Understanding and Mitigating Moisture Issues in Concrete Slabs

Moisture Content of a Concrete Slab

Excessive moisture content in concrete slabs is a major cause of floor failures and problems in the floor coatings industry. We use three procedures to test for moisture.

1. Delmhorst BD-9 Moisture Tester. This test requires inserting probe tips into ¼-inch deep holes in the surface. It measures the resistance of the slab and displays the reading on a scale immediately. Through many years of testing, the industrial flooring industry has set the standard that the maximum allowable reading of 22 is acceptable for various coating applications.

2. Vaprecision Anhydrous Calcium Chloride Vapor Emission Tests. This test measures moisture present in the near surface region or top ¾ inches of the slab. It requires the use of a gram-weight scale with a gradation of $1/10^{th}$ (0.1) gram. The calcium chloride container is weighed before and after exposure to the concrete slab using the same weight scale for all measurements. These tests are conducted over a period of approximately 60-72 hours and measure the amount of moisture vapor emitted per 1,000 square feet of floor space per 24-hour period. This reading is expressed in pounds of vapor emission. A reading in excess of 3.5 pounds of moisture vapor is unsatisfactory for application of most floor coatings. This test design conforms to ASTM E-1907-04 and F-1869-04.

3. Tramex™ CRH Moisture Content and RH Reader. One of the most advanced Moisture and Relative Humidity meters for the flooring industry. This instrument measures moisture content, relative humidity, temperature and dew point in concrete flooring. Suitable for in-situ RH testing to ASTM F2170.02 and surface RH testing to ASTM 2420-05.

Moisture is always present in concrete slabs. The reason for testing is two-fold.

1. Determine the amount of moisture.
2. Determine how much pressure is continually migrating toward the slab surface.

To achieve accurate measurements for our recommended test methods, it is recommended that the floor temperature to be at a minimum of 65° F for several weeks prior to testing or application. This is especially important during new construction projects. There are several reasons for this. The most important is that vapor migration is controlled by static vapor pressure. The higher the temperature, combined with low humidity, the greater increase in the rate of vapor migration out of the slab after the initial 30 days of curing time after placement of the slab. Depending on the amount of excess water in the concrete slab, it can take over 30 days per inch (or 180 days for a 6-inch slab) to dry to a level acceptable for floor toppings. Therefore, it is important to achieve a climate-controlled atmosphere as early as possible during construction projects.

Moisture problems can be very deceiving. Sometimes there are no visible means of detecting them. Our years of experience in the concrete floor resurfacing industry, successfully coating millions of square feet, has proven time and again the importance of proper testing.

Moisture Vapor Transmission Facts

Moisture vapor transmission is the movement of moisture vapor from the substrate to the surface of the concrete slab. Some obvious signs of excessive vapor transmission are:

- Bubbled coatings or toppings
- Soft or re-emulsified adhesives
- Curled or cracked tile floors
- Carpets that mold and mildew
- Wood floors that buckle or warp

Other signs are less obvious. These include peeling floor toppings and adhesives that have a profile on the back side but no concrete residue, or coatings that have excessive amounts of concrete residue or a fine powder-like substance. The cause of these failures is attributed to the moisture migrating or wicking the alkaline salts and contaminants to the surface of the concrete. The accumulation of salts will lead to an increase in alkalinity at the surface causing the coating to lose its ability to bond. Chemical contaminants will have the same effect.

Newly placed concrete slabs can require as long as four weeks of curing time per inch of slab thickness just to evaporate the excess water used during placement. This does not include any residual moisture contained in backfill or sub-grade materials. These conditions can greatly impact on-time completion of Fast Track© construction projects.

There are many contributing factors to this situation. First and foremost, moisture is always present in a concrete slab. Problems only arise when this becomes excessive. Irrigation, broken drain pipes, and broken water pipes are the easiest and least expensive to correct. Hydrostatic pressure, seasonal high water tables, osmotic action, capillary action of water through backfill material, punctured vapor barriers and Fast Track© construction projects are considered to be the major contributing factors today. By definition, sources of water vapor transmission fall into three categories:

- Osmotic movement is the natural release of water vapor from the soil.
- Capillary action is the wicking action of water through the bleed water channels in the cured concrete. This usually occurs when the concrete is in direct contact with wet soil or water.
- Hydrostatic pressure describes when water is actually being pushed through the concrete slab. Hydrostatic pressure is actually a very rare problem, but the term has been used inadvertently to describe all water problems.

Vapor Barrier for New Concrete

A vapor barrier, properly installed during construction, can alleviate moisture related issues. These vapor barriers are recommended to be installed above or below a granular backfill. Some prefer the barrier to be placed on top of the backfill and below the granular backfill. This allows the granular backfill to be placed and compacted on the vapor retarder to prevent the retarder from being punctured while placing the re-bar and the concrete slab. Another benefit that aids in the proper curing of the slab is that the granular fill will allow another avenue of escape for the excess water from the concrete during the curing process, therefore, helping to minimize slab curling.

The movement of moisture to the surface of a concrete slab is referred to as “static vapor pressure”, similar to barometric pressure. Below a concrete slab, the average temperature is 55° F with a relative humidity of 100%. This equals a 0.214 reading of static vapor pressure. Generally, when static vapor pressure values above the slab are lower than 0.214, the moisture vapor will be drawn out of the surface of the slab.

Moisture Vapor Emission is an issue that can be dealt with in a positive manner through the use of proper testing and remediation methods. Although, the root cause of the problem is difficult, if not impossible, to pinpoint, there are products and methods that deal with Vapor Transmission.

Products We Use to Mitigate Moisture Vapor Emission

Addressing this important issue, we use Sika® and KØSTER moisture vapor transmission products that are fully compatible with decorative and industrial floor and coating systems. These products reduce moisture vapor pressure emission rates to an acceptable level. The standard moisture vapor emission rate (MVER) is three (3) pounds per 1,000 square feet in a 24-hour time frame, as measured according to standardized tests.

- **KØSTER American VAP1® 2000 FS –** 100% solids, epoxy-based moisture vapor reduction system. It is VOC compliant, moisture and pH resistant, and can block moisture vapor emissions from coming through a concrete slab (on or below grade) from up to 25 lbs/1000 SF/24 hrs and can reduce levels to below the 3 lbs/1000 SF/24 hrs threshold established by modern flooring systems. This product cures in 4 hours and is designed for Fast Track Construction projects.

- **SIKA® Fast Track Primer** – Waterborne epoxy primer that can be used as a moisture vapor treatment or as a green concrete primer. Capable of reducing water vapor emissions from as high as 8 pounds to below the acceptable level of 3 pounds/1,000 ft²/24-hours in a single coat.

- **SIKA® Vapor Block** – Zero VOC, waterborne, self leveling and trowelable vapor pressure reduction product with the versatility to handle a wide range of moisture vapor transmission levels. Significantly increases the impact of resistance of a flooring system.

Source Reference
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Concrete Repair Bulletin Jan/Feb 2006
Peter Craig
http://www.icri.org/publications/2006/PDFs/janfeb06/CRBJanFeb06_Craig.pdf