FOR PORTLAND CEMENT CONCRETE MIXING WATER

Would a **more workable, less permeable, more defect-free, stronger, harder** (but not more brittle), and more durable concrete, made without additional effort in mixing, placing, finishing, or curing and requires only a minimal cost adjustment (if any), be of interest for your project(s)?

The answer to the above question would be an immediate resounding yes. For the finest quality, yet affordable, most durable concrete installation, **CEMENT HYDRATION CATALYST (CHC)** should be included with the concrete mix design.

Why should lower permeability be important to concrete? The integrity disintegration of concrete is usually caused by either external agents arising from the environment or by internal agents from within the concrete mass. The permeability factor of concrete is directly responsible for whether pollutants or contaminants are allowed to readily penetrate concrete or not, contaminants such as sulphates, acids, seawater and chlorides, and etc. Since internal agent attack must come from within the concrete, the attacking agents must be able to penetrate throughout the concrete, which therefore has to be permeable, so concrete permeability should be of critical interest. Internal agent attack is aided by internal transport of agents by diffusion due to internal gradients of moisture and temperature and by osmosis. Permeability is sometimes inadvertently increased even further by using porous aggregate or placing of concrete without benefit of a proper cure, applied in a timely manner. However, for concrete made with normal weight aggregate, permeability is governed by the cement paste porosity but the relation is not that simple, as the pore-size distribution is a factor. For example, for a cement gel whose porosity is 28%, its permeability is still very low (permeability coefficient is 2.3 X 10-15 feet per second), because of the extremely fine texture of the gel and the very small size of the gel pores (When **CEMENT HYDRATION CATALYST (CHC)** is utilized in the mix the gel's texture fineness is even further enhanced). The permeability of hydrated cement paste as a whole is greater because of the presence of larger capillary pores, and, in fact its permeability is generally a function of capillary porosity. Since capillary porosity is governed by the water/cement ratio and by the degree of hydration (factors enhanced by **CEMENT HYDRATION CATALYST (CHC)**), permeability is lower for pastes with low water/cement ratios, especially below a water/cement ratio of about 0.6, the point at which capillaries begin becoming more segmented or discontinuous. For a given water/cement ratio, the permeability decreases as the cement continues to hydrate, further increasing the mix's cementitious material content, providing hydrate product filling original water space (actions also greatly enhanced by **CEMENT HYDRATION CATALYST (CHC)**). The reduction in permeability being faster the lower the water/cementitious material ratio (a factor made even more extraordinary by **CEMENT HYDRATION CATALYST (CHC)** ingredients). From the durability viewpoint, it is very important to achieve low permeability as quickly as possible, and without a doubt permeability of concrete is the dominant key to overall durability. Consequently, a concrete mix made with a low water/cement ratio is advantageous because the stage where water capillaries become segmented is achieved following a shorter time period of curing. **CEMENT HYDRATION CATALYST (CHC)** ingredients promote lowest permeability, in the shortest period of time, subsequently; the smallest most segmented capillaries possible, using your current mix design. Where **CEMENT HYDRATION CATALYST (CHC)** is used in a mix starting with a 0.55 water/cement ratio by weight, the resulting water / cement ratio following placement, will be equivalent to a 0.45 - 0.42 water/cement ratio or less. This is due to **CEMENT HYDRATION CATALYST (CHC)'s** unique cement hydration capabilities utilizing more already-included cement content, generating extraordinary volumes of cementitious material and greatly-improving concrete's permeability factor

Why should a more defect-free concrete be important to a concrete installation? Concrete generally is rating. Considered to be under attack from the environment from the moment it is placed. Crack prevention of newly placed concrete should be of the utmost importance in preserving its long-range integrity. Basically, with newly placed concrete there are three intrinsic visible types of cracking to he concerned with plastic cracks, and drying shrinkage cracks all of which leave the concrete surface more vulnerable to contaminant ingress. **CEMENT HYDRATION CATALYST (CHC)** provides built-in ingredients to concrete mix water that work to counteract the causes of these three types of visible cracking. However, surface visible cracking is not the only defects that can cause concrete integrity inferiority; there are internal defects to also be considered such as cracking in the aggregate-paste contact zone. Along with permeability, aggregate-paste contact zone cracking has a tremendous effect on concrete's permeability/durability factor and reinforced concrete's vulnerability to steel corrosion. Very often concrete will initially develop internal defects in the form of microcracks in the contact zone between the aggregates and the cement paste matrix causing it to be weaker and become more permeable to moisture, oxygen, and other aggressive media. The aggregate-paste contact zone is very often the weakest link in concrete structure because of bleed-water voids, as well as micro cracking due to shrinkage and the elastic mismatch between the cement paste and the aggregate. The production of the cement paste that ultimately winds up in the aggregate-paste contact zone begins immediately upon contact between mix water and cement, and almost immediately begins coating or absorbing into the aggregates of the mix, however, this aggregate coating is later very often interfered with by bleed-water coming from within the aggregate. This problem is alleviated/eliminated where **CEMENT HYDRATION CATALYST (CHC)** was added to mix water prior to exposing aggregates to mix water, and since bleed water coming to the aggregate surface would tend to be mix water initially absorbed by the aggregate instead of residual water, it would contain **CEMENT HYDRATION CATALYST (CHC)** ingredients to encourage additional hydration of present unhydrated cement particles, even to beneath particle hydrate envelopes, significantly improving paste quality inside aggregate-paste contact zones. **CEMENT HYDRATION CATALYST (CHC)** ingredients also promote extraordinary homogeneity of the produced cement paste, an action that minimizes bleed-water coming from inside the paste itself during consolidation and setting. Where internal bleed-water is present there is possibility that bleed-water migrating upward can become trapped under horizontally stratified grain surfaces of aggregates.

Bleeding and inefficient packing of cement paste around affected aggregate can cause voids to be formed. These type voids are not filled during hydration, creating a zone that can be more porous than the entire matrix would have been without the presence of these voids. This situation even further promotes existence of initial bond microcracks at interfaces between aggregates and cement paste. When micro cracking in concrete remains localized and is not continuous, this is not an extremely serious situation initially, except from the probable low compressive strength standpoint, however, over time, volume changes, freeze-thaw and wetting-drying cycles, fatigue, alkali-aggregate reactions, etc., all tend to increase interior and possibly exterior cracking. These crack networks serve to facilitate permeation of liquid contaminants, ions and gases that destroy concrete’s integrity and corrode reinforcement steel. A more defect--free concrete is produced when **CEMENT HYDRATION CATALYST (CHC)** is utilized in the mix water, this is due to significant improvement in the make-up of cement paste mortar. Since **CEMENT HYDRATION CATALYST (CHC)** is added to the mix water, prior to mixing it with cement, it has the distinct advantage of being present at the exact same moment water and cement come in contact. This greatly improves the hydrolysis reaction's by-product quality, such as calcium hydroxide, etc. The use of **CEMENT HYDRATION CATALYST (CHC)** ensures only the finest quality cement paste attainable is being initially produced, paste which almost immediately begins coating aggregates. The higher-quality paste significantly improves the concrete's final paste-to-aggregate bond quality, ultimately producing a much higher quality concrete installation, both externally and internally. The result is extraordinary concrete that is more defect-free than it would have been without **CEMENT HYDRATION CATALYST (CHC) .** Also, the improved paste-to-aggregate bond quality helps to increase concrete's flexural and compressive strength values.

Why should additional compressive strength to an already adequate strength concrete mix design be attractive, even though the added cubic yard price may or may not increase? NOTE: Concrete mix designs should reflect what is thought to be the most economical and practical combination of aggregate, cement, and water that produces concrete of required workability, strength, and durability under specific service conditions. **CEMENT HYDRATION CATALYST (CHC)** coincidentally provides additional compressive and flexural strengths as a direct result of improvements to the concrete mix quality, and is not its main conceptual objective. And, depending on the concrete installation's intended purpose; higher compressive and flexural strengths may or may not be needed. However, every concrete needs the benefits of crack-free construction, especially where additional expense if any, is very low, in many cases, and added complexity of mixing, placing, finishing, and curing is low, even enhanced by the addition of **CEMENT HYDRATION CATALYST (CHC)**.

As an example let's focus on slab construction. **CEMENT HYDRATION CATALYST (CHC)** significantly improves the resistance of slabs cracking, scaling, dusting, steel corrosion, and many other problems associated with flatwork. In many instances, slightly higher strengths are not needed for most slabs; however, it becomes important to be aware that flexural strength developed, in a concrete is usually automatically proportional to the compressive strength developed. In fact, flexural strength of high-integrity concrete is approximately 11.7 times the square root of its compressive strength. This means that an ordinary concrete of 4000-psi compressive strength would develop approximately 740-psi flexural strength. As a comparison, when **CEMENT HYDRATION CATALYST (CHC)** is induced into the mixing water of the very same mix design, omitting water loss agent if applicable, at least an 800-psi flexural strength will easily be attained. However, remember that flexural strengths of various mix designs can vary considerably as a function of aggregate type, size, and gradation, cement type, water-cement ratio, etc. Abrasion, erosion, wear, and cavitations, also have similar effects on concrete. An example of wear in building construction is abrasion from forklifts or other hard-wheeled traffic, or production operations where heavy objects may he dropped on the concrete floor. Concrete compressive strength at the wearing surface is an indicator of potential wear resistance. Higher compressive strengths usually result in greater wear resistance.

CEMENT HYDRATION CATALYST (CHC) is not considered a concrete admixture since its conceptual function is to enhance water's cement hydration capabilities. **CEMENT HYDRATION CATALYST (CHC)'s** focus is on providing additional overall quality to portland cement concrete without targeting one specific area of improvement. Basic materials of concrete are cement, mineral aggregate and mixing water. An admixture is defined as a substance or agent that can be added into a concrete mix to enhance certain desired properties, but an admixture is not considered concrete material, in the proper sense, as is mixing water. It should also be mentioned, ASTM recommends the use of potable water where possible / practical, as portland cement concrete mix water, and water of any other quality should be adequately tested for approval prior to mixing with it. **CEMENT HYDRATION CATALYST (CHC),** added to already-good concrete mixing water subsequently improves it to extraordinarily excellent concrete mixing water status. **CEMENT HYDRATION CATALYST (CHC)** contains no VOC, so when **CEMENT HYDRATION CATALYST (CHC)** is added into potable water the water will remain potable.

CEMENT HYDRATION CATALYST (CHC) addition to mix water is suggested following a mix design approval. And also remember the number one rule-of-thumb for producing extraordinary concrete from any mix design and that is always use low water-cementitious materials ratio concrete to receive dense concrete with the lowest permeability, a feat that is accomplished each and every time when utilizing **CEMENT HYDRATION CATALYST (CHC)** in the mixing water. So, where additional compressive strength is not needed, this benefit is just an extra bonus of using **CEMENT HYDRATION CATALYST (CHC)** to further improve crack resistance and performance quality of an installation, not to mention the extended useful lifespan of the concrete. The Durability of a material is that property which indicates whether or not the material will endure, even though it may not he subjected to loads sufficient to destroy it. Durability of portland cement concrete is defined as its ability to resist weathering action, chemical attack, abrasion, or any other process of deterioration. Durable concrete will retain its original form, quality, and serviceability when exposed to its environment. Durability of concrete is one of its most important properties because it is essential that concrete should be capable of withstanding the conditions for which it has been designed throughout the life of a structure. Durability of concrete is affected by innumerable factors such as alternate wetting and drying, freezing and thawing, aggressive sulfates exposure, heating and cooling, capillary water, abrasion, corrosion of steel and other imbedded materials, chemical reactions of aggregates, deposition of salts by percolating water, dissolving of certain constituents (principally calcium hydroxide) by percolating water, dissolving of cement by certain acids, and etc. **CEMENT HYDRATION CATALYST (CHC),** utilized as a mixing water conditioner, addresses each and every one of the aforementioned problems potentially affecting concrete durability.

CEMENT HYDRATION CATALYST (CHC) added to concrete mix water produces a concrete which is extraordinarily strong, hard, and impermeable. **CEMENT HYDRATION CATALYST (CHC)** accomplishes this in several ways beginning with improvement in hydrolysis by product quality, particularly calcium hydroxide which later provides a more efficient lamination, due to its improved quality, minimizing volume of leftover unused calcium hydroxide residue remaining in the concrete installation, lowering potential for detrimental internal chemical reactions. **CEMENT HYDRATION CATALYST (CHC)** provides mix water the ingredients to initiate cement hydration without the turbulence and violence associated with hydrolysis, including cement potency loss ascribable to mix water dilution of the cement. This action, at the point of hydrolysis, also works to ensure that only finest quality cement paste attainable is absorbing into and coating the aggregates during this critical event. This will also greatly improve cement paste in the aggregate-cement paste contact zone and significantly improving final paste-to-aggregate bond quality, among other things of importance to durability. **CEMENT HYDRATION CATALYST (CHC)** utilizes a significantly greater volume of the already-included portland cement which in turn increases the cementitious material content of a mix, an action that tremendously improves durability by producing smaller and more segmented capillaries thus more impermeability. Since **CEMENT HYDRATION CATALYST (CHC)** increases utilization of the already-included portland cement, this means that more of each cement particle will be utilized, greatly decreasing the size of each particle leftover to act as filler aggregate.

These particles ultimately become sized somewhere between sand and cement grain sizes causing them to perform as silica fume would, without the brittleness. This action alone causes the concrete's integrity to increase, becoming denser, stronger, and less susceptible to contaminant pollution, freezing and thawing cycle damage, imbedded steel corrosion, and action factors that translate to greater durability.

Also, through increased already-included cement utilization, concrete's durability is even further enhanced in many other ways, such as; production of very fine-textured cement paste that has extremely small uniformedsize gel pores, improved workability through increased lubricity, less particle separation during placing and finishing resulting in less surface bleed-water, the provision of a surface much harder and more abrasion resistant, utilization of all capillary water leaving none to later evaporate resulting in less total void percentages. These are all factors that serve to increase concrete's overall integrity, compressive and flexural strengths, and decrease its permeability. All factors that directly extend concrete's useful lifespan, through increasing its durability factor.