Super-Krete® Products

Understanding Concrete Moisture Issues Technical Guide

Appendix B: ASTM F1869 and ASTM F2170 Overview

Overview:

The flooring industry in the late 1980's determined that the financial impact of moisture related flooring problems was in excess of 4 billion dollars a year in the United States alone and for more than three decades has remained unchanged.

Prior to the introduction of ASTM F1869 and ASTM F2170 the industry relied on ASTM D4263 Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method. The problem with the Plastic Sheet Method is that no quantitative values were obtained, it either got wet or it did not.

ASTM D4263 did not provide test values (numbers), instead the tester simply observed visually or by touch that moisture was present or was not. Most individuals have observed this phenomenon when lifting a rubber door-mat or cardboard box from an on-grade concrete slab. The concrete under the mat appears wet (darker and damp) even though the adjacent exposed concrete appears dry.

Use of the anhydrous calcium chloride (a desiccant) to determine the presence of moisture dates back to the 1940's, but there was no standard specification (quantity of anhydrous calcium chloride or time or environmental temperature or relative humidity) requirements. Just like the Plastic Sheet Method, no quantitative values were obtained.

Recognizing the problem, a subcommittee of American International (formerly the American Society of Testing and Materials) created ASTM F1869 Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfoor Using Anhydrous Calcium Chloride to provide the flooring industry with meaningful moisture test values. The standard defines the scope as "the quantitative determination of the rate of moisture vapor emitted from below-grade, on-grade, and above-grade (suspended) bare concrete floors." ASTM F1869 provided for the first-time quantitative moisture test data.

Now the floor industry had a test procedure that allows for "targets of acceptability" or "targets of rejectability" for non-breathing, impervious flooring systems (adhesives, epoxies, polyurethane, rubber backed products, rubber mats, vinyl sheet goods, vinyl tile, wood laminates, etc.) limits could now be established.

As a rule-of-thumb the flooring industry acknowledges that 3 to 4.5 pounds of moisture per 1,000 square feet when tested in accordance with ASTM F1869 is the maximum exposure limits of impervious non-breathing or low permeable floors.

ASTM F1869 was the only practical quantitative assessment of moisture vapor emission, but it was found to be lacking. It measured moisture that reached the concrete slab surface, that is moisture from the top inch or less, and not the entire concrete slab. ASTM F1869 did not measure the potential moisture of the concrete slab, especially if the concrete slab is not placed on an effective

negative side moisture barrier. The understated values gave rise to the development of a second moisture test.

ASTM F2170 Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs using in situ Probes. ASTM F2170 measures the relative humidity in the concrete slab at a depth equivalent to the relative humidity that would exist in the concrete slab after it reaches homeostasis caused by the installation of an impermeable flooring product or system.

APF and most professionals agree that the two test methods provide valuable information on the two different concrete slab moisture conditions: The calcium chloride test measures the moisture conditions at the surface of the concrete slab, and the in situ relative humidity test measures the moisture condition within the body of the concrete slab.

Both tests are considered to be a scientific "relative test", neither is an absolute test, since the test data can be different when the test is administered on different days, due to changes in the environment, such as, the addition rain or irrigation moisture that migrates under the concrete slab.

Acclimatized

Both ASTM F1869 and ASTM F2170 require the building to be acclimatized before they are run.

1. ASTM F1869 states: "6.1 The test should be at the same temperature and humidity expected during normal use. If this is not possible, then the test conditions shall be 75+/- 10^0F and 50 +/- 10% relative humidity."
2. ASTM F2170 states: "9.1 Concrete floor slabs shall 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."

Duration of Test

Both tests are at first believed to be a three (3) day test, however the acclimation requirement adds an additional 48 hours. In addition, ASTM F1869 requires that a 20 inch (50 mm) by 20 inch (50 mm) area be prepared allowing the concrete slab to breath for one (1) day prior to commencing the test if there were preexisting coatings or other treatments on the concrete. It is best to quote the minimum of five (5) days.

Super-Krete® Products

Understanding Concrete Moisture Issues

Technical Guide

Appendix B: ASTM F1869 and ASTM F2170 Overview

UNDERSTANDING ASTM F1869

Moisture Vapor Transmission

Liquid water and water vapor will pass through the capillaries in the concrete in an attempt to achieve equilibrium (bottom and top) within the environment. This mechanism is a diffusion process frequently called "moisture vapor transmission".

If there is a higher concentration of water under the concrete slab than through the concrete slab or above the concrete slab, water vapor will rise through the capillaries. This movement will continue until the concentration of water vapor above the concrete slab equals the concentration below the concrete slab.

ASTM F1869 testing in a nutshell:

- Testing at the facility must be within plus or minus 10 degrees Fahrenheit and plus or minus 10% Relative Humidity of its intended operating conditions.
- The tests must be placed randomly, but usually for convenience are placed out of the way of other trades.
- First 1,000 square feet (92.9 square meters) must be tested in 3 places.
- Next 1,000 square feet (92.9 square meters) or part thereof must be tested in 1 place.

Step One
Acclimatize the Building for a minimum of 48 hours.

Step Two

After the Building is Acclimatized.

ASTM F1869 requires recording of the buildings ambient temperature and relative humidity.

Recording the concrete surface temperature is recommended, but not required.

Super-Krete® Products

Understanding Concrete Moisture Issues

Technical Guide

Appendix B: ASTM F1869 and ASTM F2170 Overview

Step Three

Prepare the concrete substrate to a surface profile per International Concrete Repair Institute, ICRI Guideline No. 310.2R Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings and Polymer Overlays at a minimum ICRI CSP #2. Recommended use of a 7 inch right angle grinder and a 36 grit or more aggressive diamond stone with shroud and shop vacuum to minimize dusting. Per ASTM F1869 grind a 20 inch by 20 inch square and remove all previous surfacing materials, contaminates and bond breakers.

Step Four

A pH reading is required. The concrete slab must have a pH of 10 or above, which under normal circumstances will assure that the concrete slab is free of bond inhibitors and contaminates.

Super-Krete® Products

Understanding Concrete Moisture Issues

Technical Guide

Appendix B: ASTM F1869 and ASTM F2170 Overview

Step Five

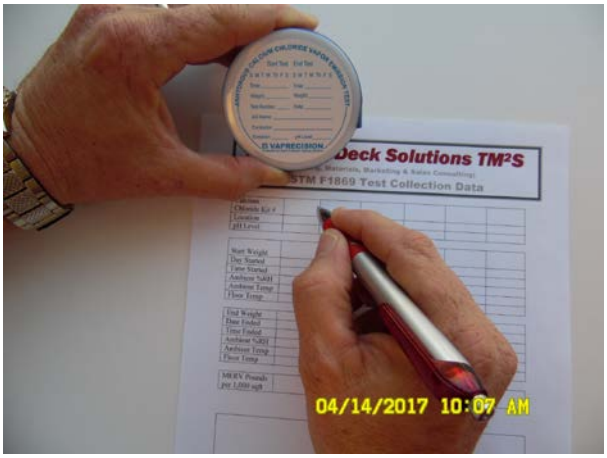
Calcium Chloride Test Kit

Digital Gram Scale

Open the sealed bag containing the calcium chloride canister. Weigh the canister with the tape seal still on the canister using a gram scale with a gradation to 1/10th gram.

Be sure the scale is set to grams (Note: Ounce weight scales will not be accurate enough to work for this test). Starting weights are usually around 30 to 31 grams, but may vary. The main concern in weighing this test canister is using the same scale when the first weigh the canister as post-test weight. The overall gain in grams is most important factor.

Step Six



Record the starting weight, date, time, temperature and relative humidity when starting the test on the canister lid and on the back of the worksheet provided with the test kit. The most important factor is determining the gain in grams from the start to finish of the test and the hours of exposure.

Super-Krete® Products

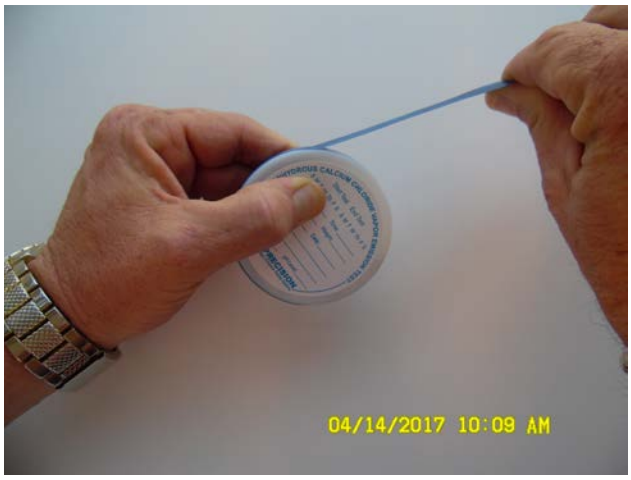
Understanding Concrete Moisture Issues Technical Guide

Appendix B: ASTM F1869 and ASTM F2170 Overview

Step Seven:

Peel off the protective backing on the tape from the dome sealant material and discard the backing. Be sure the sealant material does not contact objects or clothing as it is very sticky and is intended to provide a secure, long lasting seal to the concrete throughout the duration of the test.

Step Eight



Carefully remove the canister tape, carefully wrap the tape around the lid for "safe and clean keeping" and prepare to start the test. Make sure the tape does not pick up dirt or get lost since it will be needed to reseal the container at the termination of the test.

Do not spill the calcium chloride crystals. If crystals are lost, reweigh the plastic dish, lid, tape and remaining crystals. If ten percent or more is lost, discard the test kit.

Place the lid under the dish as shown and wrap tape around lid and dish.

Note: Take care to keep tape clean.

Step Nine

Install the test kit at the center of the concrete floor. Place the opened calcium chloride container on the concrete floor, in the center of 20 inch square. Make sure the crystals inside are relatively level. If any of the crystals are spilled the test can be invalid. Spilled crystals must be vacuumed up quickly before leaving a damp residue.

Step Ten

Immediately place the dome cover over the center of the dish unit. Always be prepared to place the dome and dish as soon as possible after opening the dish. Press down firmly along all the edges of the sealant material to securely bond the unit to the floor. A properly sealed dome will have the outside flange touching the floor. Put a slight amount of hand pressure on the center of the dome to ensure it is not leaking or absorbing air because of a poor fit. It is a good idea is to duct tape the dome edges in place to minimize disturbance.

Step Eleven

Allow the test to remain in place and undisturbed for 60 to 72 hours, prefer 72 hours. Once the test is placed into service it must not be disturbed by foot traffic or allowed to be exposed to direct sunlight. If accidental bumping occurs and the seal is not broken or the crystals inside spilled, the test may still be useable. If exposed to sunlight it will bias the test and produce inaccurate results. The use of protective cones is a good way to draw more attention to the test kit. It is a good idea to inform people that this test is sensitive and may have to be re-conducted if disturbed or destroyed.

Step Twelve

Recover the dish after exposure and calculate the results. At the end of the 60 to 72 hours of exposure, carefully open the dome with a razor blade and reach inside to retrieve the dish without spilling the calcium chloride. The used dome and sealant can be safely removed from the concrete with a razor scraper later on.

Step Thirteen

Immediately replace the dish lid and use the sealing tape to re-seal the dish. Re-weigh the dish on the same gram scale used at the start of the test, and once again record the weight and time on the dish lid and on the worksheet.

Step Fourteen

Subtract the Starting Weight from the Ending Weight to find the Weight Gained.

Multiply the Weight Gained by 117.707, then divide that number by the hours tested.

$$\frac{4.8 \text{ (weight gained)} \times 177.707}{72 \text{ hours}}$$

Results Equal 7.8 pounds per 1,000 square feet

Super-Krete® Products

Understanding Concrete Moisture Issues

Technical Guide

Appendix B: ASTM F1869 and ASTM F2170 Overview

Step Fifteen - Report

ASTM F1869 Test Collection Data

Calcium Chloride Kit #						
Location						
pH Level						
Start Weight						
Day Started						
Time Started						
Ambient %RH						
Ambient Temp						
Floor Temp						
End Weight						
Date Ended						
Time Ended						
Ambient %RH						
Ambient Temp						
Floor Temp						
MERV Pounds per 1,000 sqft						

LOCATION MAP

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Understanding Concrete Moisture Issues

Technical Guide

Appendix B: ASTM F1869 and ASTM F2170 Overview

UNDERSTANDING ASTM F2170

Relative Humidity in situ Test

ASTM F2170 testing in a nutshell:

- Testing at the facility must be at the service temperature of its intended operating conditions.
- The tests must be placed randomly, but usually for convenience are placed out of the way of other trades.
- First 1,000 square feet (92.9 square meters) must be tested in 3 places.
- Next 1,000 square feet (92.9 square meters) or part thereof must be tested in 1 place.

The in situ relative humidity test is conducted according to the test method specified in ASTM F2170, Determining Relative Humidity in Concrete Floor Slabs Using in situ Probes. ASTM F2170 measures the relative humidity in the slab at a depth that would be equivalent to the RH that would exist in the slab after installation of an impermeable floor covering.

Super-Krete® Products

Understanding Concrete Moisture Issues

Technical Guide

Appendix B: ASTM F1869 and ASTM F2170 Overview

To perform this test correctly the person doing the testing must know the depth of the concrete slab, since it is critical for the depth of placement of the relative humidity probes. The drill depth from the top of the concrete slab on grade will be 40% of the concrete slabs thickness. The drill depth of an elevated slab, not poured on and left in place metal form, that can freely dry both top and bottom at 20% of the concrete slabs thickness.

> Example #1. If the concrete slab is 6 inches (15.2 cm) thick and poured on-grade then the bottom of the probe hole should be 40% of the concrete slab thickness about 2.4 inches (6.35 cm) deep.
>
> Example #2. If the elevated concrete slab is 12 inches (30.5 cm) thick and free to dry on the top and bottom, then the bottom of the probe hole should be 20% of the concrete slab thickness about 2.4 inches (6.35 cm) deep.

Acclimatized

Most relative humidity probe providers fail to mention that acclimation of the building is Step 1. They immediately start with drilling as the first step. Acclimation must be done before "drilling begins" and several other steps should be performed before drilling with a roto-hammer begins.

STEPS:

Step 1. Determine the depth of slab

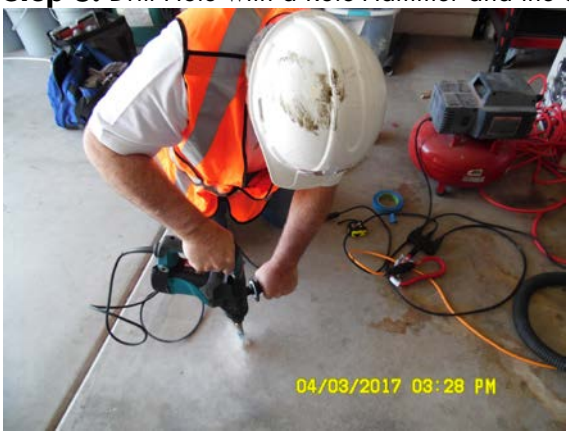
Step 2. Acclimatize the Building

Step 3. Take Ambient Temperature and Relative Humidity at the Drill Site, and take the Concrete Slab Surface Temperature with an Infrared Gauge.

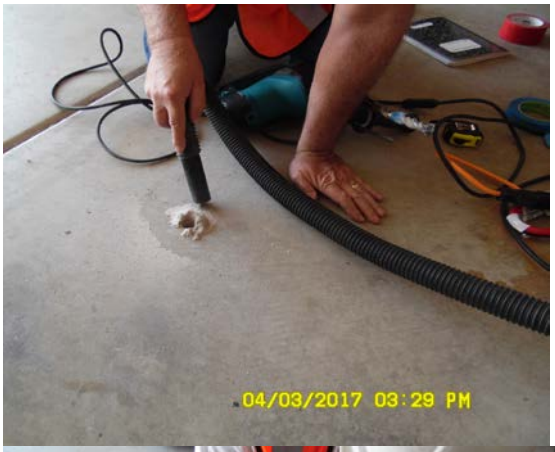
Step 4. Use 3/4 inch (1.9 cm) Concrete Drill Bit in an Industrial Roto-Hammer

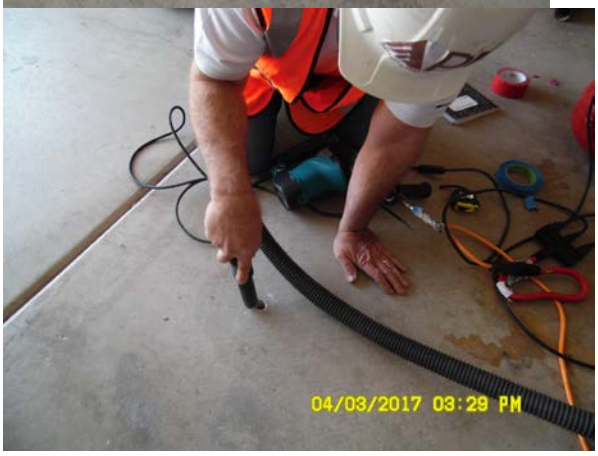
Step 5. Mark Drill Bit with Tape (a good idea with or without a depth gauge)

Step 6. Drill Hole with a Roto-Hammer and the depth gauge or "Depth Restraint Bar" in Place



Step 7. Clean the Probe Hole





Step 8. Optional Digital-Optical Inspections of Probe Hole

Step 9. Install Probe and Record Probe Number on Data Log.

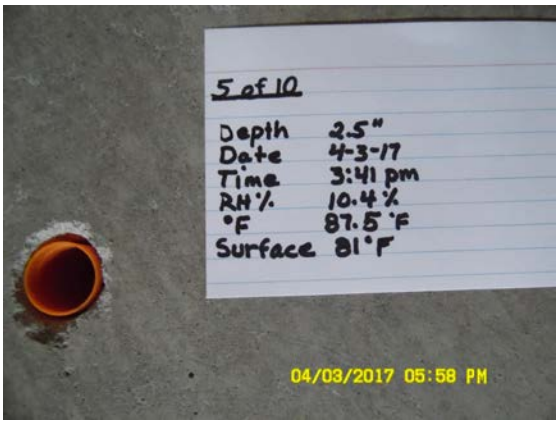
Super-Krete® Products

Understanding Concrete Moisture Issues

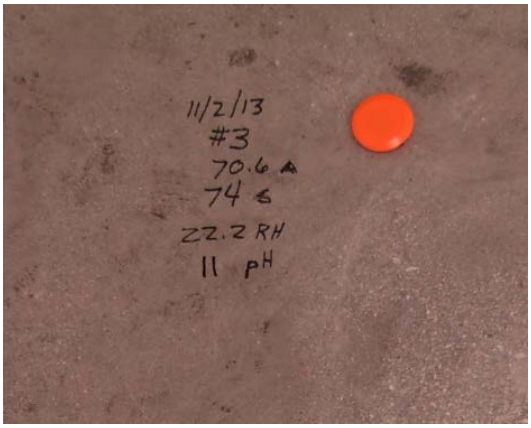
Technical Guide

Appendix B: ASTM F1869 and ASTM F2170 Overview

Step 10. Record Test Collection Data

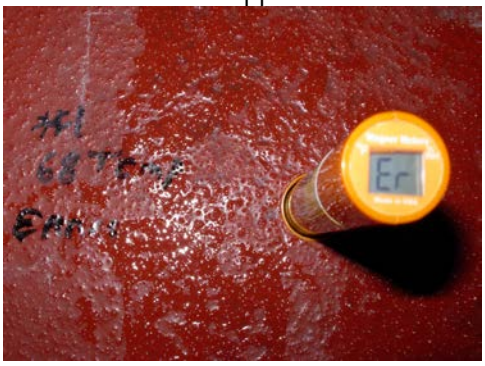


Step 11. Protect Probe with Plastic Cap and Caution Tape to Keep Other Trades from Distributing the Test



Step 12. Read Temperature and Relativity Humidity at 72 Hours

An Error Code will appear if Relative Humidity is 100%.



Report 13. Test Report

REPORT OF RELATIVE HUMIDITY IN CONCRETE TESTED RESULTS PER: ASTM F2170 Standard Test Method for Determining Relative Humidity Concrete Floor in Concrete Floor Slabs Using in situ Probes						
Name and Address of Structure:				Identity if Concrete Slab(s):		
Test Location	Drilled Hole Depth from Top of Slab (cored hole)	Ambient Air Relative Humidity Percent	Ambient Air Temperature	Surface Temperature of Concrete	Relative Humidity in Concrete Percent	Temperature in Concrete

Testing Instruments Used:	
Make, Model, Serial Number:	Calibration Date:

Test Performed By:	
Date Installed:	Date Read:

Super-Krete® Products

Understanding Concrete Moisture Issues

Technical Guide

Appendix B: ASTM F1869 and ASTM F2170 Overview

QUESTIONS

Feel free to contact APF if you have questions.

Disclaimer:

APF Technical Guidelines are developed in good faith for the sole purpose of assisting others with products, systems and industry standards. The information published herein is gathered from different sources that are thought to be reliable, but the reader should not assume that the information absolves the reader from validating information from other sources, such as listed below, before making a decision. Since information from others can change without notice, APF cannot be held at fault if any of the information conveyed in good faith is deemed in error.

References:

ASTM D4263 Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method

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

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