INDUSTRIAL FLOOR COATINGS

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WATER, WATER EVERYWHERE

The problem with moisture in concrete

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Where there is concrete, there is water. Concrete’s strength, durability, and ability to be molded make it the most widely used construction material in the world and these properties exist only through its relationship with water.

The chemical union of water and cement (hydration) combined with aggregate causes the setting, hardening, and strength of concrete. Throughout every state of mixing, curing and existence, water is necessary. The alkaline by-products of cement hydration in concrete are water loving, or hydrophilic.

In typical construction, only half of the water used in a mix is necessary for the hydration of cement. The excess moisture provides workability and migrates to the surface after the pour.

The migration of this water forms tiny pores in the concrete as it rises, and, thus develops concrete’s permeability.

Concrete, as we know, must remain in a relatively moist condition during the generally accepted 28 day curing period, and retention of moisture is necessary for continuing strength gain. The aggregates in concrete are hygroscopic; therefore, the concrete will always contain some moisture to maintain a balance with the moisture in the atmosphere.

But after the initial 28-day cure, the continuing contact with water can ironically become the onset of concrete’s destruction. The strength giving moisture cannot be allowed to continue migrating freely through the concrete. The movement of water, not its existence, is what causes water damage.

Precipitation and high humidity will frequently build moisture to an excess which continually travels through the pores of the concrete. This eventually will cause a leaching or dissolving out of the calcium compounds and increase the introduction of corrosive chemicals.

As more solids are dissolved, the concrete becomes even more permeable and thus more susceptible to further leaching.

It is at this point where our knowledge becomes less precise.

Literature about moisture related problems in concrete are sparse and exist primarily in the form of preliminary research reports.

A general understanding of moisture related problems have been severely inhibited by a lack of common terminology and knowledge of concrete chemistry. Before standards can be set and problems identified and corrected, a consensus must be reached about what to call the problem. Communicating an idea successfully is difficult, if not impossible, without a common language.

Controlling the movement of water through concrete is often the objective of those in the maintenance and repair industry.

The demand exists for those who can manipulate the water, for those who can work around it, and for those who can repair its damage.

Bob Higgins, Vice President for Sinak Corporation, wrote "Waterproofing Reference & Guide for Concrete" in 1985 after researching and working with moisture and waterproofing systems for nine years.

Higgins said that the amount of time, money, and materials that are wasted each day due to a lack of knowledge and misuse of terms is "unimaginable". A chemist who has worked in the construction industry since 1972, he stresses the importance of labeling and identifying the problems specifically and appropriately, instead of lumping them together and attempting to deal with each of them in the same manner.

Moisture Related Problems

Moisture related problems in concrete construction are indeed a difficult topic to research and explain. I hope that a layperson’s use of the terminology does not over-simplify the problems.

The four common types of moisture related problems are hydrostatic conditions, capillarity, vapor emissions, and out gassing.

Hydrostatic Conditions: Hydrostatic deals with the behavior of liquids at rest. One of the principles states, "The amount of pressure caused by the weight of a column of fluid is determined by the height of the column, not the number of gallons, cubic feet, surface area, or shape. The weight of the water causes the pressure.

Hydrostatic pressure is caused by a build up or measurable depth of water that exerts its force against a concrete structure and causes leakage, usually in below grade or water containment. A column of saturated soil may produce the same results as a column of water.

Hydrostatic pressure can literally push water through concrete. Water is essentially an incompressible liquid and will seek the path of least resistance. Flaws or cracks in the concrete will become convenient avenues of leakage.

Other moisture problems, those in on-grade concrete, are often and mistakenly attributed to hydrostatic pressure, but seldom is the moisture in on-grade concrete caused by a distinct water source exerting pressure.

Common Types In On-Grade Indoor Concrete

Capillarity: Moisture due to capillary action comes from a distinct, but relatively sedentary water source. It is not forced through the concrete, but pulled from the soil by the attraction created by a liquid’s contact with porous matter containing hair-like openings.

The absence of head force makes the distinction between a hydrostatic condition and capillary action.

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Capillary action is often referred to incorrectly as vapor emissions. It should be noted that capillary movement, unlike vapor, does not necessarily have to be in an upward direction, but can be horizontal or even downward.

Water in liquid, not vapor form, is attracted by warm concrete from the cool soil, usually at the edges of the slab. It seeks the warmer and drier concrete and can move laterally from the sides to the center of the slab. The warmer the concrete, the greater the attraction.

Physical evidence of the capillary action can take the same form as vapor that condenses on top of a concrete slab under a cover, a coating, or some other object. Other obvious symptoms of capillary action can be efflorescence (the same leaching of the soluble calcium compounds discussed earlier), blistering or peeling coatings, de-bonding, and de-lamination of coverings.

Although capillary action under normal conditions will not cause the degree of structural damage caused by hydrostatic pressure, it is usually quite difficult to remedy.

Many times, a moisture membrane under a concrete foundation may eliminate capillary action, but tearing and puncturing of the membrane during typical construction practices will render a membrane merely a temporary solution.

Vapor Emissions: Much confusion exists about the differences between capillary action and vapor emissions. Both become problematic to floor coaters in the form of blistering and peeling. The primary difference is that vapor emissions is water in a gaseous state or water vapor. Also, its emission into the environment is a natural occurrence and does not necessarily originate from a distinct, tangible water source. Another difference is that water vapor is not detectable by traditional moisture tests. If a contractor using traditional methods tests for water and receives a negative reading, he can only conclude that capillary action will not cause the coating he intends to install to blister and peel.

But only calcium chloride moisture detection kits will give a reading on vapor content, which will indeed cause a non-breathing covering to blister and peel. The commonly used mat test cannot measure emission levels and should only be used as an indicator to determine if a problem exists.

Unlike the previously discussed conditions, vapor emissions will not become problematic until its natural path is blocked. Just as the concrete's continuing contact with water is necessary for strength gain, its ability to breath and release the moisture into the environment is necessary.

Moisture release in vapor form is the least destructive of all moisture-related problems if those who coat or cover floors are aware of its presence and do not attempt to trap it below an impervious surface.

Out gassing: Out gassing in regards to moisture also surfaces in the form of blisters in floor coatings, but unlike vapor emissions, out gassing is a temporary condition usually occurring during installation.

Out gassing is caused when components of the coating, usually in urethanes and methylmethacrylates, are incompatible with moisture in the concrete. The chemical reaction takes place and the moisture, now in a gaseous form, rises to the top of the slab and becomes trapped beneath or may even react with the new covering.

One way to lessen the effects of the chemical reaction is to install the coating when the concrete is cooling and the water molecules are less active. In the warm seasons, daytime temperatures rise rapidly, and as the temperature of the concrete increases, the water molecules become active and move rapidly.

Installers should avoid any attempt to install a coating when the molecules of water are at their peak of activity (while the temperature is still rising). The activity serves merely as a catalyst to the out gassing.

Counteracting the effects of water is more complex than one with a passing knowledge might realize.

Obviously, moisture related problems manifest not only as blisters. Eighty to ninety percent of all construction claims involve some form of moisture related damage.

Considering the time and money that could be saved, the relationship between concrete and water should not only be more clearly defined, but also should be approached with a certain amount of respect.***Sections of text reprinted by permission of Sinak Corporation**

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