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Standard Guide to Methods of Evaluating Moisture Conditions of Concrete Floors to Receive Resilient Floor Coverings[1]

This standard is issued under the fixed designation E 1907; 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 (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This guide includes both quantitative and qualitative procedures used to determine the amount of water or water vapor present in or emitting from concrete slabs and criteria for evaluating the moisture-related acceptability of concrete slabs to receive resilient floor coverings and related adhesives.

1.2 Although carpet tiles, carpet, wood flooring coatings, films, and paints are not specifically intended to be included in the category of resilient floor coverings, the procedures included in this guide may be useful for evaluating the moisture-related acceptability of concrete slabs for such finishes.

1.3 This guide does not cover the adequacy of a concrete floor to perform its structural requirements.

1.4 This guide does not include procedures to determine the presence of non-moisture related impediments to the application of finishes.

1.5 This guide does not supersede the specific instructions or recommendations of manufacturers for their flooring finishes.

1.6 *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]

C 33 Specification for Concrete Aggregates

C 125 Terminology Relating to Concrete and Concrete Aggregates

C 168 Terminology Relating to Thermal Insulating Materials

C 330 Specification for Lightweight Aggregate for Structural Concrete

C 332 Specification for Lightweight Aggregate for Insulating Concrete

D 2216 Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock

D 4259 Practice for Abrading Concrete

D 4263 Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method

D 4397 Specification for Polyethylene Sheeting for Construction, Industrial, and Agricultural Applications

E 631 Terminology of Building Constructions

E 1643 Practice for Installation of Water Vapor Retarders Used in Contact with Earth or Granular Fill Under Concrete Slabs

F 2170 Test Method for Determining Relative Humidity in Concrete Floor Slabs Using In Situ Probes

F 1869 Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride

F 141 Terminology Relating to Resilient Floor Coverings

2.2 *Other Sources:*

BS 5325:1983 British Standard Code of Practice for Installation of Textile Floor Coverings[3]

BS 8203:1987 British Standard Code of Practice for Installation of Sheet and Tile Flooring[3]

CRI 104-1994 Standard for Installation of Commercial Textile Floorcovering Materilas[4]

Addressing Moisture Related Problems Relevant to Resilient Floor Coverings Installed Over Concrete [5]

Moisture Guidelines for the Floor Covering Industry [6]

3. Terminology

3.1 *Definitions:*

[1] These practices are under the jurisdiction of ASTM Committee F06 on Resilient Floor Coverings and are the direct responsibility of Subcommittee F06.40 on Practices.

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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.

[3] British Standards Institution, 389 Chiswick High Road, London W4 4AL.

[4] The Carpet and Rug Institute, P.O. Box 2048, Dalton, GA 30722-2048, 706/278-3176, 1994.

[5] Resilient Floor Covering Institute, 966 Hungerford Drive, Suite 12-B, Rockville, MD 20850 (301) 340-8580, November 1995.

[6] World Floor Covering Association, 2211 E. Howell Avenue, Anaheim, CA 92806 (800) 624-6880 Fax (714) 978-6066, undated but received August 1995.

3.1.1 For terms used in these procedures, see Terminologies C 168, E 631 and F 141.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *mat,* as in "mat test"—a sample of vapor-retardant sheet resilient floor finish material

3.2.2 *moisture emission*—a term used by the flooring industry in the U.S. to measure moisture emission from concrete floors in lb/[1,000 ft^2· 24 h] (56.51 μg/(s·m^2)) using the anhydrous calcium chloride test.

3.2.3 *concrete*—concrete made using hydraulic cement as defined in Terminology C 125.

4. Summary of Guide

4.1 This guide describes eight procedures, commonly referred to as "tests," used in the construction industry to determine if unacceptable moisture is present in or being emitted from concrete slabs.

5. Significance and Use

5.1 This guide is intended to be used by applicators of resilient floor coverings to determine if there are moisture-related conditions existing in concrete slabs which would adversely impact the successful application and performance of these products.

5.2 This guide can also be used as an aid in the diagnosis of performance failures in resilient floor coverings.

5.3 Although these procedures are called "tests" for conformity with accepted and familiar industry nomenclature, they are intended to be used only in concert with the judgment and experience of the user. One or more of the procedures may be referenced in a floor finish application specification only to establish the procedures the specifier intends the applicator to utilize in assessing the acceptability of a concrete surface for a particular finish product.

5.4 Unless otherwise indicated, these practices are applicable to slabs on grade, slabs below grade, and slabs above grade (see Terminology F 141).

6. Interferences

6.1 Conduct procedures after the internal conditions of the building in which a slab is located have been at normal service temperature and humidity for at least 48 h. Otherwise, results may not accurately reflect the amount of moisture which is present in the slab or would normally be emitted from or through the concrete during normal operating conditions. If the service temperature and humidity is unattainable, the internal conditions of the building in which a slab is located shall have been maintained within the following temperature and humidity range for at least 48 h:

6.1.1 Temperature: 65 to 85°F (18 to 29°C), and

6.1.2 Relatively humidity: 40 to 60 %.

6.2 No visible water in liquid form shall be present on the concrete at the time procedures commence.

6.3 Avoid locations in direct sunlight or subject to direct sources of heat.

6.4 The concrete surface shall be free of coatings, finishes, dirt, curing compounds, or other substances which may affect the rate of moisture dissipation or the adhesion of finishes. Non-chemical methods, such as abrasive cleaning or bead-blasting, including methods described in Practice D 4259, may be used on existing slabs with deleterious residues to achieve an appropriate state for testing. Cleaning, if required, shall take place a minimum of 48 h prior to testing.

6.5 When using procedures involving electronic instruments, the presence of chlorides or carbonates, whether present as deliberate additions or otherwise, and other concrete additives or metallic fibers can result in erroneous readings. The error will depend on the quantity present but, in general, the water content indicated by the test will be the maximum water content.

7. Procedures

7.1 *General*:

7.1.1 Perform bond and moisture testing procedures on concrete to determine if surfaces are sufficiently dry and free from deleterious substances.

7.1.2 Measure ambient temperature and relative humidity within the structure in which the floor is located at beginning and completion of each procedure.

7.1.3 Sampling

7.1.3.1 Unless otherwise indicated, sampling shall be as follows:

7.1.3.2 Locations shall not be concentrated and shall be distributed around the floor area. One location shall be near the center with others around the perimeter. Selection of locations shall include, but not be limited to, areas of potentially high moisture such as joints and areas closer than 5 ft (1.5 m) from the edge of the slab.[7]

7.1.3.3 Use three sample locations for areas up to 500 ft^2(50 m^2)

7.1.3.4 Use one additional sample location for each additional 500 ft^2(50m^2).

7.2 *Polyethylene Sheet Test*:

7.2.1 *Summary of Method*—This method uses a vapor-retardant plastic sheet sealed to the floor as a vapor trap to determine if excessive moisture is present.

7.2.2 *Significance and Use*:

7.2.2.1 See Section 5.

7.2.2.2 This method, described by Test Method D 4263, was developed by Committee D-33 on Protective Coatings and Lining Work for Power Generating Facilities. It is the responsibility of Subcommittee D33.05 on Surface Preparation.

7.2.2.3 Although developed for coating systems preparation, it is also widely used in the flooring industry.

7.2.3 *Apparatus*—none.

7.2.4 *Reagents and Materials*:

7.2.4.1 Transparent polyethylene sheet Specification D 4397, minimum 4 mils (0.1 mm) thick.

7.2.4.2 Adhesive tape that will adhere to the floor and the sheet, such as duct tape, 2 in (50 mm) wide.

7.2.5 *Preparation of Apparatus*—none.

7.2.6 *Calibration and Standardization*—none.

7.2.7 *Procedure*:

[7] Placement in a grid array is recommended when an isoplethic analysis is anticipated in order to facilitate documentation and accuracy.

7.2.7.1 Tape a plastic sheet approximately 18 in. by 18 in. (460 mm by 460 mm) tightly to the concrete surface making sure all edges are sealed.

7.2.7.2 After a minimum of 16 h[8], remove the plastic sheet and inspect the underside of the sheet and the concrete surface for presence of moisture.

7.2.8 *Calculation and Interpretation of Results*—Presence of visible liquid water indicates concrete is insufficiently dry for application of finishes.

7.3 *Mat Test*:

7.3.1 *Summary of Method*:

7.3.1.1 This method uses a sample of vapor retardant floor finish material and a water-based adhesive to predict the behavior of resilient floor covering adhesives.

7.3.2 A variation of this procedure (known as the "bond" test) beyond the scope of this document can be used to test for bond between substrate and resilient floor coverings.

7.3.3 *Apparatus*—None.

7.3.4 *Reagents and Materials*:

7.3.4.1 Latex multipurpose or water soluble adhesive intended for use with resilient flooring products. It is not necessary to use the type of floor finish product intended for application in this procedure, since the sheet product simply provides a vapor-retardant surface which has sufficient rigidity and weight to remain in place during the procedure.

7.3.4.2 Sheet vinyl, or similar resilient vapor-retardant resilient flooring sheet product.

7.3.4.3 Adhesive tape that will adhere to the floor and the sheet, such as duct tape, 2 in (50 mm) wide.

7.3.5 *Preparation of Apparatus*—Prepare number of mats as required approximately 24 by 24 in. (600 by 600 mm).

7.3.6 *Calibration and Standardization*—None

7.3.7 *Procedure*—Apply adhesive to an area 24 in. by 24 in. (600 mm by 600 mm). While the adhesive is wet, place the mat, surface or face down, immediately into the adhesive. Seal the perimeter edges using tape. The face is placed down to avoid absorption of water in the adhesive by the backing.

7.3.8 *Calculation or Interpretation of Results*:

7.3.8.1 After 72 h, make a visual inspection to determine the condition of the adhesive.

7.3.8.2 If the adhesive is partially or completely dissolved, is still wet, or has little bond, there is too much moisture present to proceed with the installation of flooring material.

7.3.8.3 If the mat is firmly bonded, or removal of the mat reveals the adhesive to be stringy and with good adhesion, the level of moisture present is considered to be sufficiently low for installation of flooring material.

7.4 *Electrical Resistance Test*:

7.4.1 *Summary of Method*—Determines the moisture content by measuring the electrical conductivity of concrete between the meter probes.[9] Conductivity varies in proportion to moisture content. Uses proprietary meters and interpretive methods provided by meter manufacturers.

7.4.2 *Significance and Use*—see Section 5.

7.4.3 This procedure provides a relatively quick way to obtain an approximation of the moisture content of concrete.

7.4.4 *Apparatus*—Suitable instrument to measure the conductivity between two electrodes which are placed in contact with the concrete floor surface or placed into two pre-drilled holes one inch (25 mm) deep into the concrete floor.

7.4.5 *Reagents and Materials*—none.

7.4.6 *Preparation of Apparatus*—Follow instrument manufacturer's instructions.

7.4.7 *Calibration and Standardization*—Follow instrument manufacturer's instructions

7.4.8 *Procedure*—To use one type of instrument, it is necessary to drill holes in the slab to receive pins. Another type can be used with or without drilling holes, but the readings will be more accurate if holes are drilled and the pins are driven into the holes. Care shall be taken to avoid contact between the probes and any metal incorporated into the slab.

7.4.9 *Calculation or Interpretation of Results*:

7.4.9.1 Generic data to correlate measured electrical resistance to acceptable moisture conditions are not available at this time; however, instrument manufacturers generally publish guides for this purpose specific to the instruments they manufacture.

7.4.9.2 Although a high reading (good conductance) typically indicates high moisture content, a low reading (poor conductance) does not necessarily indicate more than surface dryness, as the concrete may have a higher moisture content below the surface. Conversely, a concrete with low moisture content but containing metal fibers could cause a high reading.

7.4.9.3 Confirmation measurements can be made by taking readings at a number of locations which are then covered by a vapor retarder material such as polyethylene sheeting then taking subsequent readings 24 h later after removing the covers. Where the second reading significantly exceeds the first, it indicates that the concrete has an unacceptable level of moisture.

7.5 *Electrical Impedance Test*:

7.5.1 *Summary of Method*—Uses proprietary meters and interpretive methods provided by meter manufacturers to determine the moisture content of concrete by measuring both conductance and capacitance.

7.5.2 *Significance and Use*—See Section 5.

7.5.2.1 A quick, non-destructive way to determine the moisture content of concrete by measuring the electrical AC impedance. Impedance is an alternating current measurement combining both resistance and capacitance while at the same time overcoming the separate limitations of each (single-line measurement with resistance and shallow depth of penetration of signal with capacitance). With impedance measurement, a field is set up consisting of an area under the footprint of the instrument electrodes (Fig. 1). The depth of the signal penetration will vary depending on the material content of the slab and the moisture content, generally varying from 0.75 in. (20 mm) to 2.0 in. (50 mm).

[8] Although Test Method D 4263 specifies 16 h, some authorities recommend a minimum of 24 h.

[9] The most detailed information on this test comes from British Standards Institution (BSI) BS 5325:1983 British Standard Code of Practice for Installation of Textile Floor Coverings and BS 8203:1987 British Standard Code of Practice for Installation of Sheet and Tile Flooring.

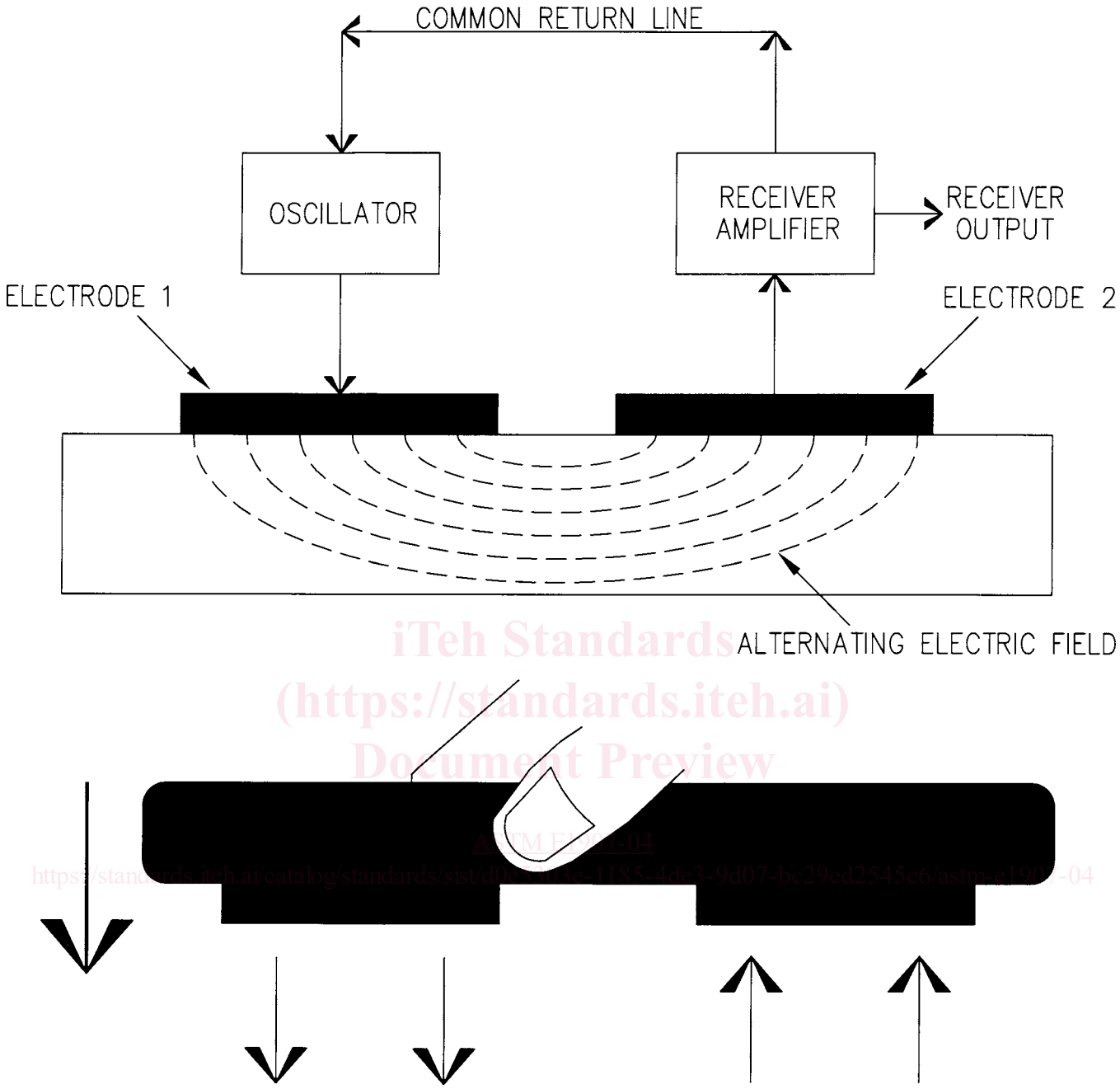

FIG. 1 Basic Schematic of Electrical Impedance Moisture Meter

7.5.3 *Apparatus*—An electrical impedance meter specifically developed and calibrated for concrete moisture measurement.

7.5.4 *Reagents and Materials*—none.

7.5.5 *Preparation of Apparatus*—See instrument manufacturer's instructions.

7.5.6 *Calibration and Standardization*—See instrument manufacturer's instructions.

7.5.7 *Procedure*—Follow instrument manufacturer's instructions. Typically, the meter is placed on the concrete slab with its electrodes pressed in direct contact with the surface. When the meter is switched on, low frequency signals are transmitted into the slab, measuring the change in impedance brought about by the presence and level of moisture. The impedance is converted to a percentage moisture content displayed on the instrument dial in both percentage and relative readings. Holes in the slab are typically not required.

7.5.8 *Calculation or Interpretation of Results*:

7.5.8.1 See instrument manufacturer's instructions.

7.5.8.2 Instructions for calibration of instruments and correlation of impedance meter readings to other methods of determining concrete moisture conditions are typically provided by instrument manufacturers.

7.5.8.3 Readings typically indicate percentage moisture content (by mass).