Multi-crystalline Intermixed Concrete Enhancer for Improving Concrete Durability and Sustainability

CHEM-CRETE® MCE™ ENHANCER

PRODUCT DESCRIPTION

Chem-Crete MCE™, an intermixed multi-crystalline enhancer, is a significant step forward in increasing long-term Portland Cement Concrete (PCC) performance and durability. Patent-pending MCE is based on technology developed from Chem-Crete PAVIX CCC-100, which has been proven in laboratory tests and real-world applications for almost two decades.

MCE is an aqueous solution that is mixed into fresh PCC during the batching process resulting in uniform distribution throughout the paste. The material has been shown through extensive laboratory studies and field trials to enhance the hydration of the Portland cement, increase workability, improve strength, reduce capillary porosity, prevent ASR, chloride intrusion and freeze/thaw damage. The improved moisture management, due to the MCE, significantly reduces the tendency for drying shrinkage and plastic shrinkage cracking. A reduction in shrinkage and cracking of up to 91% and numerous other benefits are highlighted in the PRODUCT FEATURES section

A key feature of MCE is its ability to actively manage water in the PCC thereby preventing moisture-related damage including freeze/thaw cycling and alkali silica reactivity (ASR). MCE may allow for the elimination of fly ash in concrete for ASR mitigation. In addition, by controlling the amount of water entering the concrete, chloride intrusion is minimized, mold growth is prevented, and overall PCC sustainability greatly enhanced.

MCE can be added to a concrete mix at a batching plant, in a volumetric mixing truck or at a job site similar to adding typical chemical admixtures.

Concrete with MCE can be placed using traditional methods, including slipform paving.

Dr. Michael Ayers inspects concrete curb and gutter with the MCE additive

FIELDS OF APPLICATION

- ☐ Airports Runways/Taxiways/Terminals
- ☐ Highways, Streets, Roads and Manholes
- ☐ Bridges, Tunnels and Retaining Walls
- ☐ Slabs-on-Grade and Below Grade Structures
- ☐ Precast/tilt-up and Cast-in-Place Concrete
- ☐ Concrete Parking Lots, Sidewalks and Driveways
- ☐ Dams, Reservoirs, Canals and Waterways
- ☐ Water Tanks and Treatment Plants
- ☐ Secondary Containment Structures
- ☐ Sea Walls and Port Facilities
- ☐ Commercial and Residential Structures
- ☐ Parking Structures (Above and Below Grade)
- ☐ Basements, Foundations, Floors, Patios and Pools

PRODUCT FEATURES

- ☐ Water-based, No VOC, 100% green technology
- ☐ The improved moisture management due the MCE significantly reduces the then tendency for drying, shrinkage and plastic shrink cracking. Reduces shrinkage and cracking up to 91%
- ☐ Improves internal curing and hydration producing more durable and sustainable concrete
- ☐ Reduction in PCC permeability (capillary porosity) and pore size
- ☐ Prevents freeze/thaw damage and reduces ice adhesion (>50%)
- ☐ Prevents chloride ion penetration and damage
- ☐ Enhanced water management in all phases (primarily liquid and water vapor movement within the hardened PCC)
- ☐ We prevent alkali silica reactivity problems (ASR)
- ☐ Increased compressive strength.
- ☐ Increased workability and finishing ability
- ☐ Reduced formation of calcium hydroxide (CH) during hydration (with accompanying increase in calcium-silicate-hydrate (C-S-H))
- ☐ Manages the heat of hydration (reduces temperature differential in mass pours).

PACKAGING

Product	Packaging
CHEM-CRETE MCE™	5 GAL (18.925 LITER) PAIL
	55 GAL (208 LITER) DRUM
	275 GAL (1000 LITER) TOTE
	BULK LIQUID TANK

TECHNICAL DATA

Specific Gravity	1.15 – 1.25
Viscosity	< 8 cps
Freezing Point	28ºF (-4°C)
Boiling Point	219ºF (104 °C)
Color	Blue
Environmental Hazards	None
Odor	None
Toxicity	None
Fumes	None
Flammability	None

LABORATORY TESTING RESULTS

Alkali-Silica Reactivity (ASR) (ASTM C-1567): the following test results were based on ASTM C-1567, "Determining the Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar Bar Method)". The Platte River aggregates used in the test have been characterized as highly reactive.

The addition of 2% of MCE by weight of cement reduced expansion from 32% for the 0.47 w/c ratio to 74% for the 0.39 w/c ratio. This significant level of reduction in ASR is due to improved hydration, alteration of the hydration products (CH versus C-S-H) and enhanced moisture control.

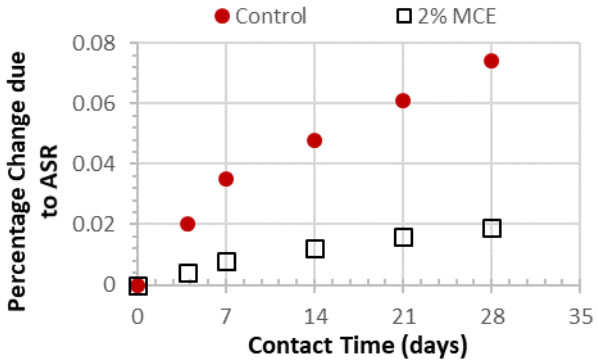

Figure 1: Increasing resistance to the alkali-silica reactions with MCE: According to ASTM C 1567, using IDOT C4 PCC mix.

Freeze-Thaw Resistance (ASTM C-666): the following test results were based on a modified and more stringent ASTM C-666, "Standard Test Method for Resistance of Concrete to Rapid Freezing and Thawing".

The mass change for the control sample shows a mass loss of approximately 5.5% after 300 freeze thaw cycles. The equivalent data for the 2 percent intermixed MCE shows a mass loss of only 0.5%. A reduction of approximately 90 percent in mass loss indicates that the concrete is highly freeze/thaw resistant and therefore will have greatly enhanced durability.

The dynamic modulus of the baseline and 2% intermixed samples was also evaluated according to ASTM C-666. The results showed an increase of approximately 20 percent for the intermixed samples thereby showing the dramatic improvement in engineering properties of the PCC.

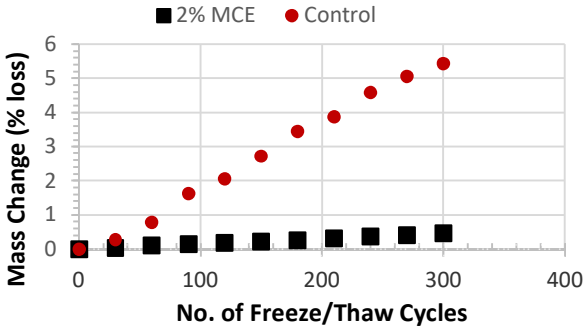

Figure 2: Increasing resistance to freeze thaw cycles with MCE™ at 2% of cement weight. According to ASTM C 666 using IDOT C4 PCC mix.

Figures 3.a and 3.b show the results of the mass change for the baseline untreated specimens and the intermixed 2% MCE respectively. These results show a 91.6% reduction in mass loss for the treated specimens compared with the control.

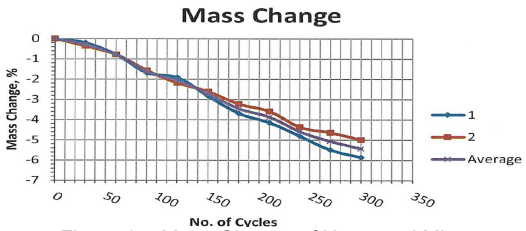

Figure 3.a Mass Change of Untreated Mix

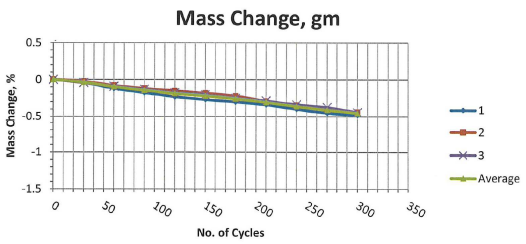

Figure 3.b Mass Change – Treated Mix 2% Internal

Figures 4.a and 4.b show the relative dynamic modulus change in the untreated and treated specimens respectively. The 2% intermixed MCE resulted in a 20.3% higher retained dynamic modulus.

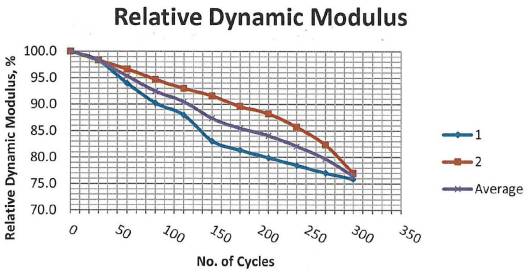

Figure 4.a: Relative Dynamic Modulus – Untreated Mix

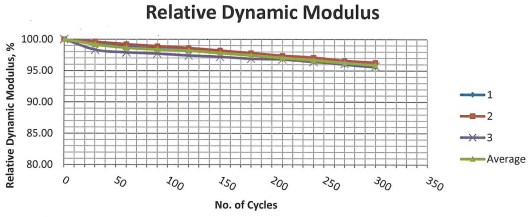

Figure 4.b: Relative Dynamic Modulus – Treated Mix 2%

Figures 5.a and 5.b show the length change for the untreated and treated specimens respectively. The treated specimens show a 14.8% reduction in length change compared with the untreated specimens at 300 F/T cycles.

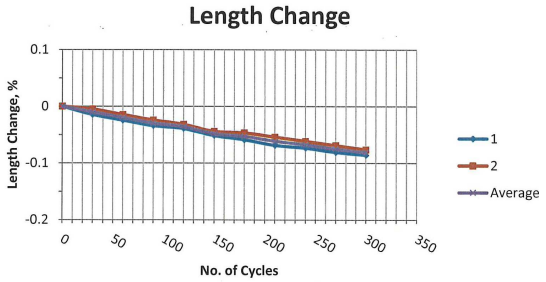

Figure 5.a Length Change – Untreated Mix

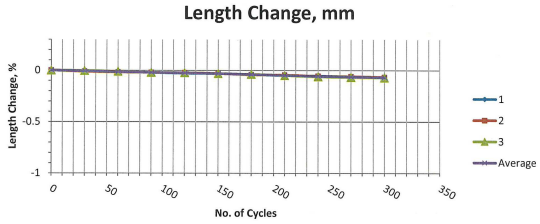

Figure 5.b Length Change – Treated Mix 2%

Compressive Strength (ASTM C39): Compressive strength is improved at all ages. Highway paving is typically specified to cure for 28 days. MCE test results show an improvement in compression strength of 5.9% at that time, potentially allowing for thinner pavement without reduction in carrying capacity. Mix designs with lower water/cement ratios will result in additional increases in compression strength.

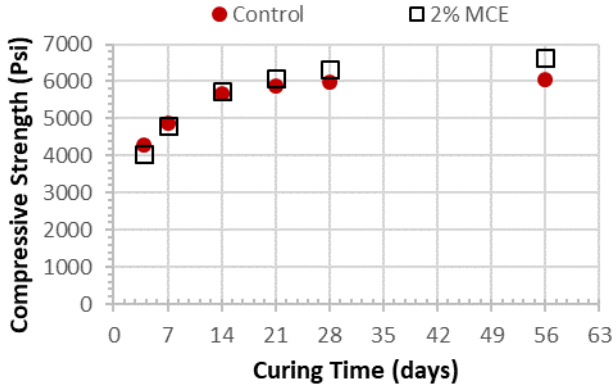

Figure 6: Enhanced compressive strength of MCE™.

Resistance to Chloride Ion Penetration (ASTM C-1202): 90.7 percent reduction in chloride ion penetration as a result of higher density, lower permeability concrete. Treated concrete is significantly more resistant to intrusion of deicing salts.

Workability (ASTM C 143): the effective crystallization mechanism of MCE enhances slump as indicated in figure 7, with results are for the case of concrete mix with a slump target of 1 in, obtained by an independent laboratory testing according to ASTM.

Slump and workability are enhanced for all water/cement (w/c) ratios. Design mixes with low w/c ratios and low slump, which are typically difficult to place, especially at long time intervals between batching and placement, remain easy to work for significantly longer time periods. Segregation related issues, due to overmixing, overworking or excessive vibration are reduced or eliminated.

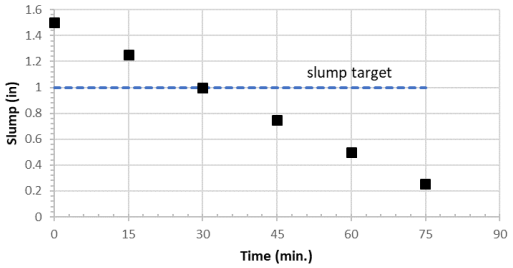

Figure 7: Enhanced workability of MCE

Figure 8 below shows slump and workability (retention) data for concrete mix designs with and without fly ash.

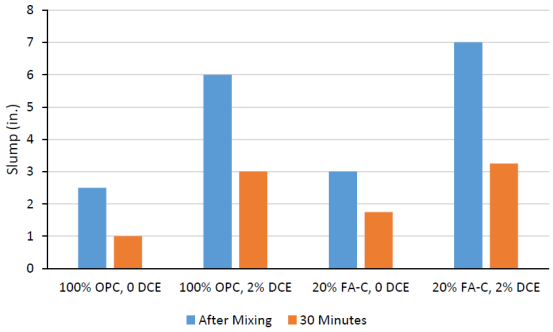

Figure 8: Concrete Workability (retention) Data

Thermal Properties: based on observations during the Freeze/Thaw (F/T) and related testing, the 2% intermixed MCE was shown to delay the freezing of the concrete test specimens. Although there are no current ASTM specifications that are applicable, a procedure was developed to evaluate the observed behavior.

The untreated PCC specimen reached freezing temperatures at approximately 3 days at the surface and 3 to 4 days at the center of the specimen when subjected to temperatures of minus 64° F. The addition of 2% MCE™ showed that the interior of the PCC specimen never reached freezing temperature while the surface took approximately 14 days. The implications of this are very significant in that the effect of surface temperature of the concrete has a direct impact on the formation of ice on the pavement surface as well as the application of deicing chemicals.

Retards Freezing:
MCE has a distinguished thermal behavior of preventing water freezing in treated concrete under severe continuous freezing conditions. Figure 9 shows the high performance of remaining MCE modified concrete above freezing temperature for about 2 months even under severe continuous (when the concrete is continuously subjected to -50°F), while the temperate of the control sample dropped to a value below freezing within three days.

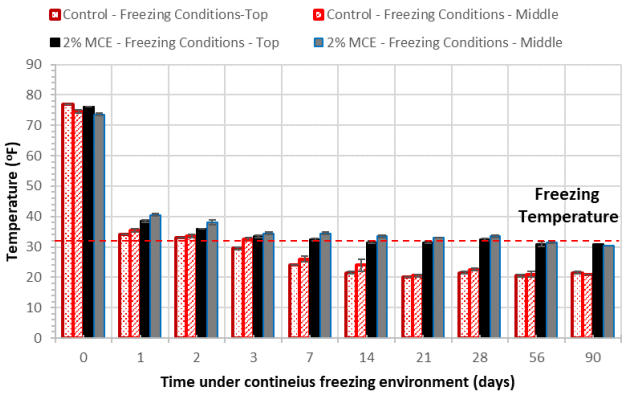

Figure 9: Concrete thermal performance under continuous freezing surroundings, reporting the temperatures at two positions: top (0.5 inch below surface) and middle (1.5 inch below surface) for a concrete with a mix design of IDOT C4, comparing control sample with concrete mixed with 2% MCE. The tests were made in freezing chambers used for ASTM C-666, with the temperature of the chamber adjusted to -50ºF and remained constant to create more severe freezing conditions.

Permeability (CRD-C 48-92)

Cylinder	Coefficient of Permeability, cm/sec.
Control	2.223×10^{-6}
Treated	5.169×10^{-10} (average of 5 cylinders)

"Based on the above test results, it would appear the MCE product creates a virtually impervious concrete matrix, as the treatment samples achieved a coefficient of permeability on the order of 1.0×10^{-10}. Tests were conducted in general accordance with noted test methods".

APPLICATION DATA

Method of Application: MCE is shipped ready-to-use. No additional mixing or preparation is required. It can be added to the mix at any time. However, when possible, it should be added to the water portion of the design mix prior to the water be combined with the cementitious materials and aggregates

Consumption: Weight of MCE equal to 2% weight of cementitious materials in mix design (cement, fly ash, slag).

CLEANING

Clean all equipment, tools with fresh clean water immediately after use.

STORAGE

Two years shelf life when stored in cool, dry place in its original unopened container. Always agitate or stir the product's container before using. **DO NOT ALLOW PRODUCT TO FREEZE.** Repeated freezing & thawing might cause damage for the product.

SAFETY PRECAUTIONS

As with all construction chemical products, adequate precautions and care must be taken during usage and storage. Avoid direct contact with foodstuff, eyes, skin, and mouth. Any direct contact with skin, eyes, etc. should be washed thoroughly with clean running water and soap.

Always wear protective goggles and gloves. In case of eye contact, flush for 15 minutes with warm water. **KEEP OUT OF REACH OF CHILDREN.**

TECHNICAL ASSISTANCE

Please contact International Chem-Crete Corporation for Technical Personnel.

WARRANTY

LEGAL DISCLAIMER • KEEP CONTAINER TIGHTLY CLOSED • KEEP OUT OF REACH OF CHILDREN • NOT FOR INTERNAL CONSUMPTION • FOR INDUSTRIAL USE ONLY • FOR PROFESSIONAL USE ONLY

Prior to each use of any product of International Chem-Crete, ("Chem-Crete"), the user must always read and follow the warnings and instructions on the product's most current product label, Technical Data Sheet and Safety Data Sheet which are available at chem-crete.com. Nothing contained in any Chem-Crete literature or materials relieves the user of the obligation to read and follow the warnings and instructions for each Chem-Crete product as set forth in the current product label, Technical Data Sheet and Safety Data Sheet prior to use of the Chem-Crete product. Chem-Crete warrants this product for two years from date of installation to be free from manufacturing defects and to meet the technical properties on the current Technical Data Sheet if used as directed within the product's shelf life. User determines suitability of product for intended use and assumes all risks. User's and/or buyer's sole remedy shall be limited to the purchase price or replacement of this product exclusive of any labor costs.

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