Ignoring moisture is a bad idea

A concrete decision

By Christopher Capobianco

This is part one of a series on working over concrete

Floor-covering failures related to concrete moisture continue to be an issue today in all categories of flooring. Carpet, resilient, wood, laminates and most categories of floor covering are affected to one degree or another by excess moisture-vapour emission from a concrete slab. Gaps between resilient floor tile, adhesive oozing or unusual looking bumps, peaking or cupping of wood or laminate floors, bubbles in carpet and indentations or wheel marks in sheet vinyl can all be caused by a damp slab.

Left uncorrected, these problems often become health and safety concerns because of mould or floors lifting. I am in my 30th year in the flooring business, and for the last 15, I have been a technical specialist/consultant/manufacturers' representative on the commercial side, mostly in the United States but occasionally in Canada as well. During this time, concrete issues have been an almost-daily topic of discussion for me. For example, there was the water-damage restoration specialist from Ottawa that contacted me this morning for input on drying concrete in a building that had been flooded.

Not being from the concrete industry, I had to learn a lot about this issue and I have attended a number of seminars and served on ASTM committees with some of the best minds in the flooring and concrete industries. This has helped me develop an understanding of concrete, although the more I know the more I realize I need to learn, and as I discuss this with installers, dealers and manufacturers reps, I realize that the industry also has a lot to learn.

***Coverings* has asked me** to do a series on the basics of concrete, testing and correction of moisture-related problems. ASTM Committee F.06 on resilient flooring has members from Canada, the United States and Europe, and has published a number of standards for concrete as it relates to floor coverings. An industry standard can be a powerful tool in educating people, so I will quote from published standards here, and I recommend that you use these quotes to educate your staff and customers.

Moisture-vapour emission from a concrete slab is the author of a host of problems, including gaps, bubbles, bumps, peaking, cupping and other signs of adhesive failure.

First I would like to clarify some terminology related to concrete. For example, "a cement floor" is an incorrect term. Cement is one of the ingredients in concrete. It is a grey powder in the mix. Concrete is made of cement, sand, rocks and water, and other additives are sometimes a part of the mix.

Curing is the chemical reaction by which the cement paste (formed by cement powder and water) chemically bonds with the sand and the aggregate to make concrete. A common mistake is assuming "cured" means the concrete is ready for floor coverings. "Cured" is not "dry!"

Drying time before slabs are

ready for moisture testing will vary depending on atmospheric conditions and mix design. Once the approximately 28-day curing process is completed, the concrete starts to dry. Drying can take another six weeks, under ideal conditions, until the slab is ready for flooring — even longer when conditions are not ideal, which is more often than not.

Take a look at this: according to the flooring standard, "A four-inch-thick slab, allowed to dry from only one side… requires approximately 90 to 120 days to achieve a moisture vapour emission rate (MVER) of 3 lb/1000 sq.ft. per 24 hours.

That certainly is longer than most fast-track construction projects allow for, and it's even worse when you go upstairs to suspended slabs. There, the standard says, "Lightweight concrete, floors containing lightweight aggregate or excess water, and those that are allowed to dry from only one side, such as concrete on metal-deck construction, may need a much longer drying time." When does concrete start to dry? After curing, as soon as the building is enclosed with a roof and walls. If the slab is getting rained on, it's not drying!

Since so many large commercial projects are first-floor buildings, such as retail stores, slabs on grade are an important concern, and one of the most important questions to ask is, "Does the slab have a vapour retarder?"

The standard says, "The installation of a permanent, effective moisture vapour-retarder…is required under all on- or below-grade concrete floors ... Every concrete floor slab on- or below-grade to receive resilient flooring shall have a water vapour-retarder (often improperly called a vapour barrier) installed directly below the slab." These retarders are often left off of the project or are damaged during construction, so this is an important question.

Even in dry climates, there is always water vapour

moving from the ground to the sky, so the retarder is critical in keeping that vapour out of the flooring system. This is an important consideration in older buildings, especially where there was no floor covering installed before – such as a warehouse converted into office or retail space. Often these slabs were placed without a vapour retarder because they were designed to be bare concrete.

Curing compounds are another concern. New concrete needs to be kept moist for several days so the curing process can proceed, and in the old days wet burlap was used to keep the surface wet. That process has been largely replaced by sprayed-on, film-forming curing compounds. However, these compounds are not needed longer than a week or so, so if they are not removed the concrete may be damp for much longer than necessary.

In addition, some compounds are not compatible with floor-covering adhesives. According to the standard, "Concrete floors to receive resilient flooring shall be free of dust, solvent, paint, wax, oil, grease, residual adhesive, adhesive removers, sealers, coatings, finishes, *dirt, film-forming curing compounds, silicate penetrating curing compounds, hardening or parting compounds* (emphasis added), alkaline salts, excessive carbonation or laitance, mold, mildew, and other foreign materials which may affect the rate of moisture dissipation from the concrete or the adhesion of resilient flooring to the concrete."

If you're doing commercial work, asking such questions as when the slab began to dry, and about the presence of a vapour retarder or curing compound can help to establish whether the slab is ready for flooring, and will also give you some credibility with the rest of the construction team. The bottom line? Testing! In part two we'll cover six testing methods for moisture and which ones work! .

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When and how to test the slab

Concrete decision: Part 2

By Christopher Capobianco

In Part 1 of this three-part series, we talked about the terminology of concrete slabs and how important it is to ask questions to determine when the slab began to dry and about the presence of a vapor retarder or curing compound. The answers to these questions can help to establish whether or not the slab is ready for flooring. However, nothing will establish this more definitively than testing the slab for moisture.

When do you test?

Floor covering and adhesive manufacturers follow the North American Standard, ASTM F 710, *Standard Practice for Preparing Concrete Floors To Receive Resilient Flooring*, which says "All concrete slabs shall be tested for moisture regardless of age or grade level". That means you must test brand-new slabs or old ones, from the basement to the top floor. If the slab is not tested and the floor covering fails because of moisture, you can bet there will be a lot of finger pointing at the least, and legal action at the most.

Because this test measures moisture inside the slab, it can predict future moisture movement from inside the slab to the surface.

What method should be used? I am aware of six testing methods in use today, but not all of them are accurate or recommended. First is what I call "the senses test" to touch, see or smell the slab. I recently had an installer say he feels with his hand to tell if there is moisture, and I have also heard of using a visual inspection or smelling the slab to determine if it is damp. "Feels dry," "looks dry" or "smells dry" are not scientific methods, so the senses test is not a good way to go.

Second, the plastic-sheet test (a plastic sheet taped to the floor for a day or two), will show that a slab is damp, but not tell you how damp. The problem with the plastic-sheet test is that humidity in the air can affect this, so a passing result may not mean the slab is dry. I saw a laboratory test where a dry plastic-sheet test was right next to a calcium chloride test that read 13 pounds, which is way over the limit. I would not recommend the plastic-sheet test for this reason.

Third, we'd all love to be able to use a handheld moisture meter to get an instant answer about moisture. However, meters are not recognized by resilient flooring or adhesive manufacturers because they just provide a spot check. This method is potentially inaccurate and should not be used to make a decision about flooring installation.

ASTM F 1869, The Calcium Chloride Test Method, has been in use since the 1950s, and most, if not all, manufacturers in North America are still using this as the benchmark. If you use this method, it is important to follow the procedure carefully because this test is often done incorrectly. Most importantly, the heat or air conditioning must be on for two days before testing, and the surface of the concrete must be cleaned by a light grinding 24 hours before testing. These steps are often not followed, which means the results may not be accurate.

There is also some serious concern about the accuracy of the test itself. According to Howard Kanare, author of *Concrete Floors and Moisture*, "In the past decade, we have learned that the test can be unreliable; capable of producing both false high and low results; and dependent on ambient temperature and humidity, water-cement ratio, use of lightweight aggregate, the presence of curing compound, how hard a floor was troweled, and how the test site is prepared.

One of the main problems with the calcium chloride test is that it only measures moisture from the top 5 cm of the slab, and does not record moisture inside the slab. For this reason and concerns about the accuracy of the calcium chloride test method, ASTM has adopted two methods that ar new to North America, but have been in use in Europe for many years.

The Relative humidity or RH Probe Method (*ASTM F 2170, Standard*

Test Method for Determining Relative Humidity in Concrete Floor Slabs Using In Situ Probes) was approved in 2002, but "has been the preferred method for assessing concrete floor moisture conditions in a number of countries for many years," Kanare says. Because this test measures moisture inside the slab, it can predict future moisture movement from the inside of the slab to the surface and can be left in place so the location can easily be re-tested a week or a month later, or whenever necessary, without the waiting time needed for the calcium chloride test. This method is starting to be referred to more often in manufacturers' guidelines, and improvements are being made to the test equipment that will make this method easier and easier to use.

Finally, an even newer method in North America is the RH Hood Method known as ASTM F2420 *Standard Test Method for Determining Relative Humidity on the Surface of Concrete Floor Slabs Using Relative Humidity Probe Measurement and Insulated Hood.* This is still a very new method, so it has not yet started to make its way into manufacturers' installation instructions, but it may do so in the future. Like ASTM F 2170, this test also measures relative humidity, but on the surface instead of inside a hole in the concrete.

Training about concrete substrates and moisture testing procedures is available from schools using the Institute of Inspection, Cleaning and Restoration Certification (IICRC) *Introduction to Substrate/Subfloor Inspections* (ISSI) three-day course, including a 160-question exam. As more floors fail because of moisture, and more data points to the best ways to test for moisture, it is imperative the industry learn these methods and put them to use on every job.

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Part 3: Preventing and correcting moisture problems

It's all about the concrete

By Christopher Cappobianco

In Part One of this three-part series, we talked about the terminology of concrete slabs and how important it is to ask questions to determine when the slab began to dry and about the presence of a vapour retarder or curing compound. In Part Two we talked about the importance of testing the slab before installing floor coverings and which testing methods are recommended. In this final part of the series, we will address prevention of floor failures from moisture, and what corrective measures can be taken on slabs that are not ready to receive floor coverings.

Sadly, preventing moisture problems is often out of our hands as flooring professionals. We are often up against, "I have always done it this way and have never had a problem," and it is hard to educate in the face of resistance. However, construction schedules have become compressed, concrete slabs are being covered more quickly, more concrete is being pumped, vapour retarders are left out of the slab system and all of these factors can result in concrete that is not ready for a floor.

At the same time, flooring products in use today are of better quality, but are thought to be more impervious to moisture because they don't "breathe" as much. These include carpet tile with backings, high-quality resilient floor tile, sheet resilient flooring products and others. In addition, a lot of so-called natural products, such as linoleum, wood and cork, are being used, and these products themselves can react to moisture.

If the moisture test results are above the flooring manufacturers' allowable limits, there are a number of options.

Finally, although the topic is hotly debated, there is the theory out there that today's water-based adhesives are not as good at resisting moisture as the old solvent-based ones were, although there is a lot of proof to the contrary.

All of this adds up to more concern than ever about concrete and its relationship to the flooring products that cover it. Preventing problems is a process that everyone can get involved in if they want to, so schedules and materials can be adjusted to assure success.

Correcting moisture problems is a growing industry, and one that is very confusing. Before the conversation about corrective measures can continue, it needs to be established that the concrete you are using was tested under the right conditions following the test protocol to the letter. If not, the results are suspect, and the decisions made based on these results may not be the right ones.

If the moisture test results are above the flooring manufacturers' allowable limits, there are a number of options.

If this is a new concrete slab, one of the best ways to solve a moisture problem is to wait — a four letter word most people don't want to hear. However, it has been shown you can open up the pores of the concrete by abrading the surface, then get the air moving with fans, lower the humidity by turning on the air conditioning or cranking up the heat, and the drying time of a concrete slab can be accelerated. The closer you can get to about 70 F and 40 to 50 percent relative humidity, the better. Some companies even make equipment that will dry out the inside of a building. This equipment was designed to repair flood damage, but can also be used to dry out a floor. If there is time to do this, it is the best way, because you are not going to rely on a coating or some other layer on the floor.

In older slabs, the source of moisture may be external, coming from the ground through the concrete if there is no vapour retarder beneath the slab. This can happen any-

where, regardless of whether the building is in a damp climate or in the desert. Other common sources of moisture are landscaping, parking lots or downspouts on the outside of the building. Broken pipes or flooding on top of the slab, or a boiler room or unheated parking garage below the slab also can be sources of moisture intrusion. If sources such as these can be identified and corrected, then the moisture problem may be eliminated. This means all that needs to be done is to dry out the slab and install a new floor.

If waiting is not an option and there are no external sources of moisture, a careful exploration of corrective procedures can be undertaken. It is important that there be a team approach when making these decisions, so the owner, the architect, the builder, the flooring dealer and the flooring manufacturer are all involved. This keeps the lines of communication open and prevents the liability from falling on any one company. Hopefully, it is a good learning experience for everyone involved so there is more awareness of these conditions on future projects.

There are a variety of surface-applied vapour reduction systems on the market to be applied to the surface of a slab to reduce moisture vapour emissions. I use this term, although there are a lot of other terms out there such as moisture-control system, moisture barrier and sealer, moisture emission and alkalinity control, sealer-primer and concrete sealer. There are a lot of systems out there at a variety of prices, and the manufacturers make a variety of claims about what they will and won't do to solve your problem.

It is important that the product be matched both with the job site and with the flooring to be installed, so get the manufacturers of the system, the flooring and the adhesive involved. For example, if the flooring manufacturer recommends a calcium chloride test (ASTM F 1869) result under five pounds per 1000 square feet per 24 hours, and the readings are eight or less, a low-cost product rated to eight or 12 pounds may do the job. However, a more complex and expensive system may be needed if there are higher F 1869 readings, or concern over moisture inside the slab because of high RH Probe (ASTM F 2170) readings, or concern for ground water or vapour intrusion because of the lack of a vapour retarder beneath the slab.

When making these decisions, the manufacturer's reputation, track record, warranty and insurance coverage should be taken into account to be sure there is a solid warranty in place. The manufacturer can also be contacted directly to get its involvement and advice. Assuming the company is honest, it will say whether its product is right for your job. If it is the right product, the company should visit the site and stay with you through the process to help make sure the product is properly applied.

Some manufacturers have taken control of the process to the point of insisting on certified applicators that are factory trained.

Consult with the flooring manufacturer to be sure it agrees with the plan of action. Often, the vapour-reduction system is designed to be covered with a self-leveling underlayment or patching compound, so there is rarely an adhesive compatibility issue. However, some reduction systems require the use of a specific adhesive in order for the warranty to be in place. It is important to be sure it's the right adhesive for the flooring. Other systems are sold as "compatible with all flooring adhesives," but check with the flooring manufacturer to be sure, or install a test area. Finally, before applying any of these systems, the concrete has to be cleaned, which usually means bead blasting to assure penetration into the concrete and a firm bond to the surface. I don't have a lot of trust for products being sold that can just be painted on without significant preparation.

Corrective measures are a lot of work and a lot of expense, especially if they have to be done after a floor is installed. This is another good reason — maybe the best one — for testing the slab regardless of age or grade level, before the flooring is installed. If moisture issues are identified before the floor is installed, corrective measures are much simpler than they are after the floor is installed.

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