CrownTech™ - Technical Bulletin No. 6

Moisture Mitigation Negative Side Moisture Barrier

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INTRODUCTION

Crown Polymers wants each installation to be a success for the Installer, Specifier and most importantly for the facility Owner. The information in each CrownTech™ Technical Bulletin is intended to provide accurate data to assist the Contractor in making the best informed decision.

EFFECTIVE MOISTURE BARRIERS

- American Concrete Institute, ACI 302.2R Guide for Concrete Slabs that Receive Moisture-Sensitive Flooring Materials points out that delamination, blistering, staining, mold growth, and other problems related to moisture intrusion. It provides recommended installation and performance standards for Crown Polymers moisture-sensitive flooring placed on concrete slabs on grade and suspended concrete slabs.
- Currently Crown Polymers Installers, Specifiers, Concrete Contractors, and Concrete Producers want to solve these problems. The moisture induced problems include lawsuits for total failure of the flooring system, construction-schedule delays and indoor air quality.

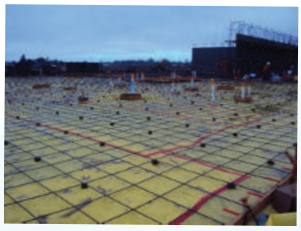
The objective of the ACI 302.2R document is to reduce the potential for moisture-related problems by providing basic information on the concrete drying process, moisture behavior in concrete, testing for pH and moisture, and vapor retarders/barriers.

- Effective positive side moisture vapor barriers must meet ACI 302.2R, for which requirements are set forth in the standard. The barrier must be placed on top of the earth or engineered fill and be in direct contact with the concrete, per Figure 2 below.

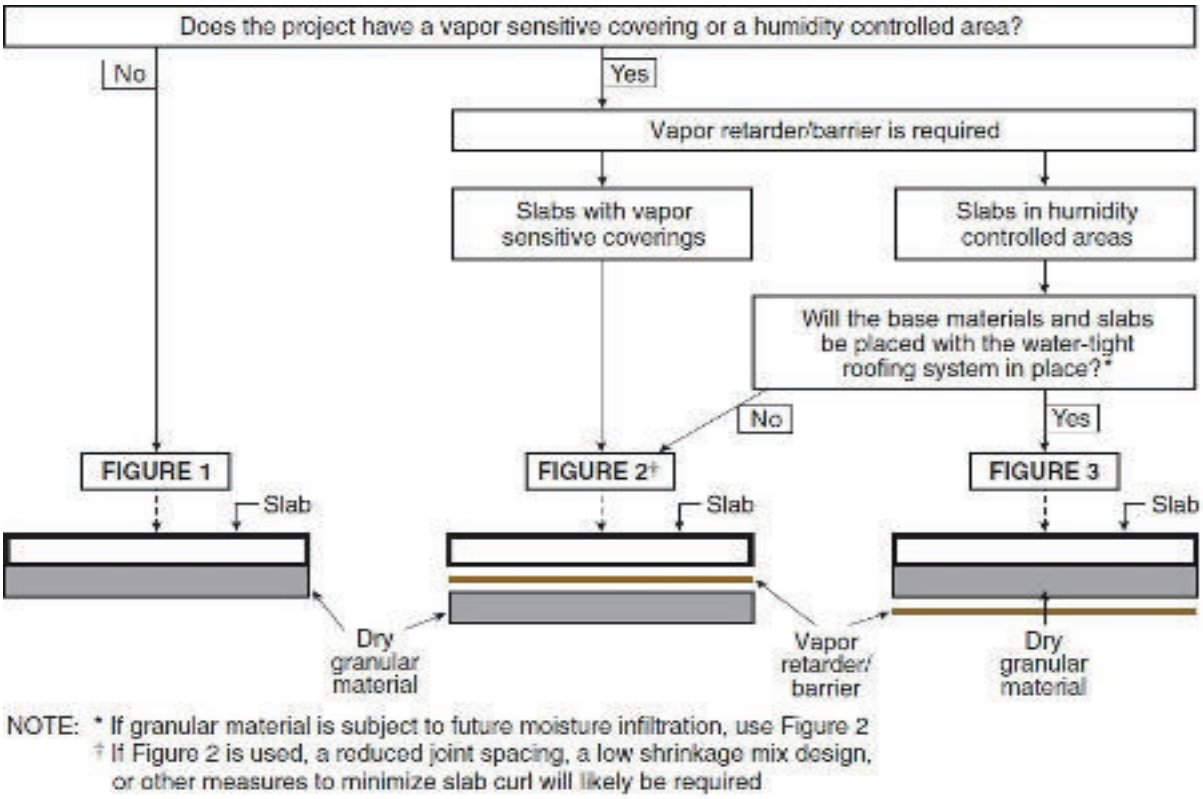
- Some concrete experts falsely believed that if a positive side vapor retarder was specified, it would be better to have an intervening layer of compacted granular material on top of the positive vapor retarder and directly under the concrete. Their thinking was that this blotter layer or engineered fill would absorb some of the concrete water of convenience and reduce shrinkage, cracking and curling. Moisture experts today believe that using this engineered fill atop the positive side moisture barrier directly under the concrete slab is not advisable because it will become water saturated and act as a water reservoir contributing to future moisture problems.

- ASTM E1745 Standard Specification for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs

- ASTM E1643 Standard Practice for Selection, Design, Installation, and Inspection of Water Vapor Retarders Used in Contact with Earth or Granular Fill Under Concrete Slabs



Positive Side Moisture Barrier Recommended (ACI 302.1R and ACI 302.2R)



ABSENCE OF A MOISTURE BARRIER

The absence of a positive side moisture barrier or an ineffective positive side moisture barrier means that the concrete slab on grade can absorb and transfer moisture through concrete that may be deleterious to the impervious or low permeable flooring placed upon the concrete.

ASTM F1869

ASTM F1869 Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride. The test was first developed by the Rubber Manufacturer's Association in the early 1960's. Performing this test requires that the concrete surface be diamond ground. If the concrete was covered by a flooring product a 24 hour waiting period is required before the test is started.

A plastic dish containing anhydrous calcium chloride is weighed and placed on the freshly ground concrete. The dish is covered with a plastic dome and sealed to the floor. After 60-72 hours, the dome is removed, the dish reweighed and the weight gain is calculated. Calcium chloride is a desiccant and absorbs moisture from the concrete, increasing the weight of calcium chloride in the dish. The weight gain is expressed in pounds of moisture emitted from 1,000 Sqft in a 24 hour period. Safe levels of moisture vary from 3 to 10 pounds depending upon the type of flooring and the manufacturer's recommendation.

The calcium chloride test requires that the building be climatized to +/- 5 degrees Fahrenheit the anticipated service conditions for 48 hours prior to testing. The windows, doors and roof must be in place with the HVAC operating. After 48 hours a relative state of equilibrium will exist with the concrete moisture and the environment above the concrete slab. When the building becomes climatized, cooler, drier air on top of the concrete slab can draw moisture out of the concrete slab and higher test readings may result. If the test is done in an "open air" or if the area is not acclimatized, it is invalid.

ASTM F2170

ASTM F2170 Standard Test Method for Determining Relative Humidity in Concrete Floor Concrete Slabs Using in situ Probes. The test is a more destructive test requiring holes to be drilled into the concrete slab at specified depths and fitted liner probe which is inserted to the bottom of the hole. The liners are capped and allowed to equilibrate for 24 hours before being read with a special "reader" that reads the relative humidity and the internal temperature of concrete. The readings are taken at 40% of the concrete slab depth on grade and at 20% of the concrete slab depth for elevated concrete slabs that can freely breathe top and bottom. The readings will be representative of the level of moisture that the flooring will be exposed to after the concrete slab is covered and a new equilibrium is reached. Acceptable levels of relative humidity within the concrete slab usually range from 75%-85% depending upon the type of flooring installed and the manufacturer's recommendation.

Because the relative humidity probe testing is done within the concrete slab, it is much less susceptible to atmospheric conditions above the concrete slab than the calcium chloride test. For this reason, it is more useful in determining moisture levels in non-climatized areas. Keep in mind that non-climatized areas are not supported by ASTM F2170, which requires that the area be acclimatized. If the test is done in an "open air" or if the area is not acclimatized, it is invalid.

MOISTURE VAPOR TRANSMISSION

Actual MVT (Moisture Vapor Transmission) is tested per ASTM F1869 and the Potential MVT is tested per ASTM F2170. MVT is the natural migration of gaseous water from a high moisture source to an environment with a lower concentration of moisture, such as the relationship between the subgrade soil and the concrete slab on grade immediately above. MVT induced flooring problems are estimated to cost the construction industry and facility owners millions of dollars a year.

Blisters before Failure

Failure

In the example of a concrete slab on grade, water migrates into the concrete usually from underneath in a gaseous or liquid state. The moisture migrates to the top surface of the concrete through capillary pores within the concrete matrix. If the top surface of the concrete is sealed with an impervious flooring system, the moisture vapor cannot pass through the floor. As pressure builds under the flooring system, the flooring adhesive, or both, they may either lose bond or separate cohesively, resulting in a flooring failure.

MVT is relatively simple to understand, since it is the movement of gaseous moisture from areas of "high to low" concentration, as it attempts to reach a homeostasis within its overall environment. When the humidity in the concrete slab is higher than the humidity in the air above the surface of the concrete, water vapor will migrate to the surface, as a gas. If an impervious flooring system or adhesive prevents the moisture from passing through, the moisture content (humidity) will become the same at all levels.

The maximum vapor pressure that can be developed from differences in humidity is less than 2 psi. Therefore, the only time this condition could be significant is before the flooring system cures, prior to development of an affective bond, since 2 psi is never enough to induce failure of a well-bonded system. However, if the slab becomes moisture saturated, because of ground humidity or liquid water, directly under the concrete and impervious flooring system it will be constantly exposed to moisture. In most flooring systems, this can result in excessive moisture absorption at the bondline that will result in softening and swelling resulting in destruction of the bond.

ASR (alkali silica reaction): Silica aggregate within the concrete reacts with other minerals in the concrete, resulting in the progressive degradation of the silica aggregate into an expansive silica gel. The gel is expansive, and some believe it can create pressure. The pressure builds and the moisture within the concrete is put into compression, which can lead to condensed moisture (liquid) at the bondline, causing blistering or buckling of the flooring system. ASR usually starts underneath and progresses through time to the surface.

Alkalinity pH problems are often noticeable as a white efflorescent powder. This residue is carried in the aqueous solution migrating to the surface. After evaporation of the water a salty deposit is left on the substrate and is usually concentrated at the joints, depressions, cracks or seams. It is a sign that excessive moisture is present.

Moisture in liquid form is drawn from its source through the capillaries to a drier environment. The capillaries in concrete are pores formed by the out-migration of excess water (not required for the hydration of cement) of the concrete during its cure. Water is drawn into and upward by capillary action into the concrete and becomes a vapor when it sees an atmosphere of less than 100% humidity.

MVT PROBLEM

The transmission of moisture vapor into the concrete substrate can wreak havoc on impervious and non-impervious flooring surfaces, including wood, vinyl, tile, urethane, epoxy and adhered carpet flooring materials. MVT can also induce rot, efflorescent residue, provide an aqueous nutrition solution for microorganisms to flourish and other deleterious problems with breathable flooring systems, such as carpet or wood.

Excessive MVT can lead to the disbondment of impervious flooring systems, as well as providing moisture for undesirable bacteria, mold, mildew and associated odors from decomposition.

Moisture that migrates into or through the concrete substrate is never the flooring contractor's or material suppliers water problem (unless specifically assigned contractually), because it is not their water. However, if there is disbondment or water damage to the flooring system it will lead to dissatisfaction of the owner and specifier. As a courtesy to the owner, the specifier should include in the general contractor's specification, proper testing for the presence of MVT by an independent testing firm. It can be argued that the manufacturer should not sell

a flooring system that will not retain bond on a saturated concrete slab, if it is known that saturation is a possibility, but that is not the case.

MVT is a major problem for owners, specifiers, contractors and formulators, because it is reported to cause millions of dollars in damage a year in both new and existing construction projects. MVT can compromise even the most meticulously installed imperious flooring system resulting in blistering, pin holing, chipping and pitting, adhesive reversion, cracking and heaving. These failures are not only costly to repair, they often create unsafe working conditions and they can damage the reputation of the specifier, manufacturer and contractor.

HEALTH

The most obvious potential health problem is seen as a tripping obstacle. Other problems associated with moisture vapor transmission are not as obvious, nor are they easily measurable. For instance, moisture migration has been identified as a major factor contributing to Sick Building Syndrome. This is an indoor air quality condition in which building occupants experience acute health problems attributed to time spent in the building. Bacteria, mold and mildew levels are attributed to the available moisture and "food stuffs" available, they can become airborne and are breathed in or ingested by the occupants. In addition, these airborne microorganisms can redeposit throughout the building, including in the HVAC system and computer systems. They may also function as unwanted airborne intruders in scientific experiments.

MVT related problems have escalated due to a number of reasons. These include fast track construction, the use of vascular lightweight aggregates, tighter building envelopes, EPA and AQMD restrictions, land limits, resulting in building on marginal lands with correspondingly high availability of water, and changes in concrete mix designs. All contribute to the increased incidence of moisture vapor transmission induced failures.

CONTROLLING MVT

Several MVT technologies are offered in the industry to control moisture migration and eliminate the associated problems. Advances in raw materials technology and proprietary formulations allow suppliers to guarantee MVT related problems would be non-existent under most in service conditions. By controlling the rate of the moisture being transmitted from high pressure to low pressure areas, or by eliminating the moisture flow completely, moisture vapor transmission related problems can be neutralized.

IMPERMEABLE

The impermeable non-breathable technologies primers stop the excessive flow of moisture. This moisture mitigation product can be used under most of the epoxy and urethane non-breathing systems, as well as other flooring surfacing (wood, vinyl, tile and carpet). The technologies are usually guaranteed to eliminate MVER (moisture vapor emission rates) up to 15 to 20 lbs/1000 sq/ft 24 hours per ASTM F1869.

MVT SOLUTION

Crown Polymers offers an advanced vapor control solution that eliminates the moisture flow and provides an effective negative side barrier against constant moisture, extreme alkalinity and high moisture vapor emissions pressure.

CrownShield MVB No. 8303

Crown Polymers Moisture Barrier Primer is CrownShield MVB No. 8303, which can handle (ASTM F1869) 25 lbs. per 1000 Sqft per 24 hours and (ASTM F2170) 100% relative humidity. The negative side moisture barrier primer is impervious and is designed to deeply penetrate the concrete substrate. It is intended to prevent moisture and moisture vapor gases from penetration of the barrier.

CrownPrime No. 8201

CrownPrime WB Low Viscosity Epoxy Primer & Coating No. 8201 is designed to be used with CrownShield No. 8303 when contaminates may not have been removed when the concrete surface preparation occurs. Use the primer if the concrete has been or is suspected of having been previously exposed to concrete curing agents or concrete densifiers, such as, sodium silicate, potassium silicate, lithium silicate or other contaminates.

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