Designation: F 710 – 05

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

This standard is issued under the fixed designation F 710; 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 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 *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.* See 5.1, 7.1.1, and 7.1.2 for specific warning statements.

1.7 The values stated in inch-pound units are to be regarded as standard. The values in parentheses are mathematical conversions to SI units and are provided for information only.

2. Referenced Documents

2.1 *ASTM Standards:* [2]

C 109/C 109M Test Method for Compressive Strength of Hydraulic Cement Mortars

C 309 Specification for Liquid Membrane-Forming Compounds for Curing Concrete

C 472 Test Method for Compressive Strength of Gypsum Cement

D 4259 Practice for Abrading Concrete

E 1155 Test Method for Determining FF/FL (Floor Flatness and Floor Levelness)

E 1486 Test Method for Determining Floor Tolerances Using Waviness, Wheel Path, and Levelness Criteria

E 1745 Specification for Plastic Water Vapor Retarders Used In Contact With Soil or Granular Fill Under Concrete Slabs

F 141 Terminology Relating to Resilient Floor Coverings

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

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

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 Guide for Concrete Floor and Slab Construction

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 03300, "Cast-In-Place Concrete"[5]

SPECTEXT Guide Spec Section 03346, "Concrete Floor Finishing"[6]

3. Terminology

3.1 *Definitions*— For definitions of terms used in this practice, see Terminology F 141.

4. General Guidelines

4.1 Concrete floors to receive resilient flooring shall be permanently dry, clean, smooth, and structurally sound. They shall be free of dust, solvent, paint, wax, oil, grease, residual

[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.

[3] Available from American Concrete Institute, 19150 Redford Station, Detroit, MI 48219.

[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.

[6] Available from SPECTEXT, National Institute of Building Sciences, 1090 Vermont Avenue, NW, Suite 700, Washington, DC 20005-4905.

adhesive, adhesive removers, curing, sealing, hardening, or parting compounds, alkaline salts, excessive carbonation or laitence, mold, mildew, and other foreign materials that might prevent adhesive bond.

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 installations, shall provide a minimum of 3000 psi compressive strength after 28 days, when tested in accordance with Test Method C 109 or Test Method C 472, 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 E 1155 or any industry-recognized method specified. See X1.7 for more information regarding flatness measurement methods.

5. Testing Procedures

5.1 Concrete floors to receive resilient flooring shall be free of sealers, coatings, finishes, dirt, film-forming curing compounds, or other substances which may affect the rate of moisture dissipation from the concrete or the adhesion of resilient flooring to the concrete. Non-chemical methods for removal, 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 shall take place a minimum of 24 h before testing. **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.

5.2 *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.

5.2.1 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.

5.3 *pH Testing*—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.

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. See X1.4 for more information about pH levels in concrete slabs.

6. Preparation of New Concrete Floors

6.1 New concrete slabs shall be properly cured and dried 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 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 meets the manufacturer's installation specifications.

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,

TABLE 1 ASTM Test Methods for Concrete Moisture Reading

Test Method	Maximum Limit
F 1869	3 lb/1000 ft^2(170 μg/m^2) per 24 h
F 2170	75 %

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[7] 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.

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) 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

[7] *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.

APPENDIX

(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. Specifications and test methods for cements and related materials are found in the *Annual Book of ASTM Standards*, Vol 04.01.

X1.1.2 Lightweight concrete, less than 115 lb/ft^3 (1841 kg/m^3), may have such low 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 most 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. A minimum of 7 days wet curing is usually required. Two alternative approaches to curing concrete are wet curing and the use of curing compounds. Wet curing is accomplished by keeping the top surface of the concrete slab wet using soaker hoses, wet burlap, Kraft paper, plastic sheets, or a combination of these materials. Membrane-forming curing compounds meeting Specification C 309 are commonly spray-applied to the top surface of the slab immediately after finishing to retard moisture evaporation. Spray, roller, or brush applied cure-and-seal compounds are sometimes used instead of membrane-forming compounds. All of these compounds aid in retaining some moisture in the concrete, thus retarding the rate of drying. Resilient flooring and adhesive manufacturers specifications often prohibit the use of such compounds as they can interfere with the bond of the adhesive to the concrete.

X1.3.2 Such agents, in many cases, form a surface film of oil, wax, resins, or a combination thereof, that tend to obstruct the bond between the and the adhesive 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. A 4 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 µg/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 *Alkalinity*—As Portland cement hydrates, calcium hydroxide and other alkaline hydroxides are formed. The pH of wet concrete is extremely alkaline, typically around pH 12 to 13. The 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 in the range of pH 8 to 10 are typical for a floor with at least 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.

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 floor covering.

X1.6 *Moisture Retarders*:

X1.6.1 The installation of a permanent, effective moisture vapor retarder with a minimum thickness of 0.010 in., and a permeability of 0.1y, as described in Specification E 1745 is recommended under all on- or below-grade concrete floors. The use of such a moisture vapor retarder, provided its integrity has not been compromised, reduces potential severity of moisture vapor penetration. Every concrete floor slab on- or below-grade to receive resilient flooring should have a moisture retarder (often improperly called a vapor barrier) installed directly below the slab.

X1.6.2 Many types of moisture retarders are available, such as plain polyethylene sheet, polyethylene sheet with fiber reinforcing, polyethylene sheet laminated with other materials, mylar-aluminum foil laminates, and asphalt impregnated multi-layer sheets.

X1.6.3 Slab curling problems can arise when a slab dries quickly at its top surface 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. To avoid causing excessive curling problems, a moisture retarder is sometimes omitted, often leading to severe floor covering failures due to moisture at a later time.

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 E 1155. The other measurement method is described in Test Method E 1486.

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 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, "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 recommends that slabs to receive thin-set flooring with moderate or heavy traffic have composite flatness and levelness of F_F 35/F_L 25. However, it also advises that the selection of the proper F_F/F_L tolerances for a new project is best made by measurement of a similar satisfactory existing floor.

X1.7.3.2 MASTERSPEC Guide Spec Section 03300, Evaluations, has a guide to floor flatness and levelness tolerances for various floor use categories. It recommends a minimum F_F 20/F_L 17 for subfloors receiving thin coverings that will not mask the subfloor condition. (Some industry sources suggest these limits are too low because subfloor ripples begin to telegraph through highly reflective coverings when F_F is in the mid-20's range.)

X1.7.3.3 SPECTEXT Guide Spec Section 03346 includes appropriate options for slabs under various floor finishes. It recommends a minimum F_F 75/F_L 50 under glossy resilient finishes, and a maximum variation using a straightedge of ⅛ in. (3.2 mm) to ¼ in. (6.4 mm) under seamless resilient flooring. (These F-numbers are much higher than other industry guidelines and may be too expensive to accomplish and unnecessary where thin floor coverings are to be applied.)

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)

X1.7.4 *Waviness Index*—Another more recent measurement method is described in Test Method E 1486. This test method was developed primarily to measure floor surface wavelengths from 2 ft (600 mm) to 10 ft (3 m)—those that most affect forklift rideability at typical speeds on floors designed for random vehicular traffic. Proponents of this test method have submitted proposed guidelines to ACI Committee 117 suggesting tolerance standards. These guidelines include the recommendation that concrete floors with vinyl tile covering be specified with a surface waviness index (SWI_{2-10}) of 0.10 in. (2.5 mm). This is approximately equivalent in the tested area to F_F 28/F_L 20 and to a ¼-in. (6.4-mm) gap permitted under a 10-ft (3-m) straightedge.

X1.7.5 *Remedial Measures*—ACI 302.1R identifies precautions, influencing factors, construction environment, and measurement timeliness relative to maintaining flatness and levelness tolerances. It suggests: "Remedial measures for slabs on ground might include grinding, planing, surface repair, retopping, or removal and replacement. For suspended slabs, remedial measures are generally limited to grinding or use of an underlayment or topping material. Contract documents should clearly identify the acceptable corrective methods(s) to be used."

X1.7.6 *Limitation of Measurement Methods*:

X1.7.6.1 One important reason for specifying flatness tolerance for concrete slabs to receive resilient tile is to attempt to minimize tile runoff and gapping due to slab surface waviness. F_F numbers and waviness index numbers necessary to accomplish this have not been determined. However, experience shows that floors with a maximum ¼-in. (6.4-mm) gap under an unleveled 10-ft (3-m) straightedge tend to lessen the tendency for tile runoff.

X1.7.6.2 Thin, applied resilient floor coverings can exhibit show-through of very small subfloor irregularities and roughness. Methods that indicate surface flatness by measuring elevations at 12-in. (300-mm) or larger increments cannot reflect surface imperfections that occur at smaller intervals. Only visual inspection will show surface defects such as concrete trowel marks, small protrusions, or pits. Resilient flooring finishing techniques and products that give increased glossiness will accentuate the telegraphing of such subfloor unevenness or texture. Therefore, specifications for slabs to receive resilient flooring should address the issue of small-scale smoothness, even if only from a qualitative point of view.

RELATED MATERIAL

(**1**) "Guide to Concrete Floor and Slab Construction," ACI 302.1R-96, *ACI Manual of Concrete Practice*, Part 2, American Concrete Institute, Farmington Hills, MI, 1989.

(**2**) *Concrete Floors on Ground*, PCA EB075.02D, Portland Cement Association, Skokie, IL, 1983.

(**3**) *Design and Control of Concrete Mixtures*, PCA EB001.13T, Portland Cement Association, Skokie, IL, 1995.

(**4**) *Moisture Migration—Concrete Slab on Ground Construction*, H.W. Brewer, PCA Bulletin D89, Portland Cement Association, Skokie, IL, 1965.

(**5**) *Drying of Construction Water in Concrete*, Goran Hedenblad, Swedish Council for Building Research, Stockholm, 1997.

(**6**) "Standard Tolerances for Concrete Construction and Materials," ACI 117-90, *ACI Manual of Concrete Practice*, American Concrete Institute, Detroit, MI, 1990.