediately upon removal. An increase in the readings indicates that moisture is present.

4.2. METHOD 2 – USE OF ELECTRICAL IMPEDANCE MOISTURE METER

4.2.1 Description: A hand-held instrument that utilizes the principles of electrical impedance to determine the percentage of moisture in substrate to a nominal depth of 25 mm (1 inch). The electrical impedance of a material varies in proportion to its comparative moisture condition. The electrical impedance of the substrate directly under the footprint of the instrument is measured by creating an alternating electric field that penetrates the material under test. Impedance meters typically have electrodes on the bottom of the unit that must be in full contact with the material. The small alternating current flowing through the field is inversely proportional to the impedance of the material. The instrument determines the current's amplitude and thus derives the moisture value. Direct contact between the instrument and the substrate is required so there is not

loss of signal sensitivity. Impedance meters typically will not work accurately on split-face block.

4.2.2 Relevant Standard – ASTM F2659: Follow the instructions of the instrument manufacturer for the use of the instrument. In the event of a conflict with this Guide, the written instructions of the instrument manufacturer take precedence over this guide.

4.2.3 Test Conditions: There are no unique requirements, but recent rain events (rain, snow, ice, or other form or precipitation) or morning dew can dampen the surface, resulting in elevated moisture readings that would be unacceptable for painting. The length of drying time after rain or dew will vary depending on the condition of the substrate (coated, uncoated, degree of porosity, etc.); ambient conditions (hot, cool, windy, etc.); and duration and intensity of the rain event. Drying time after a rain event prior to using the instrument to determine the moisture content of the substrate rather than surface moisture may range from 2 to 24 hours, or a minimum of 4 hours after the visible evaporation of dew.

4.2.3.1 The test area should be clean and free of any foreign substances. The ASTM standard indicates that paint should be removed, but to determine if the paint is impeding the detection of moisture, perform the following procedure. Take readings on a 15 x 15-mm (6 x 6-inch) area of the painted surface. Remove the paint by abrading the surface and repeat the readings. If there is a difference, the paint can either be removed at each test site, or the difference between the results applied to the measurements that are made through the paint. If the difference is applied, a sufficient number of pre/post paint removal test areas should be examined to properly characterize the difference.

4.2.4 Cautions: Taking readings through paint may provide misleading results. If paint is present, the effect of the paint on the measurements should be determined according to Section 4.2.3.1.

4.2.5 Test Results: Follow the instructions of the instrument manufacturer for reporting results. For example, the instrument of one manufacturer provides moisture content in a range from 0 to 6%.

4.3. USE OF METHOD 3 – RADIO FREQUENCY MOISTURE METER

4.3.2 Description: A non-destructive hand-held instrument that emits a radio frequency to determine the relative moisture content of substrate surfaces to a nominal depth of 19 mm (0.75 inch). Direct contact between the portion of the instrument that emits the frequency and the substrate is required so there is not loss of signal sensitivity.