Designation: ~~F710 – 19ε1~~ F710 – 21

Standard Practice for Preparing Concrete Floors to Receive Resilient Flooring[1]

This standard is issued under the fixed designation F710; 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 reappproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

~~ε1 NOTE—The reference in 6.2 to ACI 203.2R was corrected to ACI 302.2R editorially in January 2020.~~

1. Scope

1.1 This practice covers the determination of the acceptability of a concrete floor for the installation of resilient flooring.

1.2 This practice includes suggestions for the construction of a concrete floor to ensure its acceptability for installation of resilient flooring.

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

1.4 This practice covers the necessary preparation of concrete floors prior to the installation of resilient flooring.

1.5 This practice does not supersede in any manner the resilient flooring or adhesive manufacturer's written instructions. Consult the individual manufacturer for specific recommendations.

1.6 Although carpet tiles, carpet, wood flooring, coatings, films, and paints ae not specifically intended to be included in the category of resilient floor coverings, the procedures included in this practice may be useful for preparing concrete floors to receive such finishes.

1.7 *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.* See 4.1.1, 7.1.1, and 7.1.2 for specific warning statements.

1.8 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.9 *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:*[2]

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

[1] This practice is under the jurisdiction of ASTM Committee F06 on Resilient Floor Coverings and is 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.

C472 Test Methods for Physical Testing of Gypsum, Gypsum Plasters, and Gypsum Concrete
D4259 Practice for Preparation of Concrete by Abrasion Prior to Coating Application
D4263 Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method
D4397 Specification for Polyethylene Sheeting for Construction, Industrial, and Agricultural Applications
E1155 Test Method for Determining F_F Floor Flatness and F_L Floor Levelness Numbers
E1486 Test Method for Determining Floor Tolerances Using Waviness, Wheel Path and Levelness Criteria
E1745 Specification for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs
F141 Terminology Relating to Resilient Floor Coverings
F710 Practice for Preparing Concrete Floors to Receive Resilient Flooring
F1869 Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride
F2170 Test Method for Determining Relative Humidity in Concrete Floor Slabs Using in situ Probes
F3191 Practice for Field Determination of Substrate Water Absorption (Porosity) for Substrates to Receive Resilient Flooring

NOTE 1—Specifications and test methods for cements and other related materials are found in ASTM Volume 04.01. Specifications and test methods for concretes and related materials are found in ASTM Volume 04.02.

2.2 *ACI Guides:*[3]
302.1R-06 Guide for Concrete Floor and Slab Construction
302.2R-06 Guide for Concrete Slabs that Receive Moisture-Sensitive Flooring Materials
117R Standard Tolerances for Concrete Construction and Materials

2.3 *Resilient Floor Covering Institute (RFCI):*[4]
Recommended Work Practices for the Removal of Resilient Floor Coverings

2.4 *Other Standards:*
MASTERSPEC Guide Spec Section 03 30 00 "Cast-In-Place Concrete"[5]

3. Terminology

3.1 *Definitions*— For definitions of terms used in this practice, see Terminology F141.

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 or equivalent.

3.2.2 *moisture vapor emission*—a term used by the flooring industry in the U.S. to measure moisture emission from concrete floors in lb/1000 $ft^2 \cdot 24$ h (56.51 $\mu g/(s \cdot m^2)$) using the anhydrous calcium chloride test.

4. General Guidelines

4.1 The surface of concrete floors to receive resilient flooring shall be dry, clean, smooth, and structurally sound. They shall be free of dust, solvent, paint, wax, oil, grease, residual adhesive, adhesive removers, film-forming curing compounds, silicate penetrating curing compounds, sealing, hardening, or parting compounds, alkaline salts, excessive carbonation or laitence, mold, mildew, and other foreign materials that might affect the rate of moisture dissipation from the concrete, the adhesion of resilient flooring to the concrete or cause a discoloration of the flooring from below. Non-chemical methods for removal, such as abrasive cleaning or bead-blasting, including methods described in Practice D4259 may be used on existing slabs with deleterious residues.

4.1.1 **Warning—**Hydraulic cement used in concrete construction may contain trace amounts of free crystalline silica. Prolonged exposure to airborne free crystalline silica may be a health hazard. Avoid actions that cause dust to become airborne. Use local or general ventilation to control exposures below applicable exposure limits.

4.1.2 **Warning—**See 7.1.1 and 7.1.2 for warnings regarding asbestos and lead paint.

4.2 Surface cracks, grooves, depressions, control joints or other non-moving joints, and other irregularities shall be filled or smoothed with latex patching or underlayment compound recommended by the resilient flooring manufacturer for filling or smoothing, or both. Patching or underlayment compound shall be moisture-, mildew-, and alkali-resistant, and, for commercial

[3] Available from American Concrete Institute (ACI), 38800 Country Club Dr., Farmington Hills, MI 48331-3439, http://www.concrete.org.
[4] Resilient Floor Covering Institute, 966 Hungerford Drive, Rockville, MD 20850.
[5] Available from MASTERSPEC, AIA Master Systems, King Street Station, 225 Reinekers Lane, Suite 215, Alexandria, VA 22314-2875.

installations, shall provide a minimum of 3000 psi compressive strength after 28 days, when tested in accordance with Test Method C109/C109M or Test Method C472, whichever is appropriate.

4.2.1 Joints such as expansion joints, isolation joints, or other moving joints in concrete slabs shall not be filled with patching compound or covered with resilient flooring. Consult the resilient flooring manufacturer regarding the use of an expansion joint covering system.

4.3 The surface of the floor shall be cleaned of all loose material by scraping, brushing, vacuuming, or other methods, or a combination thereof, as recommended by the resilient flooring manufacturer, immediately before commencing installation of resilient flooring.

4.4 Many resilient floorings may not be installed over concrete when residual asphalt adhesive residue is present. Consult the resilient flooring manufacturer's written recommendations concerning use of resilient flooring products in these situations.

4.5 Concrete floors shall be smooth to prevent irregularities, roughness, or other defects from telegraphing through the new resilient flooring. The surface of concrete floors shall be flat to within the equivalent of 3⁄16 in. (3.9 mm) in 10 ft, (as described in ACI 117R, or as measured by the method described in Test Method E1155 or any industry-recognized method specified) and within the equivalent of 1/32 in. (0.8 mm) in 12 in. (305 mm). See X1.7 for more information regarding flatness measurement methods.

4.6 *Acclimation*—Because of the role acclimation plays in a successful installation, most resilient flooring manufacturers recommend or require that their flooring products, sundry supplies (adhesives, coatings, welding rods, etc.) and the area to receive the resilient flooring are properly conditioned. Consult floor covering and sundry manufacturers for appropriate temperature and humidity range for the products to be installed and the geographic area where the job site is located. General recommendations are for the installation area and materials listed above to be maintained at a minimum of ~~65°F (18.3°C)~~ 65 °F (18.3 °C) and a maximum of ~~85°F (29.4°C)~~ 85 °F (29.4 °C) for 48 h before, during and for 48 h after completion of the installation. Relative humidity level extremes should also be avoided because of their influence on proper drying and curing of patching compounds and adhesives. General recommended humidity control level is between 35 – 55 %. If a system other than the permanent HVAC source is utilized, it must provide proper control of both temperature and humidity to recommended or specific levels for the appropriate time duration.

5. Testing Procedures

5.1 *Moisture Testing*—All concrete slabs shall be tested for moisture regardless of age or grade level. For the preferred moisture testing method and limits, consult the written instructions from the floor covering manufacturer, the adhesive manufacturer, the patching/underlayment manufacturer, or combination thereof. In the absence of manufacturer's guidelines, refer to Table 1.>

5.1.1 Consult the resilient flooring manufacturer, the adhesive manufacturer, the underlayment manufacturer's written instructions, or combination thereof, for their acceptable test methods. If these instructions are in conflict, the most stringent requirements shall apply.

5.2 *pH and Alkalinity*—See X1.4 for information about pH and alkalinity in concrete slabs.

5.3 ~~*pH Testing*—~~*Substrate Water Absorption (Porosity)*—~~Concrete floors shall be tested for pH prior to the installation of resilient flooring. Levels of pH shall not exceed the written recommendations of the resilient flooring manufacturer or the adhesive manufacturer, or both.~~ All concrete slabs to receive resilient flooring shall be evaluated for substrate water absorption (porosity) regardless of age or grade level. For the accepted criteria and method for determining substrate water absorption (porosity), consult the written instructions from the manufacturer of the floor covering(s), adhesive(s), patching/underlayment products, and if applicable, the moisture mitigation system.

TABLE 1 ASTM Test Methods for Concrete Moisture Reading

Test Method	Maximum Limit
F1869	3 lb/1000 ft^2 (170 $μg/m^2$) per 24 h
F2170	75 %

5.3.1 To test for pH at the surface of a concrete slab, use wide range pH paper, its associated pH chart, and distilled or deionized water. Place several drops of water on a clean surface of concrete, forming a puddle approximately 1 in. (25 mm) in diameter. Allow the puddle to set for 60 ± 5 s, then dip the pH paper into the water. Remove immediately, and compare to chart to determine pH reading. Other pH testing methods such as pH pencils or pH meters, or both, are available and may be used to measure pH. Readings below 7.0 and in excess of 10.0 have been known to affect resilient flooring or adhesives, or both. Refer to resilient flooring manufacturer's written instructions for guidelines on acceptable testing methods and acceptable pH levels. SeeIf there is a conflict between the manufacturer's accepted criteria and method for determining substrate water absorption (porosity), it is the design team's X1.4 for more information about pH levels in concrete slabs.responsibility to determine the appropriate criteria and method.

5.3.2 In the absence of written manufacturer's guidelines, substrate water absorption (porosity) shall be determined by Practice F3191.

6. Preparation of New Concrete Floors

6.1 New concrete slabs shall be properly cured and dried or treated before installation of resilient flooring. Drying time before slabs are ready for moisture testing will vary depending on atmospheric conditions and mix design. See X1.3 for more information. Floors containing lightweight aggregate or excess water, and those which are allowed to dry from only one side, such as concrete over a moisture vapor retarder or concrete on metal deck construction, may need a much longer drying time and should not be covered with resilient flooring unless the moisture vapor emission rate or the percentage of internal relative humidity meets the manufacturer's installation specifications.

6.2 The installation of a permanent below-slab vapor retarder meeting the minimum performance requirements of Specification E1745 is required for all new on-, or below-grade concrete floors over which resilient flooring materials are to be installed. The use of such a material, provided that its integrity has not been compromised, retards the ingress of moisture from the ground which otherwise can increase moisture levels within the concrete which in turn can lead to flooring and adhesive problems. For resilient flooring installations the vapor retarder is to be installed in direct contact with the underside of the slab. For further information regarding below-slab vapor retarders refer to ACI 302.2R.

7. Preparation of Existing Concrete Floors

7.1 The resilient flooring manufacturer shall be consulted regarding the necessity of removal of old resilient flooring, adhesive residue, paint, or other surface contaminants. If old resilient flooring, paint, or adhesive residue is to be removed, follow 7.1.1 and 7.1.2:

7.1.1 **Warning**—Do not sand, dry sweep, dry scrape, drill, saw, beadblast, or mechanically chip or pulverize existing resilient flooring, backing, lining felt, paint, asphaltic cutback adhesives, or other adhesives. These products may contain asbestos fibers or crystalline silica. Avoid creating dust. Inhalation of such dust is a cancer and respiratory tract hazard. Smoking by individuals exposed to asbestos fibers greatly increases the risk of serious bodily harm. Unless positively certain that the product is a nonasbestos-containing material, presume that it contains asbestos. Regulations may require that the material be tested to determine asbestos content. The Resilient Floor Covering Institute's (RFCI's) recommended work practices for removal of existing resilient floor coverings should be consulted for a defined set of instructions addressed to the task of removing all resilient floor covering structures.

7.1.2 **Warning**—Certain paints may contain lead. Exposure to excessive amounts of lead dust presents a health hazard. Refer to applicable federal, state, and local laws and guidelines for hazard identification and abatement of lead-based paint published by the U.S. Department of Housing and Urban Development[6] regarding appropriate methods for identifying lead-based paint and removing such paint, and any licensing, certification, and training requirements for persons performing lead abatement work.

7.2 *Adhesive Removers*—There are a number of commercial adhesive removers that will properly remove adhesive residue from a subfloor, however, there are concerns that these products may adversely effect the new adhesive and new floor covering. The Resilient Floor Covering Institute's (RFCI's) recommended work practices for removal of existing resilient floor coverings and the resilient flooring manufacturer's written instructions should be consulted for a defined set of instructions which should be followed if existing adhesives must be removed.

[6] *Lead-Based Paint: Interim Guidelines for Hazard Identification and Abatement in Public and Indian Housing*, U.S. Department of Housing and Urban Development, Washington, DC, 1990.

7.3 It is the project design team's responsibility to determine the presence, quality, and location of a below-slab vapor retarder. This information, along with the concrete slab moisture test results, will then be used by the design team to assess the risk of a moisture-related flooring problem and determine an appropriate approach.

8. Installation on Radiant Heated Floors

8.1 Most resilient flooring can be installed on radiant heated slabs providing the maximum temperature of the surface of the slab does not exceed ~~85°F (29°C)~~ 85 °F (29 °C) under any condition of use. Consult the resilient flooring manufacturer for specific recommendations.

9. Keywords

9.1 adhesive removers; cement; concrete floors; installation; moisture; moisture vapor emissions; pH testing; preparation; resilient flooring; rubber; slabs

APPENDIXES

(Nonmandatory Information)

X1. CONCRETE COMPOSITION AND PRACTICES

X1.1 *General* —This brief information on concrete composition and practices is provided to help specifiers, resilient flooring installers, and resilient flooring manufacturers understand the properties of concrete. A concrete slab is not an inert substrate. It is a complex mixture of organic and inorganic substances whose properties and condition will affect the performance of a floor covering placed on its surface. Surface flatness, strength, joints, alkalinity, permeability, and many other concrete properties will have a significant effect on the long-term appearance and performance of resilient flooring.

X1.1.1 Concrete used for most floors is a mixture of hydraulic cement, fine aggregate (sand), coarse aggregate (stone), water and admixtures. In addition to these batch ingredients, chemical admixtures can be used to control the setting time, rate of strength development, workability, air entrapment, and other properties of concrete. For example, water-reducing admixtures can increase the slump of fresh concrete without adding additional water. Pozzolanic admixtures such as fly ash or ground granulated blast furnace slag are sometimes present as a partial replacement for the cement.

X1.1.2 Lightweight concrete, less than 115 lb/ft ^{3} (1841 kg/m^3), may have such low compressive strength that it is unsuitable for covering with resilient flooring unless 1 in. (25 mm) or more of standard weight concrete, generally 140 lb/ft^3 (2241 kg/m^3) or more, is used as a topping.

X1.2 *Water-Cement Ratio*—The most important factor affecting concrete properties is the water-cement ratio. This is the ratio of the mass of water to the mass of cement in a standard volume of concrete. For a given concrete mix design, as the water-cement ratio is increased, most concrete properties are affected negatively. Of special interest to the floor covering industry, compressive and flexural strengths are decreased, permeability is increased, and drying times are lengthened. Moderate to moderately low water-cement ratios (0.40 to 0.45) can be used to produce floor slabs that can easily be placed, finished, and dried, and which will have acceptable permeability to moisture. Floor slabs with water-cement ratios above 0.60 take an exceedingly long time to dry and cause adhesives or floor coverings, or both, to fail due to high moisture permeability.

X1.3 *Curing and Drying New Concrete*:

X1.3.1 Freshly placed concrete sets and gains strength by the chemical reaction of water with the silicate and aluminate materials in the cement. As long as water is available during the planned curing period, the concrete will continue to gain strength and decrease its permeability. Various ways concrete is cured include cover curing with paper or plastic sheets or other methods which aid in retaining some moisture in the concrete, thus retarding the rate of drying. Resilient flooring and adhesive manufacturer's specifications often prohibit the use of membrane forming curing compounds as they can interfere with the bond of the adhesive to the concrete.

X1.3.2 Membrane forming curing compounds, in many cases, form a surface film of oil, wax, resins, or a combination thereof, that tend to lengthen the drying time of the concrete, obstruct the bond between the concrete surface and the adhesive and/or the patching or underlayment compound to the concrete, or may trap moisture in the concrete which will be released at a future date, or both, causing adhesive failure or other problems related to excess water vapor between the flooring and the slab. In all cases where curing compounds have been used, the resilient flooring or adhesive manufacturer, or both, shall be consulted.

X1.3.3 Excess water is always present beyond the amount of water required for cement hydration. As the cement continues to hydrate, excess water must be permitted to flow out of the concrete, generally by evaporation at the top surface, during a planned drying period following curing. A4 in. (100 mm) thick slab, allowed to dry from only one side, batched at a water-cement ratio of 0.45, typically requires approximately 90 to 120 days to achieve a moisture vapor emission rate (MVER) of 3 lb/1000 ft^2 (170 $\mu g/m^2$) per 24 h (the resilient flooring industry standard MVER). The importance of using a moderate to moderately low water-cement ratio for floors to receive resilient flooring cannot be overemphasized.

X1.4 *pH and Alkalinity*—As Portland cement hydrates, calcium hydroxide ~~and other alkaline hydroxides are formed. The pH of~~ is formed. Due to the presence of hydroxyl ions in the cement paste, the pH of fresh, wet concrete is ~~extremely alkaline, typically around pH~~typically in the range of 12 to 13. ~~The~~ As the uncovered surface of a concrete slab ~~will naturally react with atmospheric carbon dioxide to produce calcium carbonate in the hydraulic cement paste, which reduces the pH of the surface. Results~~ is exposed to atmospheric carbon dioxide, the surface pH is lowered due to a natural process referred to as carbonation. Levels in the range of pH 8 to ~~10~~9 are ~~typical~~common for a ~~floor with at least~~ concrete slab surface that has developed a thin layer of ~~carbonation (approximately 0.04 in. (1 mm). Abrasive removal (shotblasting, sanding, or grinding) of a thin layer of concrete can remove this carbonated layer and expose more highly alkaline concrete below. Additional pH tests, waiting time, application of patching compound or underlayment, or a combination thereof, might be required after abrasive removal of the concrete surface. If the carbonated layer is removed and the pH of the concrete surface is above 10, consult the flooring and/or adhesive manufacturer for additional recommendations.~~carbonated cement paste at the surface. Testing the pH level of a concrete floor slab surface is not a measurement of the hydroxyl ions below the surface and thus not a measurement of alkali content in the concrete, or a prediction of alkali content in the concrete that a floor covering may become exposed to.

X1.4.1 Soluble sodium and potassium hydroxides (alkali hydroxides) present below the carbonated surface of a concrete floor slab can become a concern if there is sufficient moisture in the concrete to cause these hydroxides to diffuse to the surface. Applying an external source of liquid water to the surface of a concrete slab to measure the pH level does not accurately predict what pH condition may develop at the surface of a slab, over time, once the slab is covered. If the design team or manufacturer of a flooring material, adhesive, or underlayment has a requirement for substrate pH testing, their method of testing and their acceptance levels are to be described in their sub-floor evaluation specifications and their method is to be followed. If testing instructions and acceptance levels differ for any of the materials to be installed, the most stringent requirements apply.

X1.5 *Efflorescence* —Accumulation of salts on a concrete slab can be due to moisture movement vertically through the slab from bottom to top or horizontally inward from exposed edges of slabs on or below grade. Such salts can cause problems by destroying adhesive bond, displacing floor coverings, and staining. The most common efflorescence is a white powdery deposit of calcium carbonate which has a pH of close to neutral (7.0). Sulfate compounds can accumulate due to moisture migration, especially in parts of California. These compounds are not deleterious themselves but indicate that excessive moisture may be moving through the slab and should be addressed before installing a resilient floor covering.

X1.6 *Slab Curling*—Slab curling problems can arise when a slab dries at a differential rate – faster at the top while remaining wet at its lower surface. Curling is exacerbated by conditions such as hot, dry, windy weather following placement, inadequate curing, and excessively high water-cement ratio. Differential stresses due to shrinkage at the top and restraint at the bottom cause upward curling of the slab leading to uncontrolled cracking. Placing concrete directly on top of a moisture retarder reduces the possibility of outflow of excess batch water at the bottom of the slab, perhaps increasing the possibility of curling. Measurement of slab curling is not reflected in FF and FL measurements. See ACI 302.1R-06 for specific slab curling measuring techniques.

X1.7 *Flatness and Levelness of Concrete Floors to Receive Resilient Flooring*:

X1.7.1 *History:*

X1.7.1.1 For over 50 years, concrete floor surface tolerances were typically measured and described by the maximum gap allowed under a 10-ft (3-m) long straightedge placed anywhere on the floor. This manual method was difficult, especially for large areas, and often results were deceptive, too stringent, and not reproducible. Clearly, a better measurement technique was needed.

X1.7.1.2 During the 1970s and 1980s, sophisticated instruments were developed to measure floor flatness, particularly in response to the need for producing superflat floors to control the sway of moving forklifts in warehouses with high storage racks and narrow aisles. There are two accepted measurement methods using such instruments today. One is described in Test Method E1155. The other measurement method is described in Test Method E1486.

X1.7.2 *The F-Number System:*

X1.7.2.1 The American Concrete Institute now recommends that flatness and levelness be described using the F-Number System as outlined in ACI 302.1R-06 and ACI 117R. This system identifies two numbers: F_F controls local surface bumpiness (or waviness) by limiting the magnitude of successive 1-ft (300-mm) slope changes. F_L controls overall levelness (or pitch) by limiting differences in the average of 10-ft (3-m) elevations along sample measurement lines.

X1.7.2.2 ACI 117R (commentary) states, "None of the conventional concrete placement techniques in use today can adequately compensate for form or structure deflections that occur during the concrete placement and, for this reason, it is inappropriate to specify levelness tolerances on unshored floor construction." For concrete slabs receiving resilient floor covering, therefore, it is most important to describe limits of floor flatness.

X1.7.2.3 As stated in ACI 302.1R-06, "In practice, F_F and F_L values generally fall between 12 and 45. The scale is linear, so that relative flatness/levelness of two different floors will be in proportion to the ratio of their F-numbers. For example, an F_F 30/F_L 24 floor is exactly twice as flat and twice as level as an F_F 15/F_L 12 floor." While there is no direct equivalent between F-numbers and straightedge tolerances, ACI 117R does give a rough correlation between the two systems, as shown in Table X1.1.>

X1.7.3 *Guidelines for F-Number Subfloor Finish Tolerances Under Resilient Floors:*

X1.7.3.1 ACI 302.1R gives F-number results that can be achieved by following various slab construction procedures. It

TABLE X1.1 Rough Correlations Between F-Numbers and Straightedge Tolerances

F-number (F_F)	Gap Under an Unleveled 10-ft (3-m) Straightedge
12	½ in. (12.7 mm)
20	5⁄16 in. (7.9 mm)
25	¼ in. (6.4 mm)
32	3⁄16 in. (4.8 mm)
50	⅛ in. (3.2 mm)