A Quick Course in Concrete and Moisture:

How The Basics Can Keep Your Floor Intact

All types of flooring can be susceptible to failure if moisture conditions are not properly monitored and maintained. But a slab's moisture condition begins long before the flooring is installed. If the concrete slab has not been properly dried and cured before the flooring is installed, moisture problems are almost guaranteed. Moisture-related problems in flooring can also become health issues as mildew, mold, gaps, bumps and unsecured flooring pose additional risks to anyone walking over them.

Obviously no one wants to have to repair an entire floor system because of moisture problems. The cost of remediating a flooring failure (or, worse yet, a concrete subsurface) can impact business costs, labor and reputation.

But the good news is that some preventative steps can do much to reduce the risks of excess moisture in the concrete slab and in the subsequent applied flooring. But in order to properly understand the ideal conditions for flooring installation, some basic knowledge about concrete is important.

You may often hear "cement" and "concrete" used interchangeably but they are not the same thing. Cement powder is the (typically) grey powder added to the concrete mix that binds all the components together. Cement is only one of the ingredients mixed together to make concrete. Sand, water, and rocks (or other aggregates) are mixed with cement powder to form the finished product – concrete.

There are two basic types of cement. A common cement like Portland cement is one of the **hydraulic cements** that harden regardless of surrounding moisture conditions. The chemical reactions that bind these types of cement can even occur underwater! **Anhydrous cements**, like gypsum plaster, must be dry to keep their strength. Within these two categories, additives like fly ash, lime, silica fume, blast furnace slag and others give a variety of strengths and colors to the various cement blends and to the final concrete made from these blends.

When the various ingredients – cement, sand, water and aggregate - of a concrete mixture are combined, a chemical reaction takes place that binds the materials together to form concrete. In a 4-inch slab, it takes approximately four weeks for this chemical process to be complete. This is the process known as "curing." But a cured slab can still be holding a significant amount (approximately two thirds) of the moisture from the original concrete mixture – certainly too much to consider applying a flooring product over.

Drying continues after curing is complete through a process that moves moisture to the surface of the slab to then evaporate away and be replaced by more moisture drawn up through the entire slab. If the slab has cured, but not dried, it is certainly not ready for a flooring installation. And even "dry" may not be dry enough. Because the drying process can be greatly impacted by environmental conditions like temperature and air humidity, the only way to be sure a slab is dry enough to apply a floor covering is through adequate moisture testing.

Accurate moisture testing is critical to understanding the complete moisture levels of any concrete slab. One test at the surface of the slab is obviously inadequate when trying to make a go or no-go decision about installing flooring. Different areas of a slab may dry unevenly so adequate testing will test a number of different spots on each slab, and will test below the surface of the slab (at service conditions) as well. ASTM International has provided several standards related to testing moisture content with two different test methods before installing flooring over a concrete slab: in situ probes (ASTM F2170) and calcium chloride testing (ASTM F1869).

The **calcium chloride test method** is used to determine the moisture vapor emission rate (or MVER) from a concrete slab. The test 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 presumably coming from the concrete slab) and the weight gain after three days is used to calculate the MVER. While this method is still specified by many flooring manufacturers, architects and adhesive manufacturers, the calcium chloride test really only tests the surface conditions of the slab. (Side note: calcium chloride testing has also been disallowed as an appropriate method for testing on lightweight concrete)

To test the moisture conditions *within* the slab, the best indicator of the total moisture content picture is **relative humidity testing** using *in situ* probes. A series of test holes are drilled into the slab and a small probe is placed into the hole where it is allowed to equilibrate with the slab before readings are taken. Research has found that placing the probe internally, at a depth of 40% of the slab's total thickness, provides the best indicator of the moisture conditions the adhesive and finished flooring product would encounter if they were installed.

Understanding these basic concepts about concrete, and correctly monitoring its moisture content as it dries, can significantly reduce the risk of moisture-related flooring problems. From a concrete specification that suits the time frame available, to the flooring contractor that must choose the adhesive best suited to the flooring and slab conditions, with the right moisture content information, it should be possible for every professional on a building site to prevent flooring failures.