



## Moisture and Resilient Floor Covering

Moisture related failures of resilient floor coverings installed over concrete have focused unfairly over the years on the premise that the flooring product itself is at fault, or that the flooring contractor did not properly install the floor.

Where concrete slabs rest directly on the ground, installation failures can occur due to the presence of excess moisture in the slab. In fact, there can be flooring installation failures associated with excess moisture involving concrete slabs on all grade levels, if adequate precautions are not taken. The moisture can come from the slab itself, if not sufficiently dry, or from ground where a protective membrane (vapor retarder) is not present or is ineffective. A slab may seem dry, but actually has moisture and moisture vapor passing through it; what is often referred to as MVER or moisture vapor emission rate. Moisture content and rate of transmission can vary throughout the year due to climatic conditions as well as the ambient temperature and humidity level within the building. As moisture passes through a slab, it can carry with it alkaline salts and contaminants from the ground and/or the concrete itself, which can detrimentally affect the flooring adhesive, adhesive bond and floor covering performance. All grade levels of concrete floors, regardless of age can retain moisture and should be tested.

Moisture and alkali can cause the following problems after installation:

1. Adhesive and adhesive bond deterioration
2. Bumps, bubbles or ridges
3. Color change
4. Microbial growth (mold and mildew growth)
5. Efflorescence (alkali can build-up at the tile joints and floor perimeter)
6. Tile shifting, peaking or curling
7. Shrinkage and joints opening of the tile or sheet flooring

Any of these conditions can occur at any time after installation if an excess moisture condition is present. Proper job site acclimatization, preparation, slab construction and subfloor preparation will make a successful installation more likely. However, since installers and resilient floor manufacturers have little control over these factors, installation failures due to the presence of excess moisture and alkali are generally not warranted by the floor covering manufacturer. A review of the manufacturer's warranty is recommended.

The following guidelines are offered for the use by the facility owner and /or architect/engineer in preparing specifications in facilities where resilient floor coverings are to be installed. The issuance or use of these guidelines shall not be construed to mean that the Resilient Floor Covering Institute (RFCI), the flooring contractor or the floor covering manufacturer accepts any responsibility for the construction or performance of the concrete slab.

## **Site Preparation**

The single most important consideration affecting resilient floor covering installations is knowledge and proper preparation of the construction site. Prevention of excess alkaline moisture transmission through the slab into the adhesive film and resilient flooring eliminates a multitude of potential problems.

Assuming there is no control over the site selection, there are still many preparatory procedures that can be employed before pouring of the slab begins.

A list of some basic considerations is provided below:

1. Obtain a geotechnical survey to determine geological strata and water table levels
2. Survey records for historical data on ground water and flooding situations for the area
3. Determine water drainage characteristics for the area
4. Provide detailed instructions for any excavation required
5. Proper preparation of subgrade where required with appropriate fill
6. Utilization of 4" (100mm) to 8"(200mm) of washed and graded gravel over acceptable subgrade
7. Insure positive gravity outflow to resist buildup of hydrostatic pressure
8. Installation of mechanical means of achieving outflow if gravity outflow is not possible, as with many below-grade slabs
9. Placement of 1" (25mm) to 2" (50mm) of sand over the gravel to prevent puncture of the moisture barrier
10. Use of vapor retarder of proven performance. Make sure the seams are sealed and the membrane is not punctured during the concrete pour.

## **Concrete Floor and Slab Construction**

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*

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*, must 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 must be resistant to deterioration as well as to puncture during construction and must remain intact and continuous.

The specific composition of the concrete floor should be in accordance with the guides and practices of the American Concrete Institute (ACI) but should have a minimum density of 100 lbs. per cubic foot (1600 kg/m<sup>3</sup>). Information for construction of many concrete floors is contained in the four guides listed below:

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*

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 has shown 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, as well as slab thickness are just a few of the factors that affect drying time. In the past, it has sometimes been referenced to allow a minimum of six (6) weeks for a slab to cure and dry. In reality, regardless of age and grade level, testing for moisture and pH is required by all resilient flooring manufacturer's because of how widely the concrete slab curing and drying time can take(weeks to months) - (See section on moisture testing)

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

## **Testing for Moisture in Concrete Slabs** (New or Existing Slabs)

Resilient flooring manufacturers require that all concrete substrates, both new and old, 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 specifications.

It is the floor covering installer's or general contractor's responsibility to verify that appropriate moisture testing has been performed and that test results comply with the floor covering and adhesive manufacturer's recommendations, before installing the resilient flooring; or verify that suitable remedial actions have been taken to address any concerns. If additional expertise is required to assess suitability of the concrete substrate for moisture and pH, there are many very 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** 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) Tests** has become more widely used today because of concern over the accuracy of measuring moisture with the calcium chloride tests due to ambient relative humidity and temperature as well as residuals left on the concrete surface. This test method may provide a more meaningful determination of the moisture in a concrete slab by using probes to measure internal slab relative humidity. The probes are placed in holes that are drilled to an approximate depth of 40% of the thickness of the concrete slab, for most situations. 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 floor can be installed. Internal or "in-situ" relative humidity provides an indication of the potential moisture that may come out of the slab.

Resilient flooring products can have different moisture limit requirements depending on the construction of the product, the specific adhesive utilized or based on the type of installation (full spread, floating, etc.). The resilient flooring manufacturer should be contacted for this information as well as information concerning concrete surface preparation, adhesives or installation. Most of this information can be found on the flooring manufacturer's web-site.

### **Caution**

Moisture test results indicate only the condition of a concrete slab for the actual area tested at the time of the test was performed. The most accurate test results will only be achieved when taken in a room acclimated to its expected normal environmental condition (temperature and humidity). Moisture vapor emission rates can vary both from one area to another and over time for numerous reasons beyond the control of the flooring contractor or installer.

### **Surface Alkalinity on 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. 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. Check with the manufacturer regarding specific recommendations.

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 as well as ASTM F 3010 *Standard Practice for Two-Component Resin Based Membrane-Forming Moisture Mitigation Systems for Use Under Resilient Floor Coverings*

## **References**

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

ASTM E-96 *Standard Test Methods for Water Vapor Transmission of Materials*

ASTM E 1745 *Standard Specification for Water Vapor Retarder Used in Contact with Soil or Granular Fill Under Concrete Slabs*

*ASTM F-710 Standard Practice for preparing Concrete Floors to Receive Resilient Flooring*

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

*ASTM F-2170 Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using in situ Probes*

*ASTM F-2420 Standard Test Method for Determining Relative Humidity on the Surface of Concrete Floor Slabs Using Relative Humidity Probe Measurement and Insulated Hood*

*ASTM F-3010 Standard Practice for Two-Component Resin Based Membrane-Forming Moisture Mitigation Systems for Use Under Resilient Floor Coverings*

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