Floor Moisture Testing Requirements
Ensuring quality results before and during flooring installations
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What This Manual Covers

How to Test - When to Test - Tools needed - Preparation of Test Sites - Gathering Data - Recording Data

Background
Moisture testing became increasingly common as early as the mid-1980's and has since become a virtual requirement for any and all types of flooring where moisture-related issues may become a concern.

What Kind of Moisture Testing Should be conducted?
The simple answer is, as many as practical, using different methods. The more realistic answer is still a multi-tiered approach, but using methods that give the most information, with the least amount of effort and expense. Without debating the relative merits or value of each and every method, this manual will concentrate on detailing the most effective and efficient approach for testing, and what each step offers in effective and meaningful information for those involved with flooring installations and testing.

How to test
In order for ANY test program to be meaningful, it is vitally important that two factors are in place before ANY testing can be conducted:
1. The areas are properly prepared
2. The existing environment is accurately modified before initiating tests.

Within ASTM and the ACI guidelines, there is an "acceptable range" of temperature and humidity noted to be 75°F =/- 10°F, and a relative humidity of 50% +/- 10%. If these guidelines are followed without regard for some of the moisture conditions that actually can be created by the environment itself within these guidelines, any and all moisture testing will be inaccurate and potentially misleading. For information on how the environment can create these conditions please refer to "The White Paper on Dew Point" available on XL Brands' website, www.xlbrands.com.

Pretest Information gathering
Often overlooked, but potentially critical in the gathering of meaningful data, is the gathering of essential information before proceeding. Depending on the age and use of the project, information regarding specified concrete mix design, site conditions, time and date of concrete placement (withe field notes if possible that cover the temperature of the concrete at arrival, any job site added water, timing of contraction joint cutting, timing of curing procedures, etc.). This information can help to fill gaps in any unusual or seemingly contradictory and/or anomalous readings, or can fortify the testing data, further assuring the information is accurate and meaningful.

Select the site(s) for moisture testing
The selection of potential test sites should be methodical and meaningful. This is where a moisture impedance meter is an important tool. Moisture meters can be placed in various areas of any given room and can give an indication of potential issues where different concrete loads may be of varying quality, trenches have been cut and re-poured, metal in contact with concrete, along exterior walls and adjoining rooms that may be of different temperatures and humidity, etc. As with each step, each area chosen should be well-documented and photographed with a time and date stamp.

Prepare the chosen test sites for testing
Once the areas are chosen for testing, the areas should be "tested" with either pH strips or a phenolphthalein indicator.
NOTE: *When testing concrete, make certain it is actually concrete you are testing*.
During construction, concrete can be exposed to or treated with a variety of curing compounds, bond breakers, dirt, dust, spillage, etc. To ensure the surface to be tested is concrete, methods using pH strips and/or phenolphthalein indicator are reliable methods to ensure the surface to be tested **IS** concrete. A target for ensuring concrete is properly exposed is when the pH reaches 8-9 or higher. With the best method of preparation using a hand grinder or to shot blast the area. Test before any preparation and note the pH level(s). If the pH is less than 8, the surface is either coated, contaminated or occluded with a foreign material. Concrete, when fully "neutralized" (sometimes referred to as "carbonation") is still slightly alkaline. If the surface is less than a pH of 8, lightly grind the area to be tested, clean off all dust (residual dust can give an artificially high pH reading) and then retest using a pH strip, repeat if necessary until the pH is 8-9 or higher. Although pH testing isn't technically "moisture testing", it is an invaluable method to ensure proper surface preparation has been made for moisture testing.

Measure the environment
This point cannot be emphasized too much or too often. Before any moisture testing is conducted, an accurate measurement of the ambient air conditions (temperature and humidity), as well as a measurement of the concrete temperature is a determining factor before testing can begin, and if testing can be conducted under the existing conditions. Even following ASTM and ACI guidelines, the concrete may be saturated with moisture created by these ranges within acceptable limits, yet this influence is largely ignored or unknown to most who conduct such tests, creating conditions for a "false positive" (elevated moisture measurements), no matter what method of

testing is employed, and the assumption will be that the concrete is unacceptably high in moisture and mitigation is necessary, even though this may not be the case at all!
For example: If the ambient air temperature is 78°F and the RH is 58%, this would be considered a near ideal situation. However, what isn't addressed within these standards is the concrete surface temperature. If the concrete is 68°F, it is within 5 degrees of dew point and will actively absorb moisture from the air. If the concrete is 63°F or cooler, it is at dew point and would likely be saturated with water. If the interior of the concrete is cooler than the surface, then the moisture would continue to move towards the cooler interior, saturating the concrete in depth. Multiply this by how many days, weeks or months this environment has existed, a high moisture test result should be expected. In these conditions, no matter what method is used, a false reading of "moisture originating from the concrete" is virtually assured. As of this writing, there are very few testing personnel that possess the necessary skill set to accurately assess existing environmental conditions to properly set up moisture tests, much less provide accurate information or dissemination of such information. The environment MUST be factored in, before and during any and all testing. This information MUST be recorded and photographed to ensure to those involved with the project that the data has indeed been accurately monitored, tested and the data has been translated correctly. If the environment is not suitable for testing, then steps to modify the environment to remove the "environmentally introduced moisture" should be taken (there are several influencing factors invoked with this modification, and each needs to be considered for the individual project). Only after this condition has been corrected, is accurate testing possible, otherwise the data may be more misleading than helpful.

Recommended testing procedures
Although it would be ideal to test the entire project using multiple methods and the frequencies of testing placements outlined in the current ASTM standards; it is largely impractical due to timing and budget restraints. Secondly, there are many times when an issue is discoverable with a minimal, but well placed test grid, that indicate the next step in analyzing the project, and more placement areas were simply redundant and basically a waste of resources.

1. Test site(s) selection: Using an impedance and/or electrical resistance meter, first measure potential problem areas (trench lines, exterior walls, room dividers, surface discoloration, etc.). Then in a grid pattern, place the meter on areas based on a frequency of approximately 8ft by 8ft, or in a larger project (100,000+ s.f.), upwards of 15ft by 15 ft. The first priority is given to those area(s) that measure higher moisture levels, then priority is given to producing a geometrically evenly placed grid pattern, where a minimum of 5 to 6 sites are chosen.

2. Once the areas are chosen, there are two methods that give a reasonably accurate profile of the existing conditions; these are calcium chloride kits and humidity probes. These <u>must</u> be used together, otherwise some of the data gives an incomplete view as to the moisture content and slab condition.

Example 1: When a humidity probe reads a high humidity, but the calcium chloride test reads a low volume, this is typical of a high quality concrete, where corrective procedures are minimal.

Example 2: When the humidity probe reads a low humidity, but the calcium chloride test indicates a moderate to high moisture volume, this typically correlates with a permeable surface, usually caused by a high water/cement ratio, poor curing, re-tempered concrete, or possibly a combination of these elements. When these results are seemingly contradictory, a lot of information can be gathered by comparing these with the existing "pretest information".

Example 3: High readings from both the humidity probe and calcium chloride tests. This combination requires petrographic analysis, possible SEM (scanning electron microscopy), to assess the concrete before any other steps are made.

Example 4: Both humidity and calcium chloride readings are low - both low = good to go.

Testing immediately before and during flooring installation
This is arguably the most critical time for testing, once the relative quality of the concrete has been established. For exactly the reasons the environment needs to be tested before conducting the initial tests, the environment needs to be tested immediately before and during floor installation. When workers and materials are brought into a room, additional moisture sources have been introduced to the environment. Building materials (drywall, plaster, etc.), adhesives, worker respiration can all add considerable amounts of moisture to the immediate environment, enough to create its own "moisture failure". To properly asses the condition immediately before and during the installation, it is recommended to have the following tools available for the testing inspector, or whoever is responsible for quality control.

Hygrothermograph (digital with a real-time temperature, humidity and dew point read out): this can accurately monitor the ambient conditions in real time and can alert if conditions start to become critical during the floor installation.

Infrared (IR)Thermometer: This is a thermometer that can measure the temperature of the concrete in real time, allowing the operator access to information where the concrete may be approaching critical moisture conditions (rule-of-thumb: once concrete temperature is at or within 5 degrees of dew point, cessation of the floor installation may be necessary until the environment can be corrected.

Impedance/electrical resistance Meter: This device can be used as a confirming method for potentially critical moisture conditions on the existing concrete immediately before and during floor installation.

Although it may appear daunting, environmental correction is usually not very difficult, nor time consuming, and can be done is real-time and minimal disruption of the floor installation if judiciously approached. For example: many times, all that is necessary are some portable fans, and possibly a dehumidifier or two, depending on the size of the immediate environment.

Conclusion
Testing should become part of the process, not the way it is currently being utilized. Testing should be used to determine potential issues, as well and continuing issues throughout the process.

A critical factor in any and all testing is DOCUMENTATION! If moisture testing is to be conducted by professionals, then they should be held to a certain standard, as well as accountable for what is and isn't documented. Each and every area of testing must be documented, accurately dated and recorded, and photographed. With today's available technology, it is inexcusable to not demand accuracy in what is arguably the most unfocused, misunderstood and contentious area of the Flooring Industry. Moisture testing, done incorrectly, simply does a disservice to any and all involved with the project and the industry. If properly applied, the moisture issues that are currently prevalent, can become nearly extinct.

Prepared by:
Bob Higgins
RC Consulting
rcconsulting.higgins@gmail.com