Moisture Measurement in Concrete and Wood
Correct Usage and Application
Moisture Sources

- Precipitation
- Dew point $T_1$
- Dew point $T_2$
- Ambient RH
- Osmosis
- Hydrostatic
- Sub-slab vapor
- Sub-slab water

Picture Courtesy of CTLGroup
Concrete Equilibrates with the Occupied Space Air

Drier

Wet

Concrete Moisture Vapor Retarder

Sub-base
When floor covering or coating is **first** applied, the moisture at the surface may still be OK, but…
Shortly after the initial installation, the moisture in the slab will quickly equilibrate within the slab; bad news at the surface, and then...

Slab Surface now wet

Floor covering
Serious and Costly Failures and Damage

Photos Courtesy CTLGroup, George Donnelly, CFI
Drying Rate of Concrete

• Rule-of-Thumb is minimum of 30 days of drying time per inch thickness of concrete to reach approximately 85% RH
• Above assumes good drying conditions (HVAC on, no additional water, .40-.50 water/cement ratio)
• Many factors can impact the minimum time
• Even very old slabs can have high moisture
Why Measure Moisture?

• Meet flooring manufacturer’s warranty requirements
• Minimize potential IAQ problems
• Minimize moisture-induced failures
• Contractual obligation

Basically, minimize liability and financial loss
# Approaches to Measuring Moisture

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There are two main testing methods with an ASTM standard and commonly used in the industry:

- In situ Relative Humidity testing
- Calcium Chloride testing (MVER)
Brief discussion of calcium chloride (MVER) testing
Calcium Chloride (MVER)
-- Test Procedure --

TEDIOUS, LABOR-INTENSIVE, SLOW RESULTS

- Select locations
- Clean & grind surface
- Wait 24 hours
- Place kits
- Expose 60-72 hr
- Remove
- Weigh, calculate & report
Measured Moisture Vapor Emissions (MVE) come almost entirely from the upper part of the slab. 90% of the measured MVE comes from the top 12 mm (½”) of concrete. A Calcium Chloride test does not detect moisture below 20 mm (¾”) deep.
Effect of Air and Floor Temperature at 50% RH

Cooling the floor gives apparent lower MVER, but the moisture is still in the concrete.
The graph below was compiled from many paired (side-by-side) calcium chloride and relative humidity tests done over the last number of years by independent testing entities, clearly showing….

This shows a number of points that indicate what would seem "safe" readings (y axis) in the 2-5 lb. range, yet the RH levels (x axis) range from 80% to above 95%.

Graph Courtesy of CTLGroup
……that even though a floor tests below 5 lbs. MVER, the interior of the slab (where RH probes measure) can have excess moisture leading to potential flooring failure.

This shows a number of points that indicate what would seem "safe" readings (y axis) in the 2-5 lb. range, yet the RH levels (x axis) range from 80% to above 95%.

Graph Courtesy of CTLGroup
What about Moisture Meters for Concrete?

Effective penetration depth of moisture meters only about \( \frac{3}{4} \)-inch
What about Moisture Meters for Concrete?

Concrete variability (density, aggregate Size and quantity, chemical composition, etc.) affect the accuracy and repeatability of concrete moisture meter readings.
What about Moisture Meters for Concrete?

Perhaps useful as a forensic tool on a flooring failure

New ASTM 2569 standard for using “moisture meters”

1.5 Where possible, or when results need to be quantified use this standard guide to determine where additional testing such as Test Methods F1869, F2170, or F2420 as specified to characterize the floor slab and the test area environment for moisture, humidity and temperature conditions.
Advantages of using RH testing for Concrete
Relative Humidity (RH) Testing
ASTM F2170-09

- Precise, accurate
- No surface prep
- Accurate Readings generally within 1-4 hours*
- Can be quickly re-tested
- Profile, track RH
- Scientifically proven

*ASTM F2170-09 currently requires 72 hours
Important Criteria for in situ RH Testing

Molded fins seal-off bottom of hole from the outside air, similar to rings on a piston in an engine cylinder.

RH/Temp Sensor is integrated into the bottom side the Smart Sensor Barrel.

Very small equilibration pocket in bottom of hole.
Important Criteria for in situ RH Testing

• Depth-specific measurement
  • ASTM F2170-09 method calls for measurement at 40% depth (slabs drying from one side), not an average
  • Some methods may not be depth-specific or correctly isolate the hole
Calibration

Section 8 of ASTM F2170-09 is clear about cal verification and calibration
Moisture Meters and Wood

- Pin (electrical resistance) or non-pin (capacitance, electromagnetic)?
  - Both have a place, but need to be correctly used for the application
Moisture Meters and Wood

• Non-pin characteristics
Moisture Meters and Wood

- Most will effectively penetrate into the wood; not necessarily surface-only
Moisture Meters and Wood

- Some are more affected by surface moisture
Moisture Meters and Wood

- They can be set for different species
Moisture Meters and Wood

• Arguably, better for applications where wood flooring is not already down; when flooring is down, better on wood-based substrates
Moisture Meters and Wood

• Accuracy of all wood meters can be compared to the ASTM Oven-Dry Test Standard
Moisture Meters and Wood

• Pin meters, with insulated pin shafts can be depth-specific for forensic applications
• Short pins, with un-insulated shafts are fine for some applications
Moisture Meters and Wood

- Pin meters can be set for different species as well
- Should align pins with grain when using
For More Information

“Concrete Floors and Moisture”, written by Howard Kanare, Portland Cement Association, [www.cement.org](http://www.cement.org)

“302.2R-06: Guide for Concrete Slabs that Receive Moisture-Sensitive Flooring Materials, reported by ACI Committee 203, American Concrete Institute [www.concrete.org](http://www.concrete.org)


[www.rapidrh.com](http://www.rapidrh.com)
[www.wagnermeters.com](http://www.wagnermeters.com)