

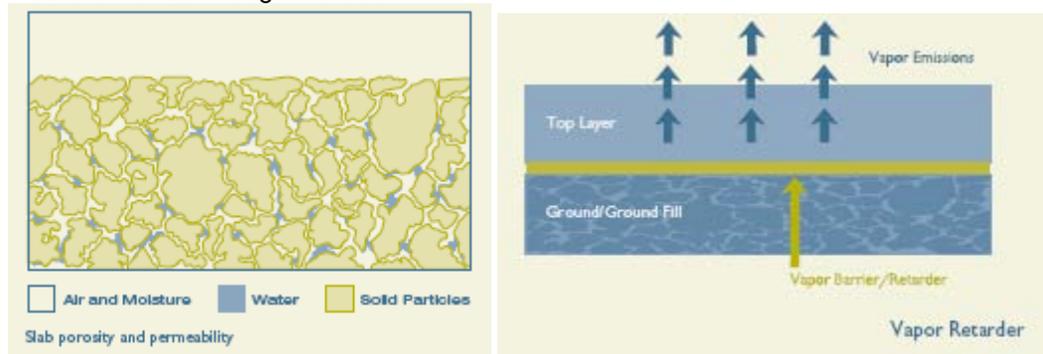
Moisture Testing of Concrete Slabs Moisture Vapor Emissions (MVER) vs. In-situ Relative Humidity Testing Technique No 24 February 2008(revised July 2012)

Technical Bulletins \ Subfloors and Substrates\Moisture Testing of Concrete Slabs
Moisture Vapor Emissions (MVER) vs. In-situ Relative Humidity Testing
Technique No 24
February 2008(revised July 2012)

Introduction

Moisture-related floor covering failures are responsible for over \$1 billion annually in damages. The problems range from cupping, buckling, blistering and adhesive failure to discoloration and mold growth. These issues can occur soon after the installation, and in some cases years down the road.

Concrete by its very nature is extremely porous (See figure 1.1); it must have water in order to be workable and in order for the correct chemical reactions to take place for curing. When slabs are not given the proper time or proper conditions to dry, excessive water or vapor can be present in the slab contributing to water or vapor movement. Major culprits for excess moisture vapor include: too much water in the concrete mix, too little curing and or drying time, rainfall from incomplete roofing systems, lack of HVAC climate control and poor landscaping that fails to drain water away from building foundations. Another culprit is buffing the concrete smooth to eliminate potential “telescoping” imperfections in the floor covering. This practice inhibits drying time even more because it seals the concrete’s pores. A related problem that can create undesirable installation surfaces is high alkalinity which can cause a breakdown in the bond of many adhesives. High alkalinity results when too much moisture moves through the slab.



(Fig. 1.1, source: StarLog Volume VII, Issue 2) (Fig. 1.2, source: StarLog Volume VII, Issue 2)

In addition to the proper interior conditions needed for successful flooring installations, proper use and placement of vapor retarders is critical. Vapor retarders installed beneath the slab can be effective in blocking moisture from migrating upward to the concrete. It is recommended concrete slabs be placed directly on the vapor retarders. (See figure 1.2 above)

Moisture Testing

Two of the more common moisture testing methods in use today when installing resilient flooring are the anhydrous calcium chloride test and the internal relative humidity probe.

The anhydrous calcium chloride test, described in ASTM F-1869-10, *Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride* measures the moisture vapor emission rate (MVER) of the slab. The relative humidity probe, described in ASTM F-2170-11, *Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs using in situ Probes* measures the internal relative humidity of the slab. Both test methods have been in practice for many years.

Calcium Chloride Test

The anhydrous calcium chloride test (See Figure 1.3) was developed as a qualitative evaluation of floor moisture condition and became the industry standard in the 1960's, since then thousands of MVER tests (See Figure 1.4) are run each year in the U.S. In the past decade more and more skepticism concerning the accuracy of this test has been called into question.



(Fig. 1.3)



(Fig. 1.4)

Calcium Chloride test benefits:

Widely accepted by most U.S manufacturers of floor covering, as noted by ASTM F-710 *Standard Practice for Preparing Concrete Floors to Receive Resilient Flooring*.

Testing is relatively easy to perform; no major investment in equipment is required.

Initial testing kits are very inexpensive relative to the initial investment of RH probes, but can become very costly over time when tests do not provide desired results and re-testing is required.

Calcium Chloride test concerns:

No practical way to calibrate the test kits. There are no standard reference concretes available with controlled MVER levels. Kit dimensions have been arbitrarily standardized to provide reproducibility between brands, but they are not absolutely "accurate."

The test determines a portion of the free moisture near the surface of a slab, generally the upper 1/2 to 3/4 in., or (12 to 20 mm) providing no information about the moisture conditions deeper in the slab.

The test does not accurately determine the true MVER of concrete; it overestimates low moisture emission levels and underestimates high emission levels.

Ambient conditions interfere with test results are warmer, more humid room air can yield higher MVER results even if the internal concrete moisture condition is unchanged. Floor surface preparation for testing, such as gentle grinding, can change measured MVER by seven-fold.

Limits set for MVER based on product type neglect the fundamental fact that floor prep, adhesives and flooring type, all play a major role in flooring performance.

Testing can delay floor installation. A 24- hour period is needed to administer the test along with independent lab analysis of test to determine results.

Relative Humidity Probe

Relative humidity (RH) testing (See figure 1.5) is determined by in-situ probes installed deep in the slab. Unlike the MVER test which looks at the top ½ to ¾” of the slab, the ASTM F 2170-11 standard recommends that RH measurements be taken at 40% of the slab depth. For example, on a 4” thick slab, the probes would need to be placed at a depth of approximately 1.5”.



(Fig. 1.5 typical RH probes)

RH Probes test benefits:

RH instruments can be independently calibrated directly traceable to national standards.

While RH instruments cost more than a calcium chloride MVER kit, large savings in testing time and labor are realized.

RH testing gives a useful picture of the actual moisture conditions within the concrete regardless of mix, aggregate types, floor thickness, or surface conditions; however, even though the relative humidity of the slab is being measured, there is no exact correlation between the relative humidity of the slab and the moisture vapor movement.

RH testing is a significant tool in predicting potential concrete moisture-related floor covering failures that can lead to costly repairs and litigation. It stands to reason that if a slab contains a high level of relative humidity within the slab, the moisture will migrate to the warmest, driest area of that slab; if that is the surface of the slab then the moisture will migrate upward.

RH probe test concerns:

Test is not as widely accepted or recommended by U.S manufacturers of floor covering, adhesives and resinous coatings.

Testing requires a substantial initial investment in tools and equipment, which may limit the number of agencies performing these tests.

Summary

The use of both testing methods performed concurrently in a building offers the greatest depth of data and confidence in decisions to install flooring. A combination of tests is the smarter choice. Test timing is as important as the method because moisture conditions change as a result of natural and man-made forces. Ideally, tests should be conducted on the slab after the building and finish materials have been acclimated to final operating conditions. HVAC systems (heating and air conditioning) in particular, have an effect on moisture in the concrete.

No matter which test is performed, it is important that testing be conducted in accordance with the respective ASTM test method. This will include such factors as proper temperature and humidity, the proper number of tests and test locations and proper subfloor preparation. If these conditions and recommendations are not strictly adhered to then no test method will ever present an accurate assessment of the concrete

References

H. M. Kanare, *Why are We Still Having Problems with Moisture?* Concrete Construction Magazine, Publication date: November 15, 2007.

George Donnelly, *Calcium Chloride v. In-situ Relative Humidity*, George Donnelly Testing & Inspections (501) 915-0626.

George Donnelly, *Vapor Retarders and Concrete Moisture Vapor Transmission*, Donnelly Testing & Inspections (501) 915-0626.

StarNet, StarLog, *The "Cure" for Concrete Moisture and pH Ills*, Volume VII Issue 2.

Peter Craig and George Donnelly, *Moisture Testing on Concrete Slabs, When 3lbs is not 3lbs*, Concrete International, September, 2006.