Dehumidification for Fast Track Concrete Drying

By Russ Brown

The construction industry has long been judged on its quality of work and the ability to complete projects on schedule. Construction managers, general contractors, and subcontractors who must meet tight construction timetables and warranty the work are often those who feel the heat for things out of their control. For them, there's nothing more painful as waiting for a concrete slab to dry to manufacturer's specifications before proceeding with scheduled flooring work.

Often, the construction schedule does not allow for the luxury of waiting for the natural hydration and drying process to occur. As a result, the length of time it takes for concrete slabs to dry can create delays in the overall schedule. Unless the specifications for moisture content in the concrete are met, flooring subcontractors cannot proceed and manufacturers' warranties won't be honored.

What is Dry?

While a concrete slab may appear to be dry, even to the point of walking on it days after it was placed, appearances can be misleading. In reality, under normal ambient conditions, a concrete slab placed within an enclosed building will dry at a rate of about 1 in. (25 mm) per month. But even that is a generalization. The actual rate will vary based on the concrete mixture proportioning, curing procedures, and ambient conditions (temperature and humidity).

Unless the excess moisture is dried, several problems may result:

- Poor initial adhesion of flooring installed on the slab;
- Moisture migration to the surface, which can result in failure of adhesives, discoloration of flooring materials, and blisters in coatings; and
- Growth of mold in other materials as high ambient moisture remains.

Why Flooring Fails

The reasons for failure of an installation of flooring materials onto a slab vary, based on the specifications of the product being applied. Some materials readily absorb water, while others require adhesive compounds that are damaged by moisture. For example, low volatile organic compound (VOC) adhesives for carpet and resilient flooring are environmentally friendly, but can be compromised by excess moisture and high pH. Some examples of how various materials react are listed as follows:

- Hardwood flooring and millwork will absorb moisture, resulting in warping and swelling of the wood or wood composite materials;
- Moisture-sensitive adhesives used to install vinyl composition tile (VCT), rubberized high-performance sports floors, and fiber-backed carpet often are compromised when the slab is too moist;
- Moisture can stain and discolor resilient flooring and coatings; and
- If the water-based adhesive on rubber-backed carpet tiles becomes wet, it often will wick upward in the joints and stain the carpet.

Amount of Excess Moisture

Concrete cures by hydration when water reacts with the cement powder, giving concrete its great strength, but the mixture always contains more water than the hydration reaction requires. This is because, without excess water, the mixture would be too lumpy and stiff to flow into forms or easily place in a slab. Also, additional water is sometimes sprayed onto the surface after the placement to keep it fully wetted for complete hydration. And of course, in outdoor settings, rain can contribute even more excess moisture. The total amount of the excess varies, depending on the desired properties of the cured concrete, the curing procedures, and whether the concrete is protected from rain.

Risk of Mold

There can be even greater amounts of moisture to contend with. Relative humidity and weather, in the form of snow and rain, are major contributors of additional moisture. Also, the materials used to construct the building retain moisture. Fire proofing, laden with water when applied, dries slowly inside enclosed areas. Large amounts of water can be trapped in concrete wall blocks. Joint compound and paint emit large volumes of water as they dry.

The combination of a number of these factors will create exceptionally high humidity levels inside a building. If the conditions are right, the interior atmosphere can even create fog and condensation that drips onto the slab.

Moisture travels a path of least resistance. So, if the moisture level in the air is high enough, water in the concrete will evaporate very slowly or not at all. That condition will reduce the drying rate even more.

Optimum indoor drying conditions occur at 30% relative humidity and 65 to 70 °F (18 to 21 °C) with constant airflow over the slab surface. Unfortunately, contractors sometimes attempt to rely on heating, ventilating, and air conditioning (HVAC) systems to establish low relative humidity. That option is inadequate for several reasons:

- HVAC systems are engineered for temperature control and not moisture removal capacity;
- Running the system can spread dust and mold spores throughout the ventilation system and even cause damage to the HVAC equipment, coils, or filters. Because of that, some building owners no longer allow the use of the building's installed HVAC system during construction;
- Many openings between the structure and the outdoors, as well as between various areas of the building, make controlling temperature and humidity uniformly nearly impossible; and
- Running the system before commissioning the building can lead to warranty issues and concerns.

Other methods such as heating and cooling are commonly used at construction sites to control the ambient environment. These processes, however, are capable of controlling the temperatures in the space only and are not effective at significant moisture removal. In fact, heating the space with standard direct fired construction heaters will often add moisture (through combustion) to the space, which may compound the problem. Cooling equipment will make the space more comfortable during warm periods but cannot provide the conditions necessary to provide significant concrete drying results.

Desiccant Dehumidification

A more efficient, reliable, and faster method of moisture abatement is aggressive drying through a desiccant dehumidification system. Desiccant dehumidifiers have proved effective in creating low relative humidity and dew points when drying air at a condition far from saturation or at low temperatures.

Desiccant units used for drying are different than those used as permanent installations in commercial buildings. Portable units, delivered to the site on trailers, are designed to withstand the construction environment and to provide the aggressive drying

required to establish and maintain proper dew point and humidity levels.

Portable, inflatable plastic ducts are used as part of the airflow system, precluding any reliance on the HVAC distribution system. Also, the temporary ducts can be moved easily as work progresses into other areas of the construction site.

Finally, to be effective, the dry air must be contained. If a building under construction is open to the exterior when a slab is curing, temporary enclosures may need to be erected to contain the dry air where needed.

Unlike cooling-based dehumidifiers, which cool the air to condense moisture and then draw it away, desiccants attract moisture molecules directly from the air and release them into an exhaust air stream. Desiccants can attract and hold from 10 to more than 10,000% of their dry weight in water vapor. They are very effective in removing moisture from the air at low humidity levels and do not freeze when operated at low temperatures. The end result is an extremely dried air source capable of drying the most saturated materials.

The Drying Process

The process to remove the excess moisture from the concrete slab is dependent on the lowering of the moisture vapor pressure difference between the slab and the ambient conditions above it. The desiccant dehumidifier will provide the dry air capable of not only reducing the threat of condensation on the surface (liquid moisture), but will reduce the overall vapor pressure in the space. Moisture will travel from areas of high vapor pressure (within the slab) to the areas of lower vapor pressure that are being mechanically created (ambient condition). The moisture vapor will be desorbed from the concrete into the air and will be pushed out of the space by air movement.

Depending on the amount of moisture to be removed and the conditions present, the number of hourly air changes can vary greatly. Air change rates can fluctuate depending on ceiling height, thickness of slab, tightness of envelope, type of vapor barrier (or lack of one), outside weather conditions, and a host of other variables.

Tradesmen can continue to work in the spaces being dried. However, they must be informed to keep the envelope secure by closing doors and windows. In summer applications, one might consider combining temporary cooling systems in conjunction with the desiccant dehumidification to provide more comfortable working conditions for the workers while still creating suitable concrete drying conditions.

One added perk to using desiccant dehumidifiers to dry concrete is that materials other than the slab will dry more quickly. Drywall compound can be ready for sanding the day after dehumidification begins in any climate. Fireproofing has been dried to industry standards in a matter of a few days rather then weeks. Mold growth on construction materials will remain in check.

The Use of Sealers

Although the use of dehumidifiers as a method to dry concrete slabs is growing quickly, it still may be some time before it surpasses the popularity of the common concrete sealer. This is most likely due to the fact that sealers have been around for several years and most likely will continue to be a presence for some time to come. The decision whether to use a sealer or a dehumidification system to prepare the slab for installing floor coverings is based on several factors, including budget, deadlines, severity of the problem, and warranties expected. If one expects to install flooring in a few days, the use of a sealer may be the only choice. The dehumidification process takes time and cannot be completed in a matter of a few days. The mechanical drying of the floor, however, might be a better long-term and cost-effective solution. Most sealers provide a barrier to trap the moisture vapor inside the slab limiting the amount of emissions that can affect the adhesives installed on the concrete. The free moisture remains trapped or searches to find an avenue to escape, leading to the possibility of future flooring failures. The use of dehumidification systems are designed to remove the moisture rather then divert it. This technique will reduce the chance of excess moisture vapor to permeate the adhesive and create future problems.

Measuring Moisture in a Slab

Most manufacturers require one to know the moisture content in the slab before moving ahead with the installation of flooring, based on their specifications. Several qualitative and quantitative testing methods are used to determine moisture content during the drying process.

Each type of test measures differently. The most commonly used techniques are:

- Plastic Sheet Method (ASTM D 4263)—this is a qualitative test and should not be used to verify compliance with flooring manufacturer's requirements for moisture content. A sheet is placed over an area and, after a time, condensation is observed, suggesting the concrete is too wet. However, if no condensation appears, it is not a valid indication of a low moisture level within the slab;
- Relative Humidity Probe Test (ASTM F 2170)—this quantitative method has been used effectively in Europe for about 15 years. The U.S. construction market is just beginning to be comfortable with the method. Relative humidity is measured by drilling a hole in the concrete and inserting a probe into it for 3 days, then measuring;

- Calcium Chloride (ASTM F 1869)—A widely used quantitative test. It measures moisture in only a thin upper layer of the slab (approximately 1/2 in. [23 mm]). The test is based on the rate of absorption of moisture by the calcium chloride. Results are subject to temperature and humidity levels the day before the test results are viewed, which can produce different readings; and
- Electronic Meters—a variety of meters, including some based on radio frequencies and others that require pins to be inserted into the concrete, measure conductivity. The method, which measures to depths of about 1/2 to 3/4 in. (13 to 19 mm), was developed by the wood industry. It is best used to obtain qualitative readings over an entire floor, followed up with a quantitative test.

In every use of measurement methods, the guiding principle is to refer to the manufacturer's recommendations for expected moisture levels and the desired methods for monitoring. To obtain the most accurate results, two or more methods should be employed to cross-check readings. Relying on the drying contractor's experience with testing procedures is the best guarantee of reliable results.

This Viewpoint article has been selected by the editors as an offering to the interest of our readers. However, the opinions given are not neccessarily those of the International Concrete Repair Institute or of the editors of this magazine. Reader comment is invited.

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