

Can Moisture Vapor Emission Be Harmful to Ceramic & Stone Tile Installations ?

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Contrary to what you may have heard, tile and stone floors are not immune to problems associated with moisture vapor emission (MVE) through concrete slabs. In response to the increasing number of moisture vapor-related problems that have occurred in the tile industry, the National Tile Contractors Association's Technical Committee recently approved a new technical document (G-13; General Statement on Moisture Emissions) for the NTCA Reference Manual.

In the past, ceramic tile assemblies were relatively simple; tile was absorptive and somewhat permeable, and often adhered directly to a concrete slab or a mortar bed with moisture-resistant cement-based mortars. In addition, tile installed over unbonded mortar beds was typically isolated from moisture vapor by loose-laid asphalt building paper or polyethylene plastic sheeting.

The popularity of the thin-set method of installation and the proliferation of impermeable materials, such as resin agglomerate tiles, large format porcelain tiles, epoxy adhesives, as well as moisture sensitive specialty products such as bonded waterproofing/crack isolation membranes and underlayments, have made tile assemblies more susceptible to deterioration from excessive MVE. The combination of these contemporary materials and today's extremely aggressive construction schedules can result in problems unless you understand some simple concepts and preventative measures.

Moisture Vapor Emission Concepts Simplified

Moisture vapor emission occurs when there is an area of high vapor pressure, such as damp concrete or cool, wet soil, and areas of low vapor pressure, such as a warm, dry building interior. The pressure differential, while relatively small, causes the moisture vapor to migrate towards the dry area. Moisture vapor can collect and condense beneath impermeable materials, and cause damage to the tile assembly.

Sources of Moisture Vapor

Excessive MVE can originate from a variety of sources. Residual moisture in curing concrete (especially lightweight concrete), and even moisture from tile installation mortars are common sources of moisture. In the absence of a suitable vapor retarder

beneath a concrete slab on-grade, capillary action from high water tables and damp soil are additional sources of moisture. While a properly designed and constructed vapor retarder will likely provide adequate protection, beware of plain polyethylene plastic sheeting consisting of recycled plastics, as this material can be easily punctured, and can also decompose over time.

Evaluating Moisture Vapor Emission

The following tests are now commonly used to measure moisture vapor in concrete:

ASTM D-4263 Plastic Mat Test - A simple and cost effective test. This test can easily identify dampness in the top surface of a concrete slab. However, this method is only recommended for use on existing concrete slabs.

ASTM F-1869-04 Calcium Chloride Test ("Standard Test Method for Measuring Moisture Vapor Emission Using Anhydrous Calcium Chloride") - A relatively inexpensive and effective way to quantitatively measure of MVE. However, this test only measures MVE in the upper section of a concrete slab. This test must also be conducted after a space is fully conditioned to in-service temperature and humidity, and not during cool, damp conditions that are typical during construction. Most important, this test only reflects conditions at the time of the test; therefore it is possible for MVE to increase or decrease over time.

ASTM F-2170-02 Relative Humidity Probe ("Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using In-Situ Probes") – This test method is the only reliable method for measuring and predicting the effect of moisture vapor emission, as the test measures the equilibrium state of the entire cross-section of a concrete slab, and can also be used to take multiple measurements to assess changes over time.

Moisture Related Tile Flooring Failures

When materials such as impermeable porcelain tile or membranes are placed over a concrete slab, they create a barrier to vapor movement. If moisture vapor emission through the slab is excessive, moisture vapor can collect and condense under the tile or membrane. Residual moisture from mortars can also get encapsulated between tile and membranes and cause problems, especially to moisture sensitive natural and engineered stone tile.

The collection of moisture and resulting increase in the alkalinity of the concrete, and not the actual exertion of pressure, is the primary cause of problems in tile assemblies. Moisture can also activate naturally occurring, alkaline salts in concrete, creating a variety of chemical reactions with natural and engineered stone tiles, adhesives, grouts and membranes.

The collection of moisture on the underside of some tile, such as certain varieties of

natural stone or resin agglomerate tiles, can cause differential expansion, resulting in warping of the tile, which in turn can lead to partial or complete delamination. Excessive MVE can also cause surface spalling of some natural stones with organic content, such as limestones. In addition, mold growth is a concern if materials such as latex mastic adhesives with organic content are used for tile or membrane installation.

Preventing MVE Related Issues

Testing for MVE and analyzing test results is a complex endeavour that falls outside the tile contractor's scope of expertise, and therefore the specification and analysis of such testing should be the responsibility of the design professional. Similarly, tests should be conducted by an independent test agency or consultant under the direction of a general contractor. Nonetheless, tile contractors should be prepared to take a proactive approach to prevent moisture vapor problems by understanding a few simple rules:

- Learn the basic cause/origin of MVE related problems, and understand test protocol
- Review contract drawings and specification requirements carefully, not only for the tile assembly, but also for concrete slab assembly
- Review specifications for moisture vapor emission testing (or absence thereof); challenge requirements which assign moisture vapor emission testing / analysis responsibility to the tile contractor
- Develop a standard policy and procedure for discussion / investigation of MVE in the absence of contract requirements. **DO NOT** assume that someone else will investigate or be responsible for addressing the issue!
- Know the characteristics of the materials you are working with, and consult with your tile and installation product manufacturers for recommendations, especially regarding acceptable levels of MVE for use of their products. **Get the manufacturer's response and any test certification in writing!**
- Consider engaging a professional tile industry consultant to conduct a "peer review" of contract documents to 1) identify design issues with the tile or concrete slab assemblies or 2) identify product specification errors, and 3) conduct and/or facilitate independent testing and analysis of MVE

A more information on moisture vapor emission testing can be found at the following link: www.proconweb.com/index.htm

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