J+J FLOORING
A DIVISION OF ENGINEERED FLOORS

Moisture in Concrete: Implications on the Selection of Flooring Systems

Concrete slabs are the most common flooring base used in a range of buildings including residential and commercial. Like the majority of building materials, concrete constantly interacts with the conditions around it - temperature, humidity, soil conditions and other factors all have an impact on the moisture levels in concrete.[1]

Water is an essential ingredient in concrete, but uncontrolled excessive moisture can create a host of problems involving concrete floor slabs. Moisture related problems in flooring are more prevalent today than they used to be.

Factors such as these listed below are responsible for moisture problems: [2]

- Fast track construction
- Omission of vapor barrier
- Inadequate materials being used
- Moisture protection being installed improperly

Moisture in a concrete slab comes from two sources: free water (otherwise known as water of convenience) the water above, which is necessary to hydrate the cement particles and bring a concrete mixture to a workable consistency. The second source of moisture in a concrete slab is the result of moisture rising from below the slab. Moisture vapor that comes up from beneath a concrete slab usually results from the lack of an impermeable vapor retarder directly below the slab.[3] See Figure 1.

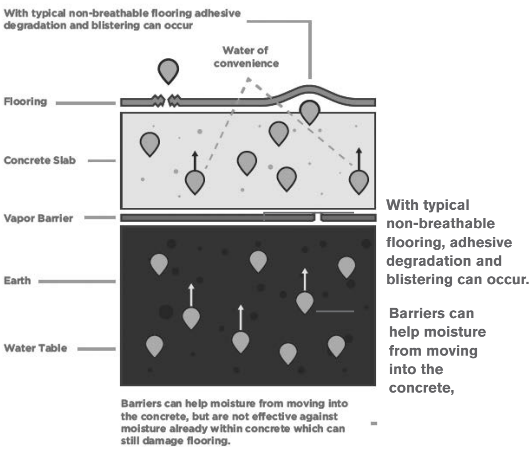

Figure 1. Moisture Activity Beneath and Within a Concrete Slab with Flooring Installed

Moisture Implications on Flooring

Excessive moisture from floor slabs after installation can cause floor covering system failures such as: [4]

- De-bonding of slab finishes
- High pH levels that damage flooring
- Microbial growth
- Release of adhesive resulting in loose floor covering
- Flooring expansion

These failures can mean significant, expensive damage to a flooring system. Hundreds of millions of dollars are spent annually in North America to correct such problems.[5] If moisture issues are identified before the floor covering is installed, corrective measures are much simpler and less expensive than after the flooring is in place. Or, flooring products with proven tolerance to high RH and pH levels can be used.

Table 1 gives some examples of maximum RH tolerance for representative types of flooring, as well as J+J Flooring modular carpet, LVT and Kinetex.

Max. % RH	Cover Material
75%–85%	Rubber, vinyl & other roll goods
80%–85%	Broadloom Carpet with Synthetic Latex Backing
90%	Luxury Vinyl Tile and Plank Modular Carpet with Thermoplastic Backing Sheet Vinyl
99%	J+J Flooring's Nexus Modular Carpet with TileTabs and 5mm LVT with TileTabs
100%	J+J Flooring's Kinetex with PreFix

Table 1. Maximum Value of Relative Humidity in Concrete

Moisture Testing

Water is an essential ingredient in concrete, but uncontrolled excessive moisture can create a whole host of problems with concrete floor slabs.

Substrate surfaces should be tested for moisture emission prior to starting the installation to prevent flooring failures in the future. There are two industry standards for measuring moisture vapor emissions in concrete: Relative Humidity testing (ASTM F-2170) and Calcium Chloride Testing (ASTM F-1869)[6]

Relative Humidity is the ratio of the amount of water vapor in the air at a specific temperature to the maximum amount that the air could hold at that temperature, expressed as a percentage.[7]

The Relative Humidity Test (ASTM F-2170) measures the percentage of moisture within the concrete. Due to its reliable accuracy, this test has become the most-preferred method for assessing the condition of a concrete slab. Probes that measure relative humidity are inserted into holes drilled into the concrete slab. The ASTM F-2170 standard requires that the holes be drilled at 40% of the depth of the concrete to achieve accurate results.[8] Examples of acceptable relative humidity probe testing results are shown in Table 1.[9] As with RH, the maximum pH will vary depending on the type of flooring and the method used to install it.

The Calcium Chloride Test (ASTM F1869) determines the moisture vapor emission rate (or MVER) from a concrete slab. The test has been in-use for decades, although the results are sometimes questionable. Calcium Chloride is a white deliquescent compound, used as a drying agent, refrigerant, and preservative.[10] The test method involves sealing a small dish of calcium chloride on a clean section of concrete under a plastic dome. The salt absorbs moisture in that environment and the weight gain after three days is used to calculate the MVER.[11]

Most manufacturers and flooring installation contractors recommend Relative Humidity (RH) probe moisture testing, as the results are more accurate, reliable and consistent than MVER testing.

Several approaches are being promoted to mitigate moisture-related influences for new and remodel projects before the flooring is installed.

I. Solutions for Moisture in Concrete

If high moisture emission is discovered, then proper precautions should be taken to prevent flooring system failures.

I. Mitigation - Several approaches are being promoted to mitigate moisture-related influences for new and remodel projects before the flooring is installed. Topical applications used for moisture mitigation include the following:[12]

a. Reactive penetrants – reduce moisture and soluble alkali transfer from the slab by reducing the surface porosity of the concrete and by chemically combining with hydroxides within the cement paste. b. Moisture retarding coatings - slows moisture emission from the slab and help isolate the applied flooring material from the pH - raising effects of soluble alkalis in the concrete.

c. Modified cementitious overlays – epoxy-based or epoxy-modified coating overlays used to form a separation layer between the base concrete and the applied flooring system. These act as an isolation barrier to keep solutions of alkaline salts within the concrete from reaching the adhesive.

d. Dispersive membranes (modular use only) - uses a fiber mat membrane to provide a diffusion path beneath flooring materials. The membrane can be adhered directly to the prepared concrete surface or applied over certain coatings.

II. Selecting a Floor Covering with Higher RH Tolerance

In the ideal case, the RH of the slab is known in advance, therefore allowing selection of compatible flooring. But often, slab conditions are only measured a few days prior to installation, and it is common to learn that the RH is too high for the specified flooring. In that case, re-selecting compatible flooring has to be done quickly and accurately.

There are three basic mechanisms currently available by which flooring manages moisture vapor emanating from a slab:

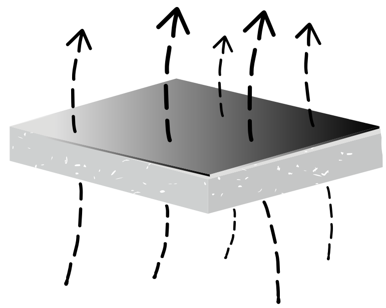

Figure 2. Permeable System: The flooring is breathable and the moisture vapor simply passes through it. This applies to both broadloom and modular systems.

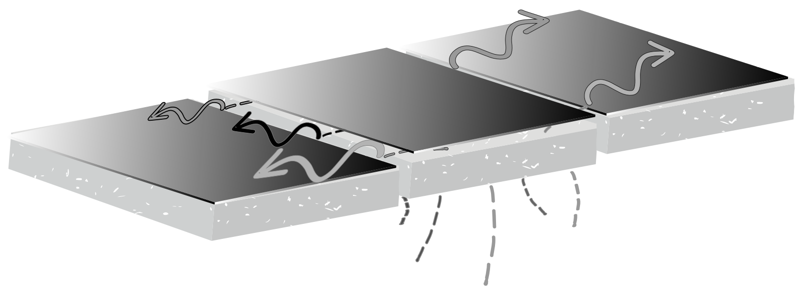

Figure 3. Dispersive System: The flooring is modular and its construction is capable of dispersing moisture vapor to the seams between modules where evaporation occurs.

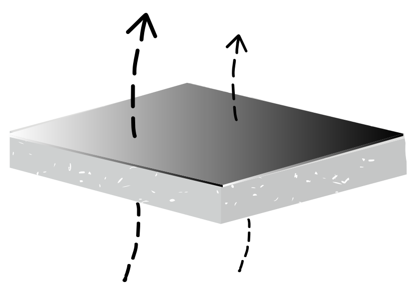

Figure 4. Semi-permeable System: The flooring is semi-permeable and allows for some low but possibly adequate level of breathing through the flooring. This can apply to both modular and broadloom systems.F

III. Testing: Permeance

In 2018, J+J Flooring commissioned the CTL Group to conduct a study to learn how these different flooring systems work on a concrete slab with 100% relative humidity environment. The study included testing four examples of the three types of flooring described above for their breathability and retention of adhesive bond strength.

The results show that a highly breathable system, such as a textile composite flooring, shown in Figure 1, dissipates moisture arising from slabs much more efficiently than either a dispersive system or a semi-permeable system. In fact, the results showed that the textile composite flooring does not reduce the permeance of the slab, in any measureable way.

Generally speaking, the two semi-permeable systems and the dispersive system performed similarly with respect to breathability. All proved sufficiently capable of dissipating water vapor to be helpful in preventing moisture-related flooring failure.

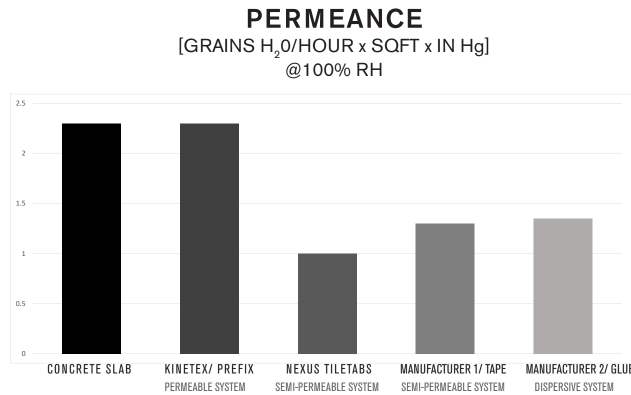

Figure 5. Permeance of Permeable, Semi-Permeable and Dispersive Systems

IV. Testing Bond Strength Retention

As noted previously, adhesive bond failure is a common moisture-related failure. Accordingly, adhesive bond retention tests were performed concurrently with the permeance tests. To test the adhesive bond strength of these products, lap shear adhesive bond strength tests were performed after long-term exposure to 100% relative humidity at 30, 60 and 90 days.

The results of the adhesive bond strength testing were revealing. In all cases, the initial bond strength was in the range generally considered to be satisfactory, which was expected. At the end of the test, all samples showed an increase in bond strength. Some increased more than others.

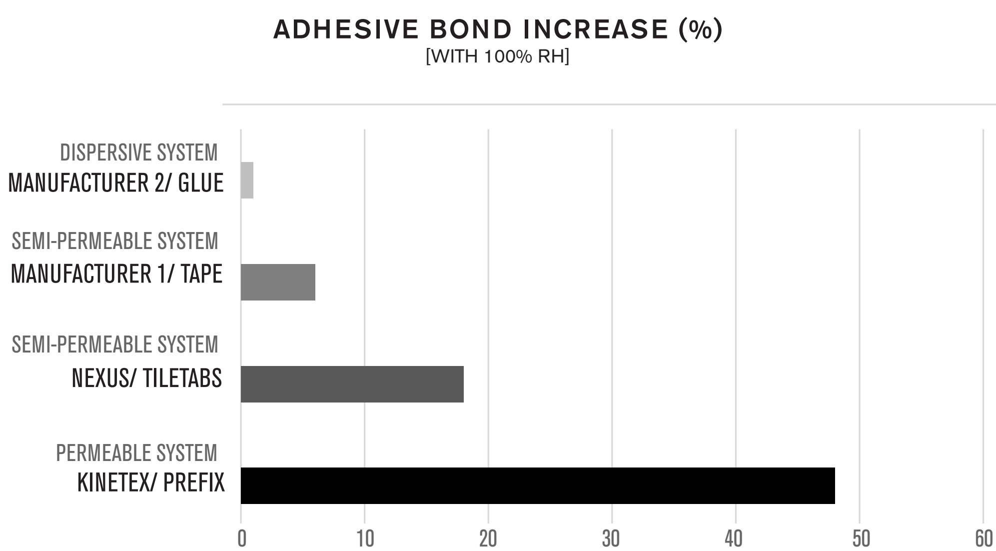

Figure 6. Adhesive Bond Strength Increase

J+J Flooring offers three product solutions to help combat concrete moisture issues:

- Kinetex with PreFix
- Nexus Modular Carpet with TileTabs
- 5mm LVT with TileTabs

For more information regarding J+J Flooring products and solutions for high moisture in concrete slabs, please visit our website: jjflooring.com.

Notes

1 Spangler, Jason. “6 Outside Sources for Concrete Moisture.” Retrieved from http://www.wagnermeters.com/6- outside-sources-moisture.php; accessed July 29, 2013.

2 Craig, Peter. “ Problem Clinic: Moisture Problems with Concrete Slabs.” Concrete Surfaces. Hanley Wood, LLC, March 2007. Web. August 13, 2013.

3 Craig, Peter. “ Problem Clinic: Moisture Problems with Concrete Slabs.” Concrete Surfaces. Hanley Wood, LLC, March 2007. Web. August 13, 2013.

4 Kanare, Howard. “ Why Are We Still Having Problems with Moisture and Concrete Floor Slabs.” Concrete Construction. Hanley Wood, LLC, November 15, 2007. Web. July, 29, 2013.

5 http://en.wikipedia.org/wiki/Epoxy_Moisture_Control_System_%28Flooring%29

6 http://en.wikipedia.org/wiki/Epoxy_Moisture_Control_System_%28Flooring%29

7 http://www.thefreedictionary.com/relative+humidity

8 Smith, Ron. “ Performing Correct and Accurate RH Testing in Concrete Slabs.” Floor Covering Installer. BNP Media, Oct/Nov 2009. Web. July 28,2013.

9 Kanare, Howard. “Concrete Floors & Moisture.” Portland Cement Assn, 2008. Chapter 6. 10 http://www.thefreedictionary.com/calcium+chloride

11 Spangler, Jason, “A Quick Course in Concrete and Moisture.” Retrieved from http://www.wagnermeters.com/ concrete_basics.php; accessed July 29, 2013.

12 Craig, Peter. “ Moisture Mitigation for Concrete Slabs.” Concrete Repair Bulletin. International Assoc of Concrete Repair Specialist, Jan/Feb 2006. Web. July 27, 2013.