PRINCIPLES OF WATER VAPOR TRANSMISSION

The Basics - In order to understand the basic principals of any technology it is important to understand the terminology. Cement and concrete are two entirely different things yet many times are incorrectly used interchangeably. Cement is the powdered raw form. Cement mixed with sand and aggregates is concrete. Cement mixed with sand and clay is referred to as stucco for exterior use, yet, is called plaster for interior or swimming pool use. A wet, high-pressure air applied mix is called shotcrete. However a dry, high-pressure air applied mix is called gunite. The basically same mixture is also referred to as mortar in masonry block and brickwork. If you dilute this same mixture with more water into a flowable form, it is called grout. Even though all of these terms are distinctly different, depending on the application, the actual chemical process that takes place, and the principles that apply, when cement is mixed with water and aggregates, are the same. Therefore, take the time to understand the basics of concrete; it could be invaluable in the future.

Water - Water comes in three different forms: A liquid (water), a vapor (humidity), and a solid (ice).

Waterproof - Waterproof concrete is concrete, which is impervious or unaffected by water or prevents the penetration of water. The term “waterproof” is frequently used inaccurately with regards to flooring materials. Waterproof concrete or waterproofing concrete does not stop water vapor movement. Concrete must be “vaporproof” with the application of flooring materials and surface coatings.

Vaporproof - Vaporproof concrete restricts or prevents the passage of water vapor. Waterproof concrete is not necessarily vaporproof but vaporproof concrete is always waterproof.

Water Vapor - Water vapor moves much faster and much more readily through concrete than water. Waterproof concrete does not stop water vapor. Water will not move through waterproof concrete, water vapor will. Additionally, when water vapor reaches the dew point under flooring materials it condenses becoming water. Therefore, to waterproof concrete is not the issue with regard to paints, coatings or flooring materials, the issue is to make concrete vapor proof and it will be inherently waterproof.

Moisture Vapor, Moisture Vapor Emissions - Moisture Vapor and Moisture Vapor Emissions are terminologies that the flooring industry uses to define water vapor. Moisture vapor emissions are the direct result of a number of factors. While irrelevant as to the cause or source, moisture vapor emissions in concrete which are higher than the flooring industry’s maximum allowable levels will cause flooring installations to fail.

Water Cement Ratio - This property is the most important factor in producing quality concrete. The water to cement ratio of concrete is simply the weight of the water divided by the weight of cement. At placement of the slab the water-cement ratio directly affects permeability and the time it takes before flooring materials can be installed.

The water to the cement ratio is relative to the local aggregates and sand available. Porous aggregates will require higher water to cement ratios to achieve a workable slump. Denser aggregates, being less absorptive, will require lower water to cement ratios to maintain a given

slump. The resulting concrete, with porous aggregates and a higher water to cement ratio, will naturally have greater permeability due to a higher percentage of interconnecting capillary voids.

Slump - Slump is measured with a slump cone. A slump cone is an inverted cone, 12" tall and open on both ends. The top is 4" wide and the bottom 8" wide. Fresh concrete is placed in the cone and "rodded" with a steel rod to compact the concrete. The cone is removed and placed next to the pile of concrete. The difference between the top of the slump cone and the top of fresh concrete is the slump. More flowable concrete is said to have a higher slump.

Hydrating Free Mix Water - Hydrating free mix water is the excess concrete mix water outflow from new concrete. In actual field conditions, new concrete construction may take five years or more, depending on the water to cement ratio of the concrete, for this free water to completely hydrate based on Portland Cement Association Research. Flooring cannot be installed when there is the presence of this water vapor outflow (hydrating free mix water).

Capillaries - Capillaries form within concrete in direct relationship to the water to cement ratio, the higher the water-cement ratio (more water) the greater volume of interconnecting capillaries, producing a more porous concrete making concrete inherently weaker.

Permeability - Concrete by its very nature is permeable. The interconnecting capillaries formed when concrete cures provides the perfect medium for water vapor transmission. The free mix water necessary for the placement of concrete is much higher than is necessary for the complete hydration of concrete. It is the process of the hydrating cement and the curing of concrete that forms these weakness planes and permeability.

Capillary Action - Capillary action (wicking action) attracts moisture from the soil through the interconnecting capillaries in the concrete slab. Moisture within the slab tries to evaporate into the room. Water vapor driven by vapor pressure, at room temperature, will condense at the dew point under impermeable flooring materials and will emulsify the adhesive. If the slab is in an expansive clay or high sulfate soil condition the moisture may also bring with it soluble alkalis which will further attack the adhesive.

Hydrostatic - Hydrostatic water pressure is the pressure caused from elevated adjacent source of water such as landscaping. Higher landscaping saturates the soil at the foundation slab and provides a continuous source of water. Additionally, this water may take the form of perking free water moving up through any existing cracks in the slab causing flooring failures.

Curing - Curing is a process which maintains the proper internal moisture level in concrete. The one significant variable which directly effects permeability, quality and the ultimate strength properties of concrete is curing. Prolonged and thorough moist curing is the most significant factor in producing waterproof and watertight, high quality, high strength concrete. One form of prolonged moist curing is to apply moist burlap to the concrete surface continually keeping it moist for a period of 28 days. Research shows that concrete continuously moist cured for a period of 28 days resulted in compressive strengths exceeding 4,500 psi. Yet, the same concrete air cured for the same period achieved only 2,550 psi. Furthermore, the compressive strengths at 180 days were actually lower

for the air cured concrete, 2,500 psi, where the continuously moisture cured concrete achieved an ultimate compressive strength of over 5,750 psi.

Enhancing the Moist Curing Process - Although prolonged and thorough moist curing produces concrete far superior in all aspects over air cured concrete, prolonged moist curing cannot produce concrete which prevents water vapor transmission. Interconnecting capillaries are formed in the cement hydration process. Slow, moist curing is the most significant factor in producing high quality, high strength, waterproof and watertight concrete yet without an enhancement to this curing process it is impossible to produce concrete which is impermeable to water vapor transmission.

MOXIE Chemically Reactive Products - MOXIE Chemically Reactive Products, MOXIE 1800 SUPER-ADMIX, MOXIE 1500 Concrete Sealer, MOXIE 1600 Cleaner Sealer and MOXIE Flooring Sealant II (MFSII) are ready-to-use, non-toxic, clear, and odorless, with specifically engineered and formulated compounds, a complex catalytic agent and active enzymes. These complex, hydrous silica, pozzolanic compounds react in a time-released fashion, depending on their specific application, prior to, during, or/and after hydration with the calcium hydroxides and by-products of hydration to form additional cementitious (cement-like) materials. This conversion of all available calcium hydroxides (free lime) into insoluble calcium silicates eliminates potential efflorescence. During this period the controlled loss of water slowly moist cures the concrete. The additional cementitious materials by their very chemical and physical nature produce concrete and portland cement based applications with a much higher density and surface hardness, a dramatic increase in bond, flexural, tensile and compression strength while achieving a near-zero capillary void state.

MOXIE 1800 SUPER-ADMIX - Enhances the curing process. The initial phase of chemical reactions create colloidal gels prior to initial set, instead of the typical bleed water, which prevents internal segregation and settling of the concrete components, and after initial set allows for immediate or almost immediate finishing. At initial surface set the gel-like characteristics of the concrete provide the properties of a thermal barrier restricting rapid evaporation of the surface water which prevents shrinkage and slab curl, and reduces or eliminates plastic cracks. These colloidal gels also protect the reinforcing steel from internal corrosion and ultimately form additional cementitious materials that provide further protection from externally caused corrosion.

During the critical three to seven day period after placement, and throughout the process of hydration, the thermal barrier properties continue to compensate for shrinkage by creating a stable and controlled environment which conserves the heat generated by hydration in low ambient temperatures and reduces the amount of heat absorption in high ambient temperatures. Therefore this thermal barrier, to a great extent, is able to compensate for variations in temperature, wind, and extended or even temporary zero mix times as a result of equipment failure. However, maximum performance would always be achieved when the standard safeguards and precautions are taken.

After cement hydration process is complete, at the 28-day period, the final stages of the initial phase take place and these colloidal gels react with what would usually be the remaining by-products of hydration and the free mix water to form the last of the cementitious materials. This timed-release process takes approximately an additional 31 days to complete its initial phase and the continuing process becomes complete when all the calcium hydroxides and by-products of hydration have formed additional cementitious (cement-like) materials. A process which takes place

prior to, during, as well as after the final stages of cement hydration will produce the maximum performance, increase in strength and decrease in permeability, for the given mix design.

The absence of interconnecting capillary voids also means that excess free mix water, typically present after hydration of the cement, would be eliminated, reducing the internal free humidity to a level that no corrosion can take place. It takes approximately 850 days, under controlled laboratory conditions, for the internal humidity of standard concrete to reach a point where it no longer corrodes the reinforcing steel. If unprotected during this period of time corrosive expansion of the reinforcing steel has already taken place, creating pressure and the onset of structural cracks.

Using the problem to provide a solution - MOXIE Chemically Reactive Products, MOXIE 1800 SUPER-ADMIX, MOXIE 1500 Concrete Sealer, MOXIE 1600 Cleaner Sealer and MOXIE Flooring Sealant II (MFSII), use the concrete's internal moisture to provide a solution to water vapor problems.

With MOXIE 1800 SUPER-ADMIX, the concrete moisture is used to provide the proper, prolonged, slow, moist curing which enhances, improves, and provides a portland cement based material which is impervious to the transmission of water and water vapor, as well as other contaminants such as oil, petroleum and acids.

MOXIE, topically applied, Chemically Reactive Sealers use the moisture within the concrete, whether it may be hydrating free mix water or moisture migration, to stop further moisture problems.

Conclusion - It is our purpose is to provide the architect, engineer, specifier, contractor, owner, or concrete professional, the most up-to-date concrete technologies, cost effective solutions, as well as continuing education on the processes, principals, physics and differences between waterproof concrete and vaporproof concrete relative to flooring, surface treatments and coatings.

For the concrete construction professional seeking answers, the consumer looking for a solution, an individual interested in concrete and its many facets, or the engineering student looking for all they can possibly find out about concrete, we hope this information will provide some of those answers.