ALPHA MIX & PERMEABILITY

Permeability in concrete is responsible for whether pollutants or contaminants are allowed to penetrate inside its interior. Degree of permeability dictates whether these pollutants. Contaminants are readily, or sparingly, allowed ingress therefore, permeability, as well as degree of permeability, effectively and directly affects a concrete's durability, translating to useful lifespan.

Concrete permeability is of critical interest because the integrity disintegration deterioration of concrete is usually caused by external agents arising from concrete's environment, or internal agents from within the concrete itself. Permeability of concrete is very often increased further than necessity requires by inadvertent use of porous aggregates, or placement without proper cure in a timely manner. However, for concrete made using normal weight aggregate, permeability is governed by cement paste porosity and pore-size distribution. For example, for cement paste whose total gel pore porosity is low; its permeability is very low. However, the permeability of hydrated cement paste, as a whole, is usually greater than its gel porosity indicates because of larger capillary pore presence, in fact its permeability is generally controlled by the capillary porosity and not gel porosity. Concrete's paste capillary porosity size is governed by concrete water-cementitious material ratio and degree of hydration. Therefore, Alpha Mix was designed very specifically to significantly enhance both factors, increased cementitious material volumes and improved hydration rates and processes, through enhancement, or re-posturing, of mix water's hydration abilities. Alpha Mix can enhance already-existent conventional mix designs with minimal change, without hassle or undue complexity. Simply by utilizing Alpha Mix to condition a concrete's mix water, increased volumes of the already-included cement content are utilized, effectively raising the volume of concrete's cementitious material (CM) content, further lowering its water-cement ratio, and accelerating the Portland cement's hydration rates and processes, which generates additional volumes of hydration product, or calcium sulphate hydrate (CSH), in a shorter than normal time period. This action alone effectively causes concrete permeability to decrease even further than usual, since the faster cement hydrates the faster hydrate product / CSH is subsequently produced to fill capillary voids, or original water spaces, a reduction in permeability also becomes even faster with the lower than usual water-cementitious material ratio, created by utilization of Alpha Mix. From a durability viewpoint it is of crucial importance to achieve the very lowest possible permeability in the shortest period of time possible, a feat achieved each and every time when utilizing Alpha Mix, an action which consistently produces concrete with smaller more segmented capillaries than usual.

ALPHA MIX & DEFECT-FREE CEMENT PASTE

Crack prevention of newly-placed concrete is extremely important is preserving long-range integrity. Basically in newly-placed concrete there are three intrinsic surface-visible types of cracking to be concerned with, and they are plastic cracks, early age thermal cracks, and drying shrinkage cracks, all of which leave concrete more vulnerable to contaminant ingress. Alpha Mix provides to mix water, ingredients that will effectively counteract root-causes of these three types of surface-visible early=age cracking. However, surface-visible cracking is not the only type of cracking that can result in Portland cement concrete integrity inferiority, in fact there are also internal defects and cracks to be concerned with, such as microcracking in aggregate-cement paste contact zone areas. Along with what would have been concrete's normal permeability, aggregate-cement paste zone area cracking, not surface-visible, has tremendous effect on final concrete permeability and vulnerability to embedded steel corrosion, thus durability, translating to useful lifespan. Very often concrete will unsuspectingly develop internal defects / microcracks in areas between aggregates and cement paste, causing concrete to be weaker and more permeable to moisture / free water, oxygen, and other forms of aggressive media. The aggregate-cement paste contact zone areas are very often the weakest link in a concrete structure because of surface-invisible bleed water voids, as well as, microcracking due to shrinkage and elastic mismatch between cement paste and the aggregates.

Ironically, this cement paste, which ultimately winds up in aggregate-cement paste contact zone areas, is cement paste initially-produced during the effects of hydrolysis. Also, this cement paste is the paste which initially absorbed into or coated the aggregates. However, the aggregate absorption / coating is very often later interfered with, by bleed-water coming from within the aggregates. Alpha Mix ingredients create extraordinarily homogenous Portland cement plate which significantly minimizes internal / external bleed-water production, attributable to particle / aggregate segregation. During concrete hardening / setting, where internal bleed-water is present there is always the possibility that bleedwater migrating upward may become trapped in horizontally stratified grain surfaces of the aggregates, leaving voids to contribute to permeability. Excessive water bleeding and inefficient packing of the cement paste, around affected aggregates, may also cause voids to be formed. These types of voids will not become filled with hydration product, or CSH, during hydration, creating internal void situations that potentially could be more porous than the entire matrix of the concrete would have been without creation of the surface-invisible voids. Internal void creation, and its root-causes, even further promote the existence of initial bond microcracks at the interfaces between cement paste and aggregates. Where concrete defects / mixrocracks remain localized, and are not contiguous, this is not an extremely serious situation initially, except from a probable low strengths (flexural, compressive) viewpoint, however, over time, with the inevitable occurrence of volume changes, freeze-thaw cycles, wetting-drying cycles, fatique, alkali-aggregate reactions, and etc., there is a tendency to greatly increase interior and possibly exterior cracking. These widening cracks serve to further facilitate permeation of liquids, pollutants, contaminants, ions, gases, and etc., all of which can potentially destroy concrete's integrity, corrode its reinforcement steel.

Where Alpha Mix is utilized to re-posture / condition concrete's mix water, enhancing its Portland cement hydration abilities, virtually defect-free cement paste is consistently produced as well as additional volumes of paste, per cement particle. Alpha Mix produced cement paste addresses every imaginable concrete ailment that could be, or is, associated with Portland cement concrete and it's manufacturing, and will alleviate and / or eliminate all of the aforementioned problem, including internal void creation and cement paste/aggregate contact zone defects, including microcracks. Alpha Mix utilization effectively increases concrete impermeability, a tremendously important factor in increasing concrete durability, translating to useful lifespan.

ALPHA MIX & ETTERINGITE

It is essential for hardened cement paste to not undergo appreciable expansion, especially expansion under conditions of restraint, since this type of expansion may result in disruption, i.e., cracking, of the hardened cement paste. One cause for such expansion is late-development etteringite in the hardened paste, caused by reactions with excess gypsum or calcium sulphate in the cement. Calcium sulphate is produced in Portland cement along with calcium hydroxide during hydrolysis, and is difficult, if not impossible, to distinguish one from the other. Normally, however, when concrete is adequately mixed, calcium sulphate is utilized as beneficial CSH, not adversely affecting concrete. However, very often, there are instances when either excessive volumes of calcium sulphate hydrate is produced, or all of which is produced doesn't become utilized as beneficial CSH, for some reason, resulting in varying volumes of leftover calcium sulphate hydrate, in the concrete, to potentially later on react with hydrated aluminates, creating destructive forces. Leftover, not utilized, calcium sulphate in concrete is liable to cause hardened cement paste expansion through formation of calcium sulphoaluminate (etteringite) by combining with the hydrated tricalcium aluminates content, in the presence of free water / moisture. Cement exhibiting this form of expansion is classified as unsound.

Etteringite if formed in other ways, such as in expansive cements. All types of expansive cements produce calcium sulphoaluminate hydrate (etteringite) which causes expansion in plastic cement. Expansive cements are used in special applications, such as prevention of water leakage. It should be noted however, the use of expanding cement cannot produce shrinkless concrete, as shrinkage will still occur following a moist curing, but magnitude of expansion can be adjusted so expansion and subsequent shrinkage are equal and opposite. Etteringite formation is created in concrete under sulphate attack. Concrete under sulphate attack usually takes on a whitish appearance; damage usually starts at corners and edges, followed by cracking and spalling of the concrete.

When Portland cement is ground into powder form, gypsum is added to the clinker in order to prevent flash setting, as water contacts cement's tricalcium aluminate component. Tricalcium aluminate is added to cement during its grinding process because it is beneficial to cement production, facilitating combination of lime and silica. Free lime is in cement clinker, intercrystallized with other compounds; consequently, free lime hydrates very slowly and requires a larger volume of space than the original calcium oxides. Volume of gypsum added to cement is crucial and depends on tricalcium aluminate and alkali content of cement. Increasing cement particle fineness has the effect of increasing its tricalcium aluminate quantity availability at early stages of hydration, raising the gypsum requirement. An excess of gypsum, added to clinker, can lead to expansion and consequent disruption of hardened cement paste, especially if sulphates are present. The essence of sulphate attack is the formation of calcium sulphate (gypsum) and calcium sulphoaluminate (etteringite), with both products requiring greater space volumes than compounds they replaced thus, subsequent disruption (cracking) of hardened concrete occurs.

Gypsum is able to prevent flash setting of cement, as hydration takes place, because gypsum quickly reacts with tricalcium aluminate to produce etteringite, which is harmless at this stage, because the concrete is still plastic and expansion can be accommodated. However, similar reactions take place in hardened concrete with excess gypsum, when exposed to sulphates. Sulphates react with both calcium hydroxide and hydrated tricalcium aluminate to form gypsum and etteringite, respectively. The extent of sulphate attack depends on concentration and permeability of concrete, i.e., ease with which sulphate can travel through the concrete pore system. If concrete is very permeable, and water can percolate right through its thickness, then calcium hydroxide will be leached out. Subsequent evaporation at the far surface of concrete leaves behind calcium carbonate deposits, formed by reaction of free lime with carbon dioxide. This whitish deposit is usually known as efflorescence. Extensive leaching of calcium hydroxide gradually increases porosity so concrete becomes progressively weaker, more prone to attack. Sulphates, salts, chemicals, and etc. only attack concrete when present in solution. The vulnerability of concrete to sulphate attack can be reduced through the use of sulphate resistant cements, however, the type of cement should be of secondary importance, or of no importance, unless concrete is dense and has low permeability. Water-cementitious material content is a vital factor since a high cementitious material content facilitates full compaction.

Late-development Etteringite can not exist where ACON Alpha Mix is utilized in Portland cement concrete mix water for many reasons with the first and most important one being extraordinarily low permeability, since without ingress from airborne sulphates, or ground transmission sources, late development etteringite cannot exist, and even if leftover, not utilized, calcium sulphate were to exist, reaction cannot take place without the presence of free water/ moisture. Alpha Mix begins preventing possibility of late development etteringite at the earliest possible moment, during hydrolysis, creating smoother less volatile transition into hydration thus, avoiding the possibility of overproduction of calcium sulphate hydrates, significantly improving hydrolysis by-product quality, translating to greatly improved final CSH quality. Alpha Mix effectively creates mixes so extraordinarily homogenous that during mixing, existing calcium sulphate residue becomes beneficial CSH, preventing leftover calcium sulphate hydrate. Alpha Mix provides ingredients that greatly enhance mix water's Portland cement hydrating abilities, resulting in production of extraordinarily hard, sound, low permeability, and truly shrinkage compensated concrete that effectively resists cracking, crazing, internal microcracking, and every ailment that could detrimentally affect permeability, thus vulnerability, virtually eliminating potential for adverse internal chemical reactions, and the need for expansive or other special cements.