Moisture Mitigation

Installation Considerations for Resilient Floor Covering

Introduction

In the context of flooring installation, moisture should always be considered as a relevant project condition. A collaborative team should include the product manufacturer, specifier, and installer, as each party provides information to support a successful installation of a resilient flooring product. From a specifier and installer perspective, it is important to review technical information and installation requirements to assist the designer in selecting an appropriate product for a specific application. If moisture conditions are not conducive to a particular resilient flooring product specification, manufacturers can assist specifiers and flooring installers with mitigation options and/or alternative product recommendations. It is important to note that installation failures due to the presence of excess moisture are generally not covered under warranty if manufacturer recommendations are not followed; therefore, review of the manufacturer's warranty by the specifier is prudent.

Project Conditions

A thorough understanding of the project conditions is critical to determination of the appropriate subfloor preparation. Installation failures can occur on all grade levels if adequate precautions are not taken. Moisture can come from the slab itself, if not sufficiently dry, or can come from the ground, if an effective vapor retarder (barrier) is not installed below the slab. Even if a slab seems dry, moisture and moisture vapor may still pass through the slab. This is expressed in terms of the moisture vapor emission rate (MVER). Moisture content and rate of transmission can vary throughout the year due to climatic and environmental conditions, as well as the ambient temperature and humidity level within a building. As moisture passes through a slab, it can carry alkaline salts and contaminants from the ground and/or the concrete itself, which can detrimentally affect the flooring adhesive, adhesive bond, and performance of the actual floor covering. All grade levels of concrete floors, regardless of age, should be tested for moisture. Prevention is key, and the cost and time associated with proactive preventive measures can prove significantly less than the costs and delays associated with post-installation repair, mitigation/remediation and even resilient flooring replacement.

Following manufacturer recommendations will minimize the risks associated with excessive moisture and alkali. Excess moisture in concrete slabs can cause a host of potential problems post-installation, such as:

1. Adhesive and adhesive bond deterioration;
2. Blisters, bubbles, or ridges;
3. Discoloration;
4. Microbial (mold and mildew) growth;
5. Efflorescence (alkali can build-up at tile joints and floor perimeter);

6. Shifting, peaking, or curling of modular flooring products (planks and tiles); and/or
7. Shrinkage and joints opening of the tile or sheet flooring.

Key drivers of successful installation for resilient floor coverings include technical knowledge and proper preparation of the construction site. Preventing excess alkaline moisture transmission through the slab into the adhesive film and resilient flooring eliminates a multitude of potential problems.

Specification Process and Design & Construction of Concrete Slab
The specification process starts with the design team identifying the Owner Project Requirements (OPR). The OPR includes the performance characteristics of the flooring products being specified for each specific application within a project.

The resilient flooring manufacturer is a source of technical information for new construction and existing building concrete slab preparation recommended prior to the installation of a resilient flooring product. See ***Appendix A: Concrete Slab Design Considerations Checklist*** for items recommended for verification when designing a concrete slab in relation to moisture mitigation. The design and construction of the slab is a critical component in completing a successful installation of any resilient flooring.

Resilient flooring manufacturers typically require that new and existing concrete subfloors meet the requirements of the latest edition of ASTM F 710 *Standard Practice for Preparing Concrete Floors to Receive Resilient Flooring.*

The specific composition of the concrete floor should be in accordance with the guides and practices of the American Concrete Institute (ACI) and should have a minimum density of 100 lbs. per cubic foot (1600 kg/m³). Information for construction of many concrete floors is contained in the following four guides:

1. ACI 302.1R *Guide for Concrete Floor and Slab Construction*
2. ACI 360R *Guide to Design of Slabs- on-Ground*
3. ACI 223R *Standard Practice for the Use of Shrinkage-Compensating Concrete*
4. ACI 302.2R *Guide for Concrete Slabs that Receive Moisture-Sensitive Flooring Materials*

After the site has been properly prepared, a vapor retarder with a permeance of less than 0.1 perms (0.06 metric perms), as measured in accordance with ASTM E-96 *Standard Test Methods for Water Vapor Transmission of Materials*, is to be installed directly under the concrete slab for on and below grade installations. The permeance requirements can be found in ASTM E 1745 *Standard Specification for Water Vapor Retarder Used in Contact with Soil or Granular Fill Under Concrete Slabs*. The retarder needs to be resistant to deterioration as well as puncture during construction, as the moisture barrier has to remain intact and continuous to be effective.

In enclosed buildings, properly constructed slabs of all grade levels (on, above and below-grade) are considered stable after they are cured, dry, and maintained at constant temperature. There should be little lateral or vertical movement at either contraction or construction joints. Therefore, if joints are present, they should be filled with appropriate patching compound formulated with Portland cement, fine aggregate, and organic latex binder in accordance with ACI 302.2R.

Experience shows that properly formulated concrete, specifically with respect to water/cement ratios and slump factors, will produce benefits of lower-porosity concrete. The time for a concrete slab to cure and dry to a level suitable to receive resilient floor covering varies greatly. The water/cement ratio, ambient drying conditions (temperature and relative humidity), and slab thickness are just a few of the factors that affect drying time. Regardless of age and grade level, testing for moisture should be completed as recommended by most resilient flooring manufacturers, and some also require pH testing.

Some additives promoting shortened cure time or easier/longer concrete workability may increase concrete's natural alkalinity (pH) which can in turn lead to increased risks of resilient flooring failure if moisture moves this alkali in contact with the floor/adhesive system.

The diagram in ***Appendix B: Site Conditions Decision Tree*** includes the steps that should be taken to verify site conditions prior to installing adhesive and resilient flooring product. The completion of testing provides information that either supports the installation of a specific product system, results in a change in the product specification that still meets the OPR and/or requires moisture mitigation methods in order to install the original or revised resilient flooring specification.

Testing for Moisture in Concrete Slabs

As stated above, manufacturer-provided instructions for the installation of resilient flooring products typically require that all concrete substrates, both new and existing, be tested for moisture content to determine if the concrete is acceptable under the manufacturer's installation requirements. There are several tests available for moisture testing including those listed below. The specific moisture test method required will be included in the flooring manufacturer's installation technical information and subsequently in the architectural specifications as part of the construction documents.

It is the responsibility of the general contractor or the floor covering installer to verify **prior to installation** that appropriate moisture testing has been performed and that test results comply with the floor covering and adhesive manufacturers' recommendations, **before** installing resilient flooring; or, in the alternative, to verify that suitable remedial actions have been taken to address any moisture mitigation concerns with the slab **prior** to the resilient flooring installation. If additional expertise is required to assess suitability of the concrete substrate for moisture and pH, there are qualified independent professionals and testing laboratories that specialize in concrete moisture testing available to floor covering

installers and general contractors.

Calcium Chloride Moisture Vapor Emissions Rate (MVER) Test
This test has been used to measure moisture emission rates since the 1960's. The test is conducted in accordance with ASTM F 1869 *Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride*. Each flooring manufacturer recommends a maximum pounds / 1000 sq. ft. / 24 hours for a flooring product before it is installed.

Internal Relative Humidity (In-Situ) Test
This test has become more widely used and often is specified in addition to the calcium chloride test to further evaluate ambient relative humidity and temperature as well as residuals left on the concrete surface. This test method provides a determination of the moisture in a concrete slab by using probes to measure internal slab relative humidity. For most situations, the probes are placed in holes that are drilled to an approximate depth of 40% of the thickness of the concrete slab. The test is conducted in accordance with ASTM F 2170 *Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using in situ Probes.* Each flooring manufacturer recommends a maximum relative humidity (RH) % for the concrete slab before a resilient flooring product can be installed. Internal or "in-situ" relative humidity provides an indication of the potential moisture that may come out of the slab.

Where excess moisture exists, one option may be to utilize a moisture suppression system to reduce or block surface moisture vapor emission. Refer to manufacturer's recommendations and ASTM F 3010 *Standard Practice forTwo-Component Resin Based Membrane-Forming Moisture Mitigation Systems for Use Under Resilient Floor Coverings*. Another option, if use of a two-component resin-based membrane-forming moisture mitigation system is not possible or practicable, is to consider installation of a sheet moisture retarder such as a polyfilm underlayment between the subfloor and the flooring.

Resilient flooring products can have different moisture limit requirements depending on the construction of the product, the specific adhesive utilized, and/ or the type of installation (full spread, floating, etc.).

The resilient flooring manufacturer should always be contacted for their product recommendations in addition to information on concrete surface preparation, adhesives, and installation. Typically, this information can be found on the resilient flooring manufacturer's website.

Test Results: Consideration and Caution
Moisture test results indicate only the condition of a concrete slab for the actual area tested, and only at the time the test was performed. The most accurate test results will be achieved when taken in a room acclimated to its expected normal environmental condition (i.e., temperature and humidity). Moisture vapor emission rates can vary from one area to

another, as well as from one point in time to another, for numerous reasons beyond the control of the flooring installer. If the project will involve installation of various products, and/or the same product in different locations, or if multiple concrete batches are used throughout a project, manufacturer recommendations may require testing in multiple locations.

Product Example and Adhesives
Some products have a higher moisture tolerance than others, such as LVT/LVP, which are typically more moisture-tolerant than, for example, vinyl sheet. This is due to the modular nature of LVT/LVP products (installed as individual tiles or planks) versus a vinyl sheet product that is contiguous over a larger area. Adhesives also have different moisture level requirements based upon the type of resilient flooring product being installed and the related installation methods. This is another reason why it is important for the specifier to carefully review and adhere to the manufacturer recommendations for tile versus sheet product installations. Product options or use of a moisture mitigation system may be required based upon the site conditions. Product requirements are different for various types of products; therefore, adhesives and detailing are equally as important as understanding the slab moisture limits for a specific type of flooring product.

Surface Alkalinity (pH) and Concrete Substrate
Excessive alkali has been known to degrade adhesives and resilient floor coverings leading to poor appearance, maintenance difficulties, and in extreme cases, total floor failure. Typically, when alkalinity is an issue, moisture is present. Measures of alkalinity are usually expressed in terms of a pH number. The normally encountered pH scale ranges from 1 to 14 with 7 being neutral. Numbers moving upward from 7 indicate increasing alkalinity. A pH range of above 7 and below 10 is normally acceptable. A pH reading above 10 may require corrective measures and may be an indicator of excessive vapor or moisture transmission. Testing is typically performed using a pH indicator paper or use of an electronic pH meter. If pH is higher than 10, review the manufacturer recommendations for mitigation options.

Slab Surface, Space, and Product Preparation
In addition to testing for moisture, the slab must also be prepared prior to installing any new product. This preparation process reduces unintended telegraphing of imperfections from the subfloor to the flooring's finished surface.

To function properly, the resilient flooring product and adhesive need to be acclimatized to the environment before installation, and the installation space itself must be at a minimum temperature for a specified period of time in accordance with recommendations of the product manufacturer.

As with pre-installation testing, these installation steps should be included within the architectural specifications as based upon manufacturer technical recommendations.

Conclusion

Following required subfloor preparation and installation (including moisture testing) in accordance with the flooring manufacturer's instructions can protect against potential flooring failures, costly change orders, and extended construction schedules.

In addition to the construction cost, moisture-related issues can cause significant disruption to ongoing building operations that can result in lost revenue, project delays, client dissatisfaction, and—most critically—potential health and safety hazards. The collaborative team approach coupled with subfloor testing and preparation are therefore critical to a successful flooring installation and subsequent use.

After installation is completed, owners should follow manufacturer recommendations for maintenance and cleaning, typically included within the Owner's Maintenance Manual. For chemistry compatibility of cleaning and disinfection chemicals, it is recommended for owners to consult both the information, instructions, and warnings provided by the resilient flooring product manufacturer and those provided by the cleaning chemical/product manufacturers, to ensure proper use and compatibility of flooring and cleaning products.

The resilient flooring industry has experienced tremendous growth in both the commercial and residential sectors, offering a range of products that, when installed properly, represent elegant, durable, and sustainable solutions to meet consumer demand for both performance and aesthetics over the product's lifespan.

References

ASTM International, 100 Barr Harbor Drive, West Conshohocken, Pennsylvania 19428-2959

ASTM E96 *Standard Test Methods for Water Vapor Transmission of Materials*

ASTM E1745 *Standard Specification for Water Vapor Retarders Used in Contact with Soil or Granular Fill Under Concrete Slabs*

ASTM F710 *Standard Practice for Preparing Concrete Floors to Receive Resilient Flooring*

ASTM F1869 *Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride*

ASTM F2170 *Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using in situ Probes*

ASTM F2659 *Standard Guide for Preliminary Evaluation of Comparative Moisture Condition of Concrete, Gypsum Cement and Other Floor Slabs and Screeds Using a Non-Destructive Electronic Moisture Meter*

ASTM F3010 *Standard Practice for Two-Component Resin Based Membrane-Forming Moisture Mitigation Systems for Use Under Resilient Floor Coverings*

Concrete Floors and Moisture, 2nd Edition. Author: Howard M. Kanare. Portland Cement Association, 5420 Old Orchard Road, Skokie, Illinois 60077

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CONCRETE SLAB DESIGN CONSIDERATIONS

Project Checklist for Architects and Engineers

Reference: Resilient flooring manufacturers require that new and existing concrete subfloors meet the requirements of the latest edition of *ASTM F 710 Standard Practice for Preparing Concrete Floors to Receive Resilient Flooring.*

1	**Obtained and reviewed a geotechnical survey and determine geological strata and water table levels as part of the site due diligence.**
2	**Obtained and reviewed site survey records for historical data on ground water and flooding situations for the area in relation to the site impacts.**
3	**Determined water drainage characteristics and storm water mitigation measures for the area.**
4	**Completed detailed specifications for any excavation required in relationship to water table and slab construction.**
5	**Provided details of subgrade where appropriate fill is required.**
6	**Provided details that include 4” (100mm) to 8” (200mm) of washed and graded gravel over acceptable subgrade.**
7	**Provided details that ensure positive gravity outflow to resist buildup of hydrostatic pressure below slab; including installation of mechanical means of achieving outflow if gravity outflow is not possible.**
8	**Provided details that include 1” (25mm) to 2” (50mm) of sand or other engineer recommended ballast over the gravel to prevent puncture of the vapor retarder (moisture barrier).**
9	**Provided details and specifications for vapor retarder (moisture barrier) of proven performance, including information on sealing seams for continuous membrane and during concrete pour verify membrane is not punctured.**

Site Conditions Decision Tree

Are the site conditions ready for installation of resilient flooring product?

Are related interior finish trades completed?

- **NO** → If No, complete interior finish trades prior to installation.
- **YES** → ALL STEPS ARE COMPLETED

Is construction site enclosed and site, flooring, and adhesives acclimated?[4]

- **NO** → If No, site and products to be acclimatized based on manufacturer recommendations before **product** is installed.
- **YES** → ALL STEPS ARE COMPLETED

Has slab been tested for moisture?
Calcium Chloride MVER test[1]
Internal Relative Humidity Test[2]
Surface Alkalinity (pH)[3]

- **NO** → Need to Test
- **YES** →
  - Product and adhesive are ***not*** compatible with test results.
    - Review flooring specification with specifier to choose alternative product for application that meet OPR.
    - ***OR***
    - Work with product manufacturer to provide moisture mitigation for slab to meet conditions required.
  - Product and adhesive ***are*** compatible with test results and manufacturer recommendations. → ALL STEPS ARE COMPLETED

Is subfloor smooth and level[3] to reduce telegraphing of subfloor imperfections to the finished floor surface?

- **NO** → If no, prepare slab according to manufacturer recommendations.
- **YES** → ALL STEPS ARE COMPLETED

ALL STEPS ARE COMPLETED

PROCEED WITH INSTALLATION

[1] ASTM F 1869 Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride
[2] ASTM F 2170 Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using in situ Probes
[3] ASTM F 710 Standard Practice for Preparing Concrete Floors to Receive Resilient Flooring. Verify with product manufacturer if required. Typically when alkalinity is an issue, moisture is present.
[4] Acclimated means humidity, ambient temperature, and temperature of the surface is above dew point in controlled environment. Five (5) degrees or greater above dew point is recommended temperature. Avoid condensation on installation surface.