Calcium chloride vs. Relative Humidity

A general discussion

Most U.S. producers of floor coverings, adhesives and resinous coatings look to the calcium chloride method of testing concrete slabs to determine dryness and suitability for the installation of their products. The American Society for Testing and Materials (ASTM) has written a standard for the use of anhydrous calcium chloride when testing dryness of concrete. The standard is also known as ASTM F-1869-04. ASTM has also published an additional method for testing the dryness of concrete; the test designation is ASTM F-2170-02. This test method involves measuring relative humidity levels within the concrete slab and finds it's basis in testing commonly performed in Europe. ASTM F-710-03 offers recommendations regarding the suitability of a concrete slab for the installation of resilient floor coverings based on results achieved by these test methods. This standard states that moisture vapor emission, per ASTM F 1869, should not exceed 3 pounds per 1,000 square feet per 24 hours, unless otherwise specified by the flooring or adhesive manufacturer. The standard continues by stating that relative humidity within a concrete slab should not exceed 75%, per ASTM F 2170, unless otherwise specified by the flooring or adhesive manufacturer.This agency is now performing tests by both methods and while neither method can offer a 100% guarantee of long-term successful floor covering installation the following is offered for your consideration.

Before discussing the individual test methods, it is important to note that in our opinion, all existing test methods are capable of being "fooled" under certain conditions. In example, when a very porous concrete, or a concrete mix design with a high water/cement ratio, is placed without the protection of an effective sub-slab vapor retarder, concrete moisture content and vapor emission can vary dramatically with seasons or other changing conditions. There have been studies published that show an effect of installing floor coverings or coatings with limited permeability is that of increasing moisture content in concrete, when a sub-slab moisture source is available. For example, we regularly see situations in which the new tenant of a building wants to increase office or production space into areas that were designed to be warehouse floor (without sub-slab vapor retarder). Inexperienced people tested the floor with a calcium chloride test kit, found the results met the criteria required by the selected floor covering manufacturer and recommended that installation of materials proceed. Soon after installation, the flooring or its adhesive system failed and new tests were ordered. The new tests reveal moisture vapor emission levels far higher than the original test results and the inevitable finger pointing ensued. In this scenario the concrete surface in the open warehouse had in fact dried sufficiently to give MVER levels low enough to pass. However, once covered moisture content in the concrete began to rise resulting in failure. Although we have not yet seen this difficulty when testing with in-situ relative humidity probes, there should always be concern when covering or coating concrete that is not protected by an effective sub-slab vapor retarding membrane. Some floor covering manufacturers now require the existence of sub-slab vapor retarders beneath slab-on-grade concrete when their materials are to be installed.

Calcium Chloride or "Moisture Dome" Test

Pro

1. The benchmark for concrete dryness and suitability for the installations of floor covering, adhesive and resinous coating products currently accepted by U.S. manufacturers is the Calcium chloride test. As noted above ASTM F-710 contains the statement that concrete can be considered suitably dry when vapor emission does not exceed 3 pounds per 1,000 square feet per 24 hours, when tested in accordance with test method ASTM F 1869-04.
2. Testing is relatively easy test to perform; no major investment in equipment is required.

Con

1. The subject building must be acclimated at or near the temperature and relative humidity levels anticipated during occupancy or use. This is often a difficult requirement to meet on a new construction project. If the HVAC system is not operational at the time of testing a recording hygrometer should be employed to monitor and record ambient temperature and relative humidity levels for comparison to intended occupancy conditions. Significant variance between the test environment and intended use environment should cause test data to be questioned.

2. Calcium chloride tests reflect moisture vapor emission from the surface of the concrete. It has been suggested that the test reflects moisture in the top 1/4 to 1/2 inch of the slab's thickness. If ambient environmental conditions immediately preceding testing have been extremely dry or wet, the concrete surface may be affected and test results may be skewed accordingly.

3. Testing on an open, or breathing, concrete surface may not reflect moisture deep within or directly below the concrete slab. Once covered by low permeability floor coverings, concrete moisture content will equalize within the thickness of the slab. This may mean that a greater volume of moisture will be present at the floor covering/concrete interface after installation is completed than was originally anticipated.

4. We are seeing "home-made" calcium chloride test kits used in some cases by very reputable labs. Some of these kits do not meet the apparatus requirements of ASTM F-1869 and are delivering questionable results.

5. Too many tests are being set without floor preparation as required by ASTM F-1869. Surface contaminants and residue from paint, adhesive, curing or parting compounds can reduce vapor emission at the test site and produce inaccurate test results. Some penetrating parting compounds (tilt-up construction) or penetrating cure and seal products are difficult to detect and impossible to remove. They restrict moisture release and result in reduced vapor emission test results. It is our experience that some of these products will slowly degrade leading to latent moisture release from the concrete and eventual floor covering system failure.

In-situ Relative Humidity Testing

Pro

1. It is our field experience that testing slab-on-grade concrete offers results, which are less impacted by ambient temperature and relative humidity conditions than calcium chloride type tests. Thus generating meaningful data under conditions that may not be acceptable for calcium chloride testing. Concrete slabs in contact with the earth are a heat sink and their internal temperature is affected by both the sub-slab soil temperature and by the temperature of the air space above. Whereas the internal temperature of suspended concrete will be driven by temperature of the air space above and below the slab. It must be noted that ASTM F2170 states that slabs, which are to be tested should be "at service temperature and the occupied air space above the floor slab shall be at service temperature and service relative humidity for at least 48 hours before making relative humidity measurements in the concrete slab."

2. Testing performed at multiple depths permits a testing agency to develop a profile of moisture conditions through the thickness of a concrete slab. This information permits the user to make a more informed decision regarding the installation of floor coverings or the need to consider other alternatives.

3. Test results appear to be less impacted by the type of, or lack of, floor coverings in place prior to testing.

Con

1. As of this writing only a few US. manufacturers of floor coverings, adhesives or resinous coatings have published recommendations or guidelines for the installation of their products based on in-situ relative humidity test results. ASTM F-710-03 Section 5.2.2 states "In accordance with Test Method ASTM F 2170, the relative humidity in a concrete floor slab shall not exceed 75% at the time of testing, unless otherwise specified by the flooring or adhesive manufacturer."

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

3. We are seeing data developed by testing agencies that are not following ASTM F 2170 protocol, particularly with regard to acclimation of the test hole and test probe. Without temperature equilibration of the test site and test apparatus, the data generated may be skewed high or low relative to the direction of inequity, thus rendering data collected misleading or meaningless.