PROTECRETE®
CONCRETE'S BEST SOLUTION

Mix Water Conditioner

Would a . . .

- **More workable**
- **Less permeable**
- **More defect-free**
- **Stronger**
- **Harder (but not brittle) and**
- **More durable**

. . . concrete sound good on your next construction project?

PROTECRETE-MWC (Mix Water Conditioner) adds all these benefits without any additional effort in mixing, placing or curing. And there is minimal cost adjustment (if any) per cubic yard. Its ingredients promote the lowest permeability in the shortest period of time. You get the smallest, most segmented capillaries possible using your own mix design. Due to **PROTECRETE-MWC**'s unique cement hydration capability, it utilizes more of the already included cement content. It generates extraordinary volumes of cementitious material and it greatly improves the concrete's permeability factor rating.

Why should lower permeability be important to concrete?

The disintegration of integrity of the 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 contaminates such as sulfates, acids, sea water, chlorides, etc. are allowed to readily penetrate concrete.

Concrete permeability should be of critical interest since internal agent attack must come from within the concrete. The attacking agent(s) must be able to penetrate throughout the permeable concrete. 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 more 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 relationship is not as simple as that since the pore size distribution is a factor. For example, although cement gel porosity is 28%, its permeability is still very low (permeability coefficient is 2.3 x -1015 feet per second) because of the extremely fine texture of the gel and the very small size of the gel pores (gel's texture fineness is even further enhanced where PROTECRETE-MWC is used).

The permeability of hydrated cement paste as a whole is greater because of the presence of larger capillary pores. 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 PROTECRETE-MWC), permeability is lower for pastes with low water/cement ratios. Especially a water/cement ratio below about 0.6, which is the point capillaries begin becoming 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. This provides hydrate product that fills the original water space (actions also greatly enhanced by PROTECRETE-MWC).

The reduction in permeability is faster the lower the water/cementious material ratio (a factor made even more extraordinary by PROTECRETE-MWC ingredients). 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. 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.

Why should more defect-free concrete be important to a concrete installation?

Concrete generally is 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 be concerned with:

- plastic cracks
- early-age thermal cracks
- drying shrinkage cracks

All of these leave the concrete surface more vulnerable to contaminant ingress. PROTECRETE-MWC provides built-in ingredients to concrete mix water which work to counteract the causes of these three types of visible cracking.

However, surface-visible cracking is not the only defect 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. This causes it to be weaker and become more permeable to moisture, oxygen, and other aggressive media.

The aggregate paste zone contact is very often the weakest link in the concrete structure, because of (1.) bleed water voids, (2.) microcracking due to shrinkage and (3.) 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 the contact between mix water and cement. It 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 when PROTECRETE-MWC is added to mix water prior to exposing aggregates to the mix water. And since bleed-water coming to the aggregate surface will tend to be mix water initially absorbed by the aggregate instead of residual water, it will contain PROTECRETE-MWC 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.

PROTECRETE-MWC ingredients also promote extraordinary homogeneity of the paste itself. During consolidation and setting, where internal bleed-water is present, there is a 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 microcracking 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 cycles, 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 which destroy concrete integrity and corrode reinforcement steel.

A more defect-free concrete is produced when PROTECRETE-MWC is utilized in the mix water. This is due to the significant improvement in the makeup of cement paste mortar. Since PROTECRETE-MWC is added to mix water prior to mixing with cement, it has the distinct advantage of being present at the exact same moment water and cement make contact. This greatly improves the hydrolysis reaction's by-product quality, such as calcium hydroxide, etc. The use of PROTECRETE-MWC ensures that only the finest quality cement paste attainable is being initially produced. Paste which almost immediately begins coating aggregates. The higher-quality PROTECRETE-MWC paste significantly improves the concrete's final paste-to-aggregate bond quality. The improved paste-to-aggregate bond quality helps to increase the concrete's flexural and compressive strength values. It ultimately produces a much higher quality more durable concrete installation both externally and internally.

Why should additional compressive strength to an already adequate strength concrete mix design be good for concrete, even though the added cubic yard price increase (if any) is low?

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 adequate workability, strength and durability under specific service conditions.

Even where additional compressive strength is not needed, PROTECRETE-MWC coincidentally provides additional compressive and flexural strengths as a direct result of improvements to the concrete mix quality. It is not MWC's main conceptual objective and higher strengths may or may not be needed depending on the concrete installation's intended purpose. However, every concrete needs the benefit of crack-free construction, especially when the additional expense (if any) is very low and the added complexity of mixing, placing, finishing and curing is nil. PROTECRETE-MWC adds extra benefits which extend the useful lifespan of the concrete, further improving crack resistance and raising the performance quality of an installation.

As an example, let us focus on slab construction. PROTECRETE-MWC significantly improves the resistance of slabs to curling, cracking, scaling, dusting, steel corrosion and other problems associated with flatwork. In many instances, slightly higher strengths are not needed for most slabs. It is important to be aware that flexural strength developed in a concrete is usually automatically proportional to the compressive strength developed. As a matter of fact, flexural strength of high integrity concrete is approximately 11.7 times the square root of its compressive strength. This means that ordinary concrete of 4000 psi compressive strength would develop approximately 740 psi flexural strength. PROTECRETE-MWC added to the mix water of the very same mix design, (omitting water loss agent if applicable) will easily attain at least an 800 psi flexural strength. However, remember that flexural strengths of various mix designs can vary considerably due to aggregate type, size and gradation, cement type, water-cement ratio, etc.

Abrasion, erosion, wear and cavitation can also have similar effects on concrete. An example of wear in building construction is abrasion from forklifts or other hard wheeled traffic. Another example is production operations where heavy objects may be dropped on the concrete.

Concrete compressive strength at the wearing surface is an indicator of potential wear resistance. Higher strengths usually result in greater wear resistance.

Why is durability of concrete so important?

The durability of a material is that property which indicates whether or not the material will endure even though it may not be 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 it is exposed to its environment. Durability of concrete is one of its most important properties. It is essential that concrete be capable of withstanding the conditions it has been designed for throughout the life of the structure.

Durability of concrete is affected by innumerable factors such as alternating wetting and drying, heating and cooling, freezing and thawing, aggressive sulfates exposure, capillary water, abrasion, corrosion of steel and other imbedded materials, dissolving of certain constituents (principally calcium hydroxide) by percolating water, dissolving of cement by certain acids, etc. Each and every one of these problems potentially affecting concrete

Durability is addressed using PROTECRETE-MWC as a mixing water conditioner.

PROTECRETE-MWC added to concrete mix water produces a concrete which is extraordinarily strong, hard and impermeable. This is accomplished in several ways beginning with improvement in hydrolysis by-product quality. Particularly calcium hydroxide which later provides a more efficient lamination. This minimizes the volume of leftover unused calcium hydroxide residue remaining in the concrete installation, thus lowering the potential for detrimental internal chemical reactions. PROTECRETE-MWC provides mix water the ingredients to initiate cement hydration without the turbulence and violence associated with hydrolysis. This includes cement potency loss ascribable to mix water dilution of the cement. This action at the point of hydrolysis also works to ensure that only the finest quality cement paste attainable is absorbing into and coating the aggregates during this critical event. This greatly improved cement paste in the aggregate-cement paste contact zone significantly improves the final paste-to-aggregate bond quality.

PROTECRETE-MWC utilizes a much greater volume of the already included Portland Cement, which in turn increases the cementitious material content of a mix. This action tremendously improves durability by producing smaller and more segmented capillaries, thus more permeability. Since PROTECRETE-MWC increases utilization of the already included Portland cement, this means that more of each cement particle will be utilized. This greatly decreases the size of each particle leftover to act as filler aggregate. These particles ultimately become sized somewhere between sand and cement grain sizes. It causes them to perform as silica fume would, except without the brittleness. This action alone causes concrete integrity to increase. The concrete becomes even denser, stronger and less susceptible to contaminate pollution, freeze-thaw cycle damage, imbedded steel corrosion, etc. Factors which translate to greater durability.

Concrete durability is further enhanced in many other ways through this increase of already included cement:

- The production of very fine-textured cement paste that has extremely small uniformed-size 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 and increase void percentages.

These are all durability factors which serve to increase concrete's overall integrity, compressive and flexural strengths, decrease its permeability and extend the useful lifespan of the concrete.

Why isn't PROTECRETE-MWC considered an admixture?

PROTECRETE-MWC is not considered a concrete admixture since its conceptual function is to enhance water's cement hydration capabilities. It focuses 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. 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 and practical as mix water for Portland cement. Water of any other quality should be adequately tested for approval prior to mixing with it. PROTECRETE-MWC added to already good concrete mixing water improves it to extraordinarily excellent concrete mixing water status. PROTECRETE-MWC has no VOC content. PROTECRETE-MWC added into potable water still remains potable.

The number one rule-of-thumb for producing extraordinary concrete from any mix design is to always use a low water-cementious materials ratio to receive dense concrete with the lowest permeability. This feat is accomplished each and every time with PROTECRETE-MWC added to the mix water following approval of your mix design.