CHEM-CRETE® MCE

SUBMITTAL

PAVIX MCE™

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

PRODUCT DESCRIPTION

Chem-Crete PAVIX MCE™, an intermixed multi-crystalline enhancer, is a significant step forward in increasing long-term Portland Cement Concrete (PCC) performance and durability. PAVIX MCE™ is an aqueous solution that is mixed into fresh PCC during the batching process resulting in uniform distribution throughout the Portland cement 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, reduce chloride intrusion and numerous other benefits as highlighted in the PRODUCT FEATURES section.

A key feature of PAVIX MCE™ is its ability to actively manage water in the PCC thereby minimizing or eliminating moisture-related damage including freeze/thaw cycling and alkali silica reactivity (ASR). In addition, by controlling the amount of water entering the concrete, chloride intrusion is minimized, mold growth is inhibited, and overall PCC sustainability greatly enhanced.

PAVIX MCE™ is applicable to both central mixed and ready mixed plant operations. The method of incorporating the material into the PCC during the batching process is somewhat dependent on the specific batching equipment. However, the PAVIX MCE™ is generally added into the water feed similar to chemical admixtures.

FIELDS OF APPLICATION

- ☐ Airports.
- ☐ Highways, streets, and local roads.
- ☐ Tunnels.
- ☐ Bridge structures.
- ☐ Port facilities.
- ☐ Precast/tilt-up concrete structures.
- ☐ Cast-in-place concrete structures.
- ☐ Retaining walls.
- ☐ Concrete parking lots, sidewalks, driveways, slabs-on-grade.

PRODUCT FEATURES

- ☐ Reduction in PCC permeability (capillary porosity). ☐ Improved freeze-thaw durability.
- ☐ Reduces chloride ion penetration from deicing salts.
- ☐ Enhanced water management in all phases (primarily liquid and water vapor movement within the hardened PCC).
- ☐ Reduced alkali silica reactivity problems (ASR).
- ☐ Increased compressive strength.
- ☐ Increased workability and finishability.
- ☐ 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).
- ☐ Aids in internal curing thereby promoting more thorough hydration.

PACKAGING

Product	Packaging
PAVIX MCE™	1 GAL (3.785 LITER) JUG
	5 GAL (18.925 LITER) PAIL
	55 GAL (208 LITER) DRUM

TECHNICAL DATA

Physical Properties

Specific Gravity	1.1 – 1.2
Viscosity	2.4 centipoises
Freezing Point	28ºF (-4°C)
Boiling Point	219ºF (104 °C)
Color	Clear
Environmental Hazards	None
Odor	None
Toxicity	None
Fumes	None
Flammability	None

RELEVANT RESEARCH RESULTS

The research results presented in this document illustrate key findings and is not intended to be all inclusive. In-depth research results are available on request or in the summary document titled "Intermixed PAVIX MCE™ (Multi-Crystalline Enhancer) in Portland Cement Concrete"

Alkali-Silica Reactivity (ASR): the following tests 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 PAVIX 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.

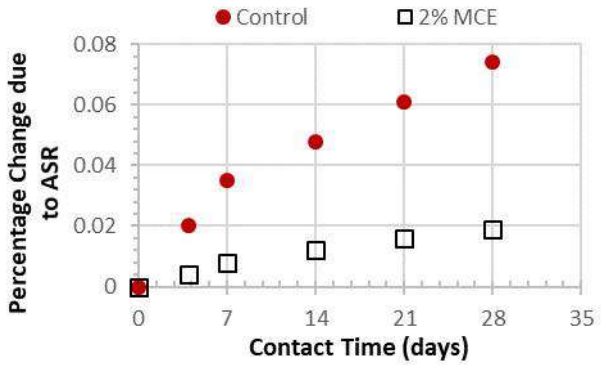


Figure 1: Increasing resistance to the alkali-silica reactions with MCE: According to ASTM C 1567, using IDOT C4 PCC mix.

Freeze-Thaw Resistance: 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 PAVIX 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.

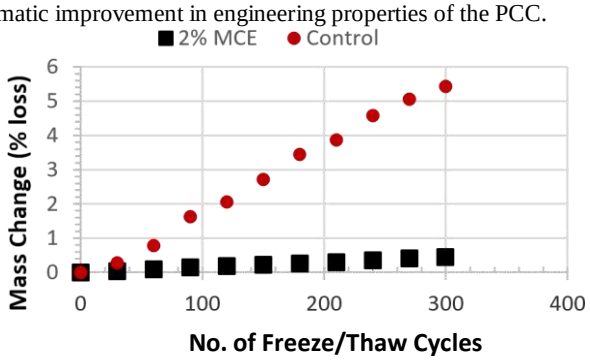


Figure 2: Increasing resistance to freeze thaw cycles with MCE at 2% of cement weight. According to ASTM C 666 using IDOT C4 PCC mix.

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

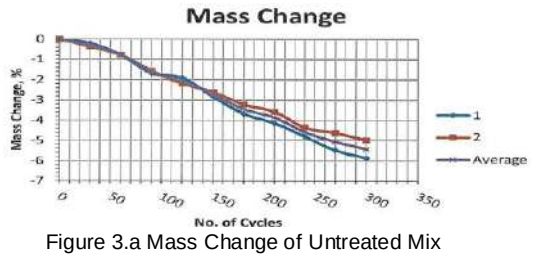


Figure 3.a Mass Change of Untreated Mix

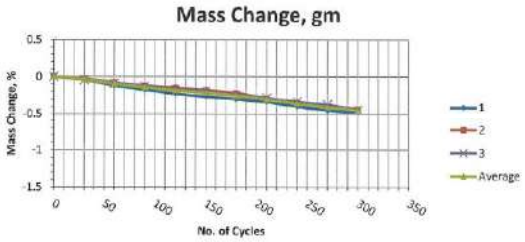


Figure 3.b Mass Change – Treated Mix 2% Internal

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

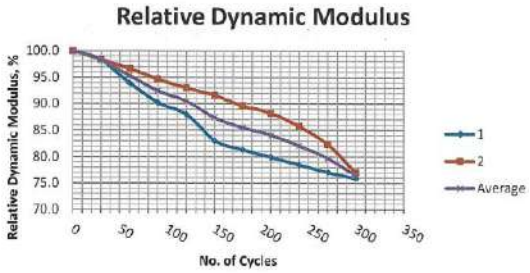


Figure 4.a: Relative Dynamic Modulus – Untreated Mix

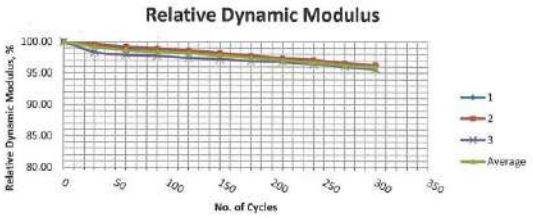


Figure 4.b: Relative Dynamic Modulus – Treated Mix 2%

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

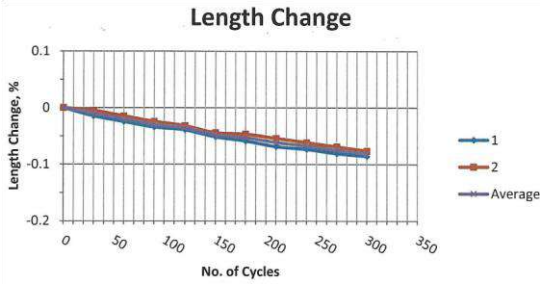


Figure 5.a Length Change – Untreated Mix

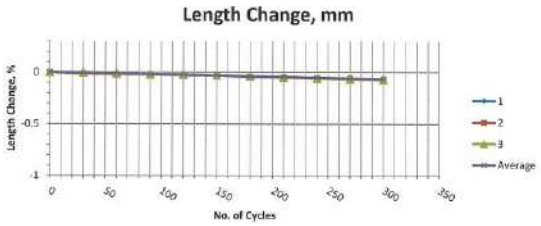


Figure 5.b Length Change – Treated Mix 2%

Compressive Strength: the average compressive strength at all ages evaluated is enhanced by the addition of the intermixed PAVIX MCE™. Most noteworthy is the average 28-day compressive strength, the curing period typically specified for highway paving, is 5.8% higher. The implications are that a pavement design thickness based on a non-MCE enhanced PCC could be slightly thinner for the same load carrying capacity.

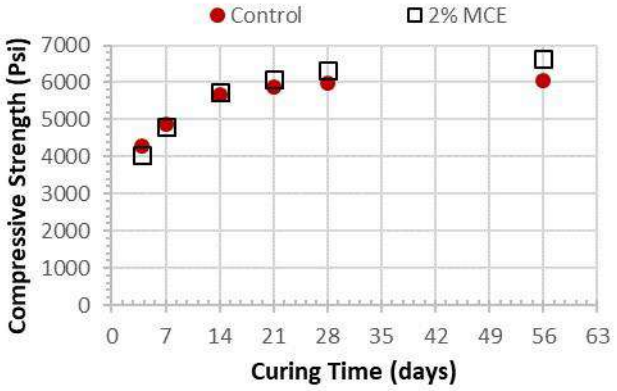


Figure 6: Enhanced compressive strength of MCE.

Resistance to Chloride Ion Penetration: the chloride permeability of the intermixed PAVIX MCE™ was evaluated according to a slightly modified ASTM C-1202, Standard Test Method for Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration procedure. The 2% intermixed sample showed a reduction of 90.7 percent compared with the baseline value. In practical terms, this implies that the concrete is less permeable, has a higher density and is more resistant to intrusion by chloride ions from deicing salts.

Workability: 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.

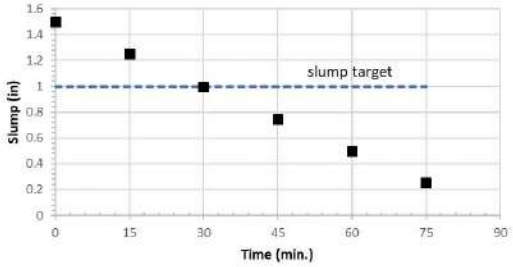


Figure 7: Enhanced workability of MCE

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

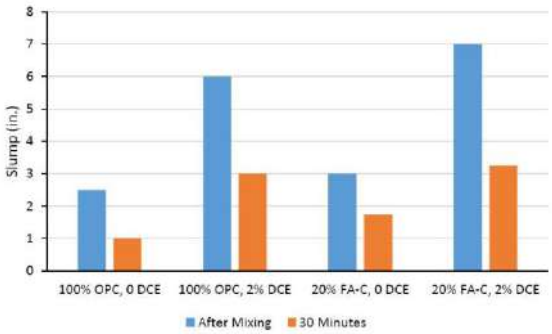


Figure 8: Concrete Workability (retention) Data

Thermal Properties: based on observations during the Freeze/Thaw (F/T) and related testing, the 2% intermixed PAVIX 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% PAVIX 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.

Preventing 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.

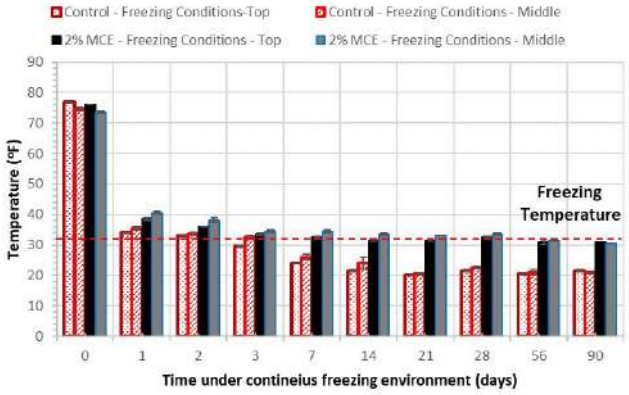


Figure 9: Concrete thermal performance under continuous freezing surroundings, reporting the temperatures at two positions: top (0.5 inch below surface) and middle (1.5 inch below surface) for a concrete with a mix design of IDOT C4, comparing control sample with concrete mixed with 2% MCE. The tests 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.

APPLICATION DATA

Method of Application: Pavix® MCE is shipped in a ready-to-use state, with no additional preparation prior to use. The product is simply mixed with the concrete at the time of batching and is applicable to both ready-mixed and central mix production**.**

Blending: The PAVIX MCE™ should be introduced into the water stream at the time of batching.

Consumption: 2% by weight of cement

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.

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.

SAFETY PRECAUTIONS

WARRANTY

LIMITED WARRANTY: International Chem-Crete Inc. warrants that, at the time and place we make shipment, our materials will be of good quality and will conform to our published specifications in force on the date of acceptance of the order.

.

DISCLAIMER: The information contained herein is included for illustrative purposes only and, to the best of our knowledge, is accurate and reliable. International Chem-Crete Inc. is not under any circumstances liable to connection with the use of information. As International Chem-Crete Inc. has no control over the use to which others may put its products, it is recommended that the products be tested to determine the suitability for specific applications and/or our information is valid in particular circumstances. Responsibility remains with the architect or engineer, contractor and owner of the design, application, and proper installation of each product. Specifier and user shall determine the suitability of the product for specific application and assume all responsibility in connection therewith.
MA101019.

Manufactured By:

International Chem-Crete Inc.
800 Security Row, Suite 1, Richardson, TX 75081, U.S.A
Tel: (972) 671-6477, Fax: (972) 238-0307
contactus@chem-crete.com ● www.chem-crete.com

Chem-Crete Europe, s.r.o.
Stanicna 13, 90851 Holic, Slovakia
Tel: +421 34 668 3181 Fax: +421 34 668 3119
www.chem-crete.sk ● info@chem-crete.sk

PAVIX® MCE™

List of Test Reports

1-29-2020

800 SECURITY ROW
RICHARDSON, TX 75081

TEL: (972) 671-6477 FAX: (972) 238-0307
contact-us@chem-crete.com www.chem-crete.com

LIST OF TEST REPORTS FOR CHEM-CRETE's PAVIX® MCE™

Absorption

05-08-2017 ASTM C642
Density, Absorption and Voids in Hardened Concrete

Alkali Silica Reaction

12-20-2017 ASTM C-1260
ASTM C-1567
Coated Aggregate

08-21-2017 ASTM C-1567
Internal Iowa Design Mix (W/C .39, .43, .47)

Chloride Ion Penetration

03-19-2019 ASTM C-1202 (AASHTO T-277 Modified)
Resistance to Chloride Ion Penetration

Thermal Studies

(#1) 03-19-2019 ASTM C-666 Rapid Freeze/Thaw (300 Cycles, -64°/77°F)

(#2) 05-14-2019 ASTM C-666 Rapid Freeze/Thaw (300 Cycles, -64°/77°F) – Repeat

(#3)05-17-2019 ASTM C-666 Rapid Freeze/Thaw (300 Cycles) Durability Test
Mass Loss
Length Change
Relative Dynamic Modulus

(#4) 05-14-2019 ASTM C-666 Continuous Freeze (-50°F, 90 Days)

(#5) 08-29-2019 ASTM C-168 Thermal Conductivity and Resistivity

(#6) 05-16-2019 Mass Concrete Study

Compression

08-22-2019 ASTM (Multiple)Compression and Flexural Strength

Slump

03-29-2019 90 Minute
05-17-2019 1 Inch Target

Humidity/Moisture Emission/Compressive Strength (TTF)

09-07-2018 ASTM F-2170 Relative Humidity
ASTM F-1869 Vapor Emission Rate
ASTM C-1074 Concrete Strength by Maturity Method

Construction Materials Testing

Project No: 1906004ICC

March 15, 2019

International ChemCrete
Attn: Mr. Radi Al-Rashed
800 Security Row
Richardson, TX 75081

Project: Pavix MCE Thermal Study
Mix ID: C4-WRC20
Design Strength: 4,000 psi at 7 days

Material	Type / Brand Source	Design Per c/y	Volume, ft³
Cement	Central Plains Type I/II	491 lbs.	2.51
Fly Ash	Headwaters Type C	123 lbs.	0.76
Coarse Aggregate	1 inch Concrete Stone (MM-Ames)	1,522 lbs.	9.10
Fine Aggregate	Sand (Hallett Materials-Booneville)	1,506 lbs.	9.07
Water	Local	246 lbs. (29.5 gallons)	3.94
Air Entrainment	GRT SA-50 (Euclid Admixtures)	6.0 % Dose as needed	1.62
Water Reducer	GRT 400-NC (Euclid Admixtures)	4.0 lq oz per cu.yd	---
Test Results			27.0 ft³

Entrained Air	3.2%
Slump	2.0 inches
Water / Cementitious Ratio	0.40

I herby certify that this engineering document was prepared by me or under my direct personal supervision and that I am a duly licensed Professional Engineer under the laws of the State of Iowa.

Sybil K. Ferrier, P.E. — Date 12-3-19
License No. 20479

My License renewal date is **December 31,** 2020.
Pages or sheets covered by this seal: All Pages.

1610 East Madison Ave. • Des Moines, Iowa 50313
(515) 263-0794 • Fax (515) 263-0851
www.cmt-iowa.com

Construction Materials Testing

Project No: 1801593ICC

December 21, 2018

International ChemCrete
Attn. Radi Al-Rashed
800 Security Row
Richardson, TX 75081

Project: Roof Decking Evaluation
Mix ID: 1 - 60/40 Grout with 2% Pavix MCE
Design Strength: 4,000 PSI

Material	Type / Brand Source	Design Per cubic yard	Volume cubic ft
Cement	Lafarge Type I/II	611 lbs.	3.11
Fine Aggregate	Concrete Sand (Martin Marietta Saylorville)	1878 lbs.	11.31
Coarse Aggregate	3/8 inch Limestone Chips (Martin Marietta Ames)	1255 lbs.	7.56
Water	Local	263 lbs. (31.6 gallons)	4.21
Entrapped Air	---	3.0%	0.81
Enhancer	Pavix MCE	2% (per 100 lbs. cem.)	
total			27.0 cu. ft

Air	N/A
Slump	N/A
Water / Cementitious Ratio	0.45
Concrete Temperature	70 °F
Ambient Temperature	72 °F

LICENSED PROFESSIONAL ENGINEER
SYBIL K. FERRIER 20479
IOWA

I hereby certify that this engineering document was prepared by me or under my direct personal supervision and that I am a duly licensed Professional Engineer under the laws of the State of Iowa.

Sybil K. Ferrier, P.E. — 12-3-19
License No. 20479 — Date

My License renewal date is **December 31, 2020**.
Pages or sheets covered by this seal: All Pages.

1610 East Madison Ave. • Des Moines, Iowa 50313
(515) 263-0794 • Fax (515) 263-0851
www.cmt-iowa.com

Construction Materials Testing

Project No: 1801593ICC

December 21, 2018

International ChemCrete
Attn. Radi Al-Rashed
800 Security Row
Richardson, TX 75081

Project: Roof Decking Evaluation
Mix ID: 2 - 55/45 Grout with 2% Pavix MCE
Design Strength: 4,000 PSI

Material	Type / Brand Source	Design Per cubic yard	Volume cubic ft
Cement	Lafarge Type I/II	611 lbs.	3.11
Fine Aggregate	Concrete Sand (Martin Marietta Saylorville)	1721 lbs.	10.37
Coarse Aggregate	3/8 inch Limestone Chips (Martin Marietta Ames)	1412 lbs.	8.51
Water	Local	263 lbs. (31.6 gallons)	4.21
Entrapped Air	---	3.0%	0.81
Enhancer	Pavix MCE	2% (per 100 lbs. cem.)	
total			27.0 cu. ft

Air	N/A
Slump	N/A
Water / Cementitious Ratio	0.45
Concrete Temperature	70 °F
Ambient Temperature	72 °F

LICENSED PROFESSIONAL ENGINEER
SYBIL K. FERRIER
20479
IOWA

I hereby certify that this engineering document was prepared by me or under my direct personal supervision and that I am a duly licensed Professional Engineer under the laws of the State of Iowa.

Sybil K. Ferrier, P.E. — 12-3-19
License No. 20479 — Date

My License renewal date is **December 31,** 2020.
Pages or sheets covered by this seal: All Pages.

1610 East Madison Ave. • Des Moines, Iowa 50313
(515) 263-0794 • Fax (515) 263-0851
www.cmt-iowa.com

Construction Materials Testing

April 24, 2017

International ChemCrete
Attn. Radi Al-Rashed
800 Security Row
Richardson, TX 75081

Project: Pavix MCE Study
Mix ID: C4-C20-.37
Design Strength: 4,000 PSI

Material	Type / Brand Source	Design Per cubic yard	Volume Per cubic yard
Cement	LeHigh Type I	451 lbs.	2.30
Fly Ash	Council Bluffs (Type C)	113 lbs.	0.70
Fine Aggregate	Concrete Sand (Martin Marietta Saylorville)	1712 lbs.	10.31
Coarse Aggregate	Concrete Stone (Martin Marietta Ames)	1729 lbs.	10.34
Water	Local	209 lbs. (25.0 gallons)	3.35
Enhancer	Pavix MCE	2% (per 100 lbs. cem.)	
Total			27.0 cu. ft

Air	0.5%
Slump	1 1/2 inches
Water / Cementitious Ratio	0.37
Concrete Temperature	70 °F
Ambient Temperature	68 °F
Time of Set (Initial at 500 psi)	137 minutes

I hereby certify that this engineering document was prepared by me or under my direct personal supervision and that I am a duly licensed Professional Engineer under the laws of the State of Iowa.

Sybil K. Ferrier 12-3-19

Sybil K. Ferrier, P.E. Date
License No. 20479

My License renewal date is **December 31,** 2020.
Pages or sheets covered by this seal: All Pages.

1610 East Madison Ave. • Des Moines, Iowa 50313
(515) 263-0794 • Fax (515) 263-0851
www.cmt-iowa.com

Construction Materials Testing

April 24, 2017

International ChemCrete
Attn. Radi Al-Rashed
800 Security Row
Richardson, TX 75081

Project: Pavix MCE Study
Mix ID: C4-C20-.50
Design Strength: 4,000 PSI

Material	Type / Brand Source	Design Per cubic yard	Volume Per cubic yard
Cement	LeHigh Type I	451 lbs.	2.30
Fly Ash	Council Bluffs (Type C)	113 lbs.	0.70
Fine Aggregate	Concrete Sand (Martin Marietta Saylorville)	1618 lbs.	9.75
Coarse Aggregate	Concrete Stone (Martin Marietta Ames)	1630 lbs.	9.75
Water	Local	281 lbs. (33.7 gallons)	4.51
Enhancer	Pavix MCE	2% (per 100 lbs. cem.)	
Total			27.0 cu. ft

Air	0.6%
Slump	6 1/2 inches
Water / Cementitious Ratio	0.50
Concrete Temperature	70 °F
Ambient Temperature	68 °F
Time of Set (Initial at 500 psi)	247 minutes

I hereby certify that this engineering document was prepared by me or under my direct personal supervision and that I am a duly licensed Professional Engineer under the laws of the State of Iowa.

Sybil K Ferrier 12-3-19

Sybil K. Ferrier, P.E. Date
License No. 20479

My License renewal date is **December 31,** 2020.
Pages or sheets covered by this seal: All Pages.

1610 East Madison Ave. • Des Moines, Iowa 50313
(515) 263-0794 • Fax (515) 263-0851
www.cmt-iowa.com

Construction Materials Testing

December 26, 2018

Project No: 1801593ICC

International ChemCrete
800 Security Row
Richardson, TX 75081

RE: Roof Decking Study
Compressive Strength / TTF
Pavix MCE Mixture

Dear Mr. Al-Rashed,

As per your request, CMT has completed Compressive Strength/Temperature Time Factor (TTF) research utilizing your Pavix MCE product for a roof decking application. Two grout mixtures were analyzed using a 55/45 and 60/40 blend of fine to coarse aggregate. The fine aggregate was comprised of typical concrete sand gradation, while the coarse aggregate was a 3/8 inch minus limestone chip gradation. The mixes were generally comprised using Lafarge Type I/II cement and a 2% dosage rate of Pavix MCE. Each mix was tested for correlation between the compressive strength and the TTF, ASTM C-1074 "*Estimating Concrete Strength by the Maturity Method*." The TTF factor gives an indication of the heat of hydration with regards to strength gain within the matrix of the mix. The results were as follows:

	TTF Reading/ Compressive Strength, psi 24 hr	**TTF Reading/ Compressive Strength, psi 3 day**	**TTF Reading/ Compressive Strength, psi 7 day**	**TTF Reading/ Compressive Strength, psi 14 day**	**TTF Reading/ Compressive Strength, psi 28 day**
55/45 Blend	495/1,540	1,082/3,175	5,010/4,825	6,388/5,935	6,996/6,635
60/40 Blend	481/1,630	1,094/3,945	4,998/5,450	6,514/6,740	7,013/7,520

The results indicate minimal differences between the two mixes in the initial 24 hour reading. The 60/40 blend appears to attain a higher strength beginning at the 3 day timeframe. This could be a factor of the aggregate mixture or a slight difference in starting temperature of the concrete mixture. Both mixes appear to be performing well beyond normal concrete expectations.

Please feel free to call should you have questions or if we may be of further assistance.

Sincerely,

Doug Clement
President/CEO
RC/SF

Sybil K. Ferrier, P.E.
Principal Engineer

1610 East Madison Ave. • Des Moines, Iowa 50313
(515) 263-0794 • Fax (515) 263-0851
www.cmt-iowa.com

Construction Materials Testing

April 16, 2019

Project No: 1901203LCS

ICC Distribution Group
4101 106th Street
Urbandale, Iowa 50322

RE: Slump Study Phase 2
2% internal Pavix MCE

Dear Mr. Logan,

As per your request, CMT has completed a research study with regards to slump value. This phase of the research was to evaluate a 1 inch and 6 inch slump. CMT created a mix design similar to an IDOT C4 mixes, utilizing 614 lbs cement, and a 50/50 blend of coarse to fine aggregate. Refer to the enclosed mix design for exact quantities. After the initial slump reading was taken, subsequent readings every 15 minutes were recorded, until 90 minutes was reached. Listed below are the results of the test. Refer to the attached photos of each time interval for slump readings.

Timeframe, min	Slump inches
Initial	7.50
15	7.50
30	7.00
45	6.75
60	5.75
75	4.00
90	3.25

Tests were conducted in general accordance with ASTM test methods and procedures noted. Please feel free to call should you have questions or if we may be of further assistance.

Sincerely,

Doug Clement
President/CEO

Sybil K. Ferrier, P.E.
Principal Engineer

DC/SF

1610 East Madison Ave. • Des Moines, Iowa 50313
(515) 263-0794 • Fax (515) 263-0851
www.cmt-iowa.com

Construction Materials Testing

Slump Observation Photos

15 min

30 min

1610 East Madison Ave. • Des Moines, Iowa 50313
(515) 263-0794 • Fax (515) 263-0851
www.cmt-iowa.com

Construction Materials Testing

45 min

60 min

1610 East Madison Ave. • Des Moines, Iowa 50313
(515) 263-0794 • Fax (515) 263-0851
www.cmt-iowa.com

Construction Materials Testing

75 min

90 Min

1610 East Madison Ave. • Des Moines, Iowa 50313
(515) 263-0794 • Fax (515) 263-0851
www.cmt-iowa.com

Construction Materials Testing

May 17, 2019

Project No: 1901203LCS

ICC Distribution Group
4101 106th Street
Urbandale, Iowa 50322

RE: Slump Study
2% internal Pavix MCE
1 inch Slump Target

Dear Mr. Logan,

As per your request, CMT has completed a research study with regards to slump value. CMT created a mix design similar to an IDOT C4 mixes, utilizing 614 lbs cement, and a 50/50 blend of coarse to fine aggregate. Refer to the enclosed mix design for exact quantities. After the initial slump reading was taken, subsequent readings every 15 minutes were recorded, until 90 minutes was reached. Listed below are the results of the test. Refer to the attached photos of each time interval for slump readings.

Timeframe, min	Slump inches
Initial	1.50
15	1.25
30	1.0
45	0.75
60	0.50
75	0.25
90	0.25

Tests were conducted in general accordance with ASTM test methods and procedures noted. Please feel free to call should you have questions or if we may be of further assistance.

Sincerely,

Doug Clement
President/CEO

Sybil K. Ferrier, P.E.
Principal Engineer

DC/SF

1610 East Madison Ave. • Des Moines, Iowa 50313
(515) 263-0794 • Fax (515) 263-0851
www.cmt-iowa.com

Construction Materials Testing

Slump Observation Photos

15 min

30 min

1610 East Madison Ave. • Des Moines, Iowa 50313
(515) 263-0794 • Fax (515) 263-0851
www.cmt-iowa.com

Construction Materials Testing

45 min

60 min

1610 East Madison Ave. • Des Moines, Iowa 50313
(515) 263-0794 • Fax (515) 263-0851
www.cmt-iowa.com

Construction Materials Testing

75 min

90 Min

1610 East Madison Ave. • Des Moines, Iowa 50313
(515) 263-0794 • Fax (515) 263-0851
www.cmt-iowa.com

Construction Materials Testing

March 29, 2019

Project No: 1901203LCS

ICC Distribution Group
4101 106th Street
Urbandale, Iowa 50322

RE: Slump Study
2% internal Pavix MCE

Dear Mr. Logan,

As per your request, CMT has completed a research study with regards to slump value. CMT created a mix design similar to an IDOT C4 mixes, utilizing 614 lbs cement, and a 50/50 blend of coarse to fine aggregate. Refer to the enclosed mix design for exact quantities. After the initial slump reading was taken, subsequent readings every 15 minutes were recorded, until 90 minutes was reached. Listed below are the results of the test. Refer to the attached photos of each time interval for slump readings.

Timeframe, min	Slump inches
Initial	7.50
15	7.50
30	7.00
45	6.75
60	5.75
75	4.00
90	3.25

Tests were conducted in general accordance with ASTM test methods and procedures noted. Please feel free to call should you have questions or if we may be of further assistance.

Sincerely,

Doug Clement
President/CEO

Sybil K. Ferrier, P.E.
Principal Engineer

DC/SF

1610 East Madison Ave. • Des Moines, Iowa 50313
(515) 263-0794 • Fax (515) 263-0851
www.cmt-iowa.com

Construction Materials Testing

Slump Observation Photos

15 min

30 min

1610 East Madison Ave. • Des Moines, Iowa 50313
(515) 263-0794 • Fax (515) 263-0851
www.cmt-iowa.com

Construction Materials Testing

45 min

60 min

1610 East Madison Ave. • Des Moines, Iowa 50313
(515) 263-0794 • Fax (515) 263-0851
www.cmt-iowa.com

Construction Materials Testing

75 min

90 Min

1610 East Madison Ave. • Des Moines, Iowa 50313
(515) 263-0794 • Fax (515) 263-0851
www.cmt-iowa.com

Construction Materials Testing

May 16, 2019

Project No: 1901203LCS

ICC Distribution Group/ICC
4101 106th Street
Urbandale, Iowa 50322

RE: Mass Concrete Study
2% internal Pavix MCE

Dear Mr. Logan,

As per your request, CMT has completed a research study with regards to mass concrete applications. CMT utilized a mix design similar to an IDOT C4WRC20 mixes, utilizing 593 lbs cementitious (474 lbs cement, 119 lbs class c fly ash), and a 50/50 blend of coarse to fine aggregate. The target w/cm ratio was 0.38. Refer to the enclosed mix design for exact quantities. After initial batching, the 5.0 yd load was treated with 2% internal, which was approximately 7.5 gallons of solution. The ready mix truck was agitated for 5 extra minutes to fully incorporate the dosage into the load before discharge. Concrete was batched at Concrete Supply of Iowa at a 4 inch slump. After the addition of 2% internal, slump increased to 7 inches. Plastic test results of the treated mix yielded an air content of 8.5%, a slump of 7 inches and a temperature of 76 °F. Compressive strength specimens were cast and will be reported separately.

A 60 inch cassion was fitted with a rebar cage, to place 9 TTF sensors at 15 inch increments throughout the mass. These were placed in a series of three, from the top, middle and bottom of the cassion. The sensors used were Smart Rock sensors from Giatec Scientific. Once placement of the concrete commenced, total time to complete the pour was approximately 10 min. Refer to the attached diagram and photos of placement operations. Enclosed are the data sheets from the TTF sensors.

From the initial 7 day data, it can be seen the heat of hydration is held much lower than traditional mass concrete pours. The temperatures averaged 115 °F, during the initial set phase. Traditionally these values can reach upwards of 180 °F. This is approximately a 36% reduction in the heat of hydration temperatures. It should be noted only four of the sensors revealed complete data. Our findings are based on those four sensors.

Tests were conducted in general accordance with ASTM test methods and procedures noted. Please feel free to call should you have questions or if we may be of further assistance.

Sincerely,

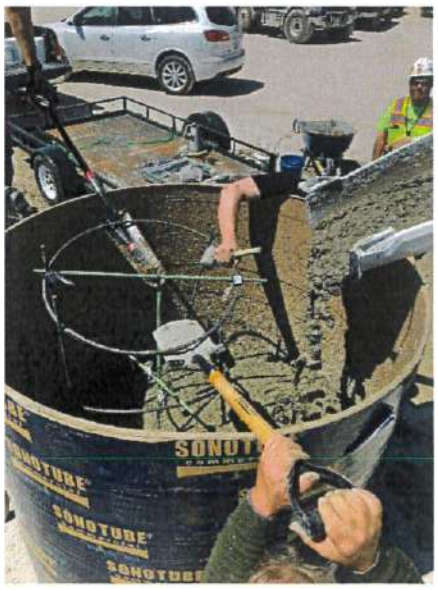
Doug Clement
President/CEO

Sybil K. Ferrier, P.E.
Principal Engineer

DC/SF

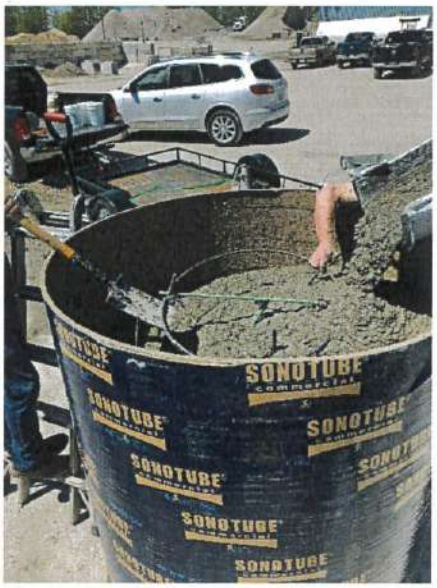
1610 East Madison Ave. • Des Moines, Iowa 50313
(515) 263-0794 • Fax (515) 263-0851
www.cmt-iowa.com

Construction Materials Testing



1610 East Madison Ave. • Des Moines, Iowa 50313
(515) 263-0794 • Fax (515) 263-0851
www.cmt-iowa.com

Construction Materials Testing



1610 East Madison Ave. • Des Moines, Iowa 50313
(515) 263-0794 • Fax (515) 263-0851
www.cmt-iowa.com

Construction Materials Testing

May 16, 2019

Project No: 1901203LCS

ICC Distribution Group/ICC
4101 106th Street
Urbandale, Iowa 50322

RE: Mass Concrete Study
2% internal Pavix MCE

Dear Mr. Logan,

As per your request, CMT has completed a research study with regards to mass concrete applications. CMT utilized a mix design similar to an IDOT C4WRC20 mixes, utilizing 593 lbs cementitious (474 lbs cement, 119 lbs class c fly ash), and a 50/50 blend of coarse to fine aggregate. The target w/cm ratio was 0.38. Refer to the enclosed mix design for exact quantities. After initial batching, the 5.0 yd load was treated with 2% internal, which was approximately 7.5 gallons of solution. The ready mix truck was agitated for 5 extra minutes to fully incorporate the dosage into the load before discharge. Concrete was batched at Concrete Supply of Iowa at a 4 inch slump. After the addition of 2% internal, slump increased to 7 inches. Plastic test results of the treated mix yielded an air content of 8.5%, a slump of 7 inches and a temperature of 76 °F. Compressive strength specimens were cast and will be reported separately.

A 60 inch cassion was fitted with a rebar cage, to place 9 TTF sensors at 15 inch increments throughout the mass. These were placed in a series of three, from the top, middle and bottom of the cassion. The sensors used were Smart Rock sensors from Giatec Scientific. Once placement of the concrete commenced, total time to complete the pour was approximately 10 min. Refer to the attached diagram and photos of placement operations. Enclosed are the data sheets from the TTF sensors.

From the initial 7 day data, it can be seen the heat of hydration is held much lower than traditional mass concrete pours. The temperatures averaged 115 °F, during the initial set phase. Traditionally these values can reach upwards of 180 °F. This is approximately a 36% reduction in the heat of hydration temperatures. It should be noted only four of the sensors revealed complete data. Our findings are based on those four sensors.

Tests were conducted in general accordance with ASTM test methods and procedures noted. Please feel free to call should you have questions or if we may be of further assistance.

Sincerely,

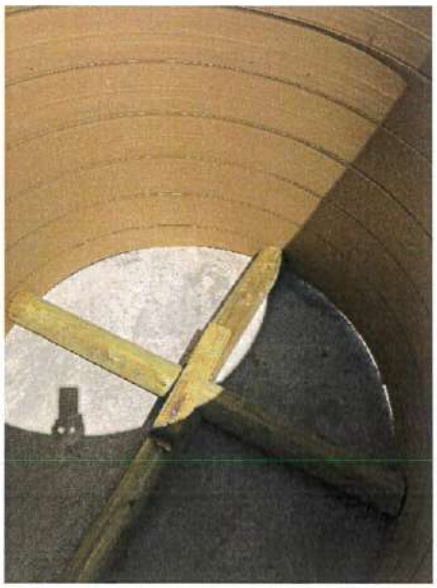
Doug Clement
President/CEO

Sybil K. Ferrier, P.E.
Principal Engineer

DC/SF

1610 East Madison Ave. • Des Moines, Iowa 50313
(515) 263-0794 • Fax (515) 263-0851
www.cmt-iowa.com

Construction Materials Testing

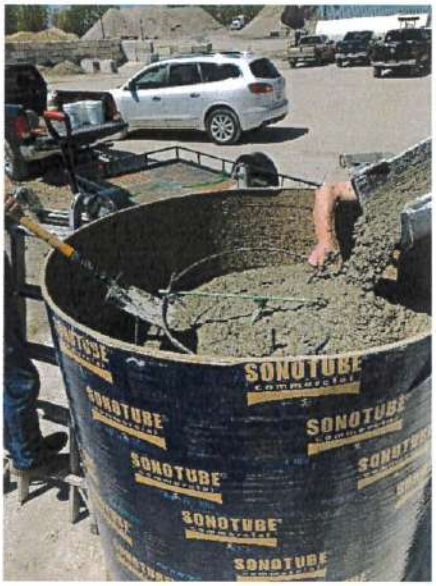


1610 East Madison Ave. • Des Moines, Iowa 50313
(515) 263-0794 • Fax (515) 263-0851
www.cmt-iowa.com

Construction Materials Testing

1610 East Madison Ave. • Des Moines, Iowa 50313
(515) 263-0794 • Fax (515) 263-0851
www.cmt-iowa.com

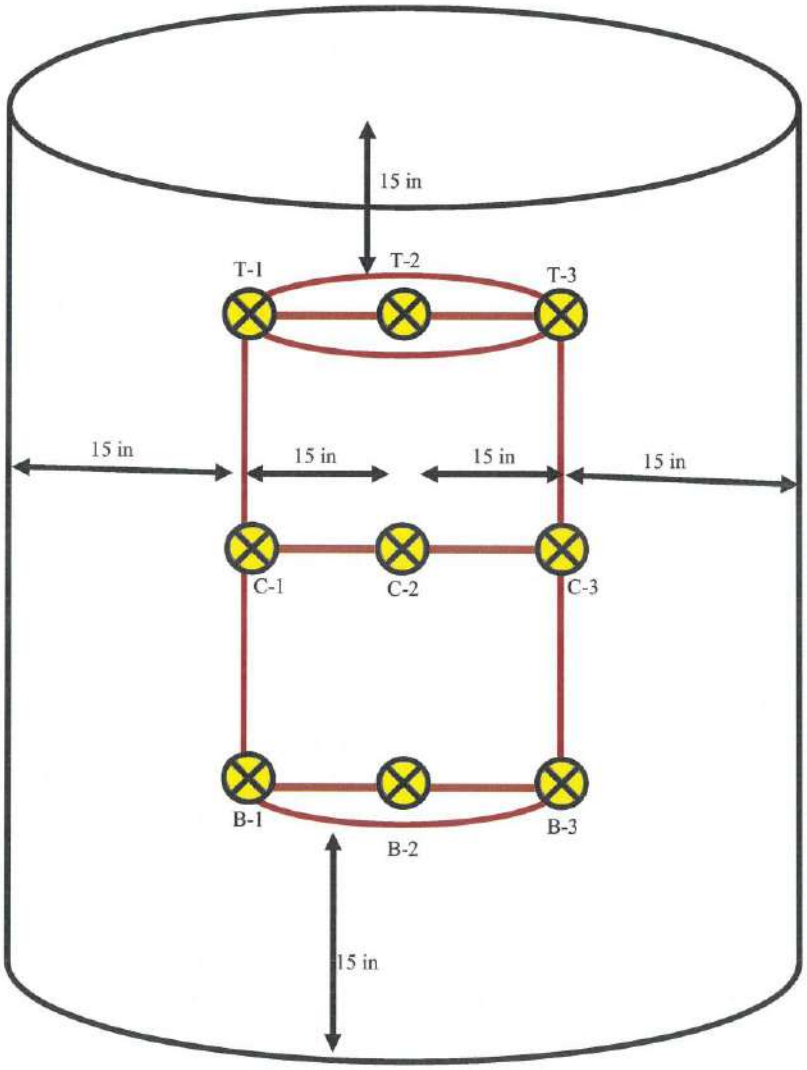
Construction Materials Testing



1610 East Madison Ave. • Des Moines, Iowa 50313
(515) 263-0794 • Fax (515) 263-0851
www.cmt-iowa.com

Construction Materials Testing

Sensor Diagram



1610 East Madison Ave. • Des Moines, Iowa 50313
(515) 263-0794 • Fax (515) 263-0851
www.cmt-iowa.com

Construction Materials Testing

May 16, 2019

Project No: 1901203LCS

ICC Distribution Group/ICC
4101 106th Street
Urbandale, Iowa 50322

RE: Mass Concrete Study
2% internal Pavix MCE

Dear Mr. Logan,

As per your request, CMT has completed a research study with regards to mass concrete applications. CMT utilized a mix design similar to an IDOT C4WRC20 mixes, utilizing 593 lbs cementitious (474 lbs cement, 119 lbs class c fly ash), and a 50/50 blend of coarse to fine aggregate. The target w/cm ratio was 0.38. Refer to the enclosed mix design for exact quantities. After initial batching, the 5.0 yd load was treated with 2% internal, which was approximately 7.5 gallons of solution. The ready mix truck was agitated for 5 extra minutes to fully incorporate the dosage into the load before discharge. Concrete was batched at Concrete Supply of Iowa at a 4 inch slump. After the addition of 2% internal, slump increased to 7 inches. Plastic test results of the treated mix yielded an air content of 8.5%, a slump of 7 inches and a temperature of 76 °F. Compressive strength specimens were cast and will be reported separately.

A 60 inch cassion was fitted with a rebar cage, to place 9 TTF sensors at 15 inch increments throughout the mass. These were placed in a series of three, from the top, middle and bottom of the cassion. The sensors used were Smart Rock sensors from Giatec Scientific. Once placement of the concrete commenced, total time to complete the pour was approximately 10 min. Refer to the attached diagram and photos of placement operations. Enclosed are the data sheets from the TTF sensors.

From the initial 7 day data, it can be seen the heat of hydration is held much lower than traditional mass concrete pours. The temperatures averaged 115 °F, during the initial set phase. Traditionally these values can reach upwards of 180 °F. This is approximately a 36% reduction in the heat of hydration temperatures. It should be noted only four of the sensors revealed complete data. Our findings are based on those four sensors.

Tests were conducted in general accordance with ASTM test methods and procedures noted. Please feel free to call should you have questions or if we may be of further assistance.

Sincerely,

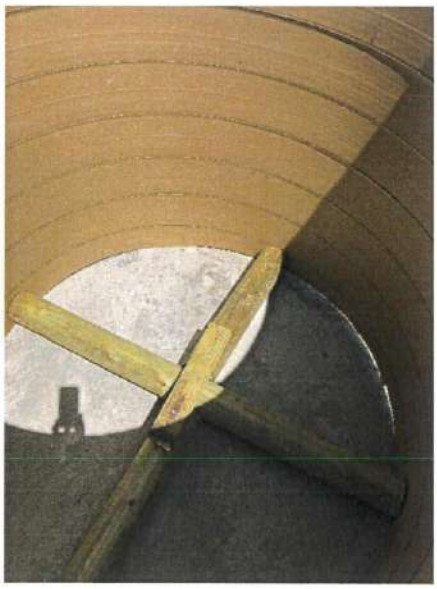
Doug Clement
President/CEO

Sybil K. Ferrier, P.E.
Principal Engineer

DC/SF

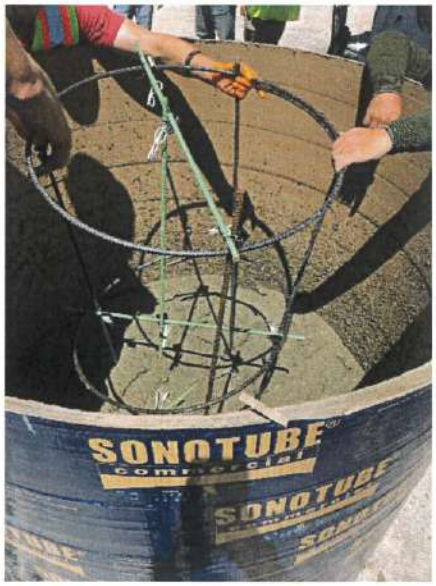
1610 East Madison Ave. • Des Moines, Iowa 50313
(515) 263-0794 • Fax (515) 263-0851
www.cmt-iowa.com

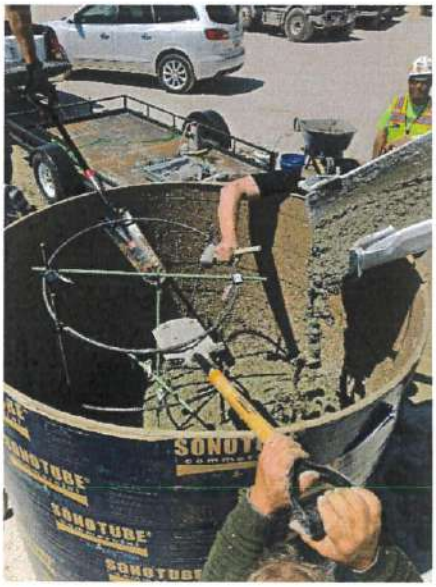
Construction Materials Testing



1610 East Madison Ave. • Des Moines, Iowa 50313
(515) 263-0794 • Fax (515) 263-0851
www.cmt-iowa.com

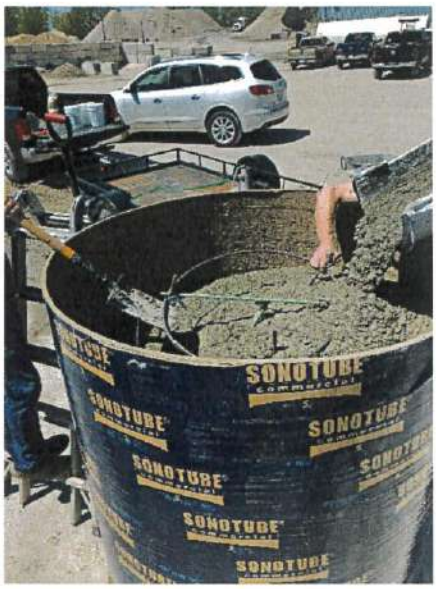
Construction Materials Testing





1610 East Madison Ave. • Des Moines, Iowa 50313
(515) 263-0794 • Fax (515) 263-0851
www.cmt-iowa.com

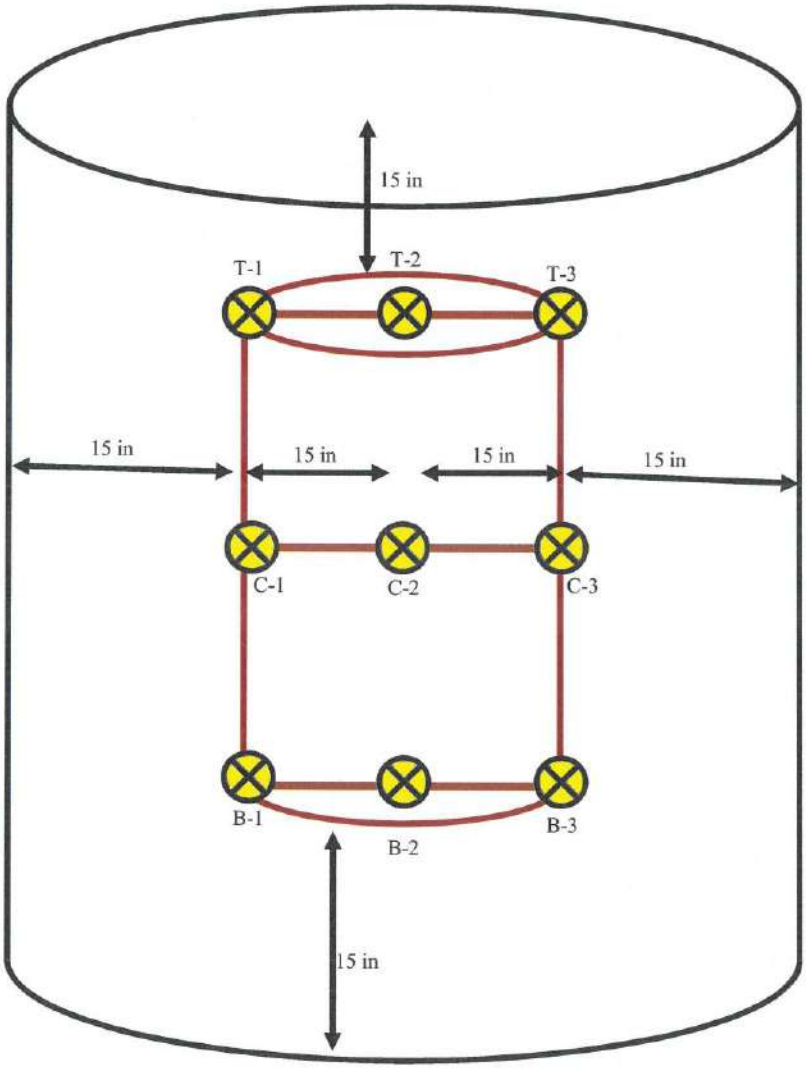
Construction Materials Testing



1610 East Madison Ave. • Des Moines, Iowa 50313
(515) 263-0794 • Fax (515) 263-0851
www.cmt-iowa.com

Construction Materials Testing

Sensor Diagram



1610 East Madison Ave. • Des Moines, Iowa 50313
(515) 263-0794 • Fax (515) 263-0851
www.cmt-iowa.com

Construction Materials Testing

July 29, 2019

Project No: 1906004ICC

International ChemCrete
Attn: Mr. Radi Al-Rashed
800 Security Row
Richardson, TX 75081

RE: Time of Set
2% Internal Study
Pavix MCE

Dear Mr. Al-Rashed,

As per your request, CMT completed a time of set study designed to determine the freeze/thaw characteristic of normal concrete and concrete treated internally with 2% Pavix MCE. The concrete mix design chosen for this study was similar to an IDOT C4 mix design, enclosed for your review. The mix was comprised of 491 lbs of Type I/II cement, 123 lbs of Class C fly ash, and a 50/50 blend of fine to coarse aggregates. The fine aggregate are silica based sands and the coarse aggregate was one inch limestone. The mix was created at a water to cementitious ratio of 0.40.

A baseline mix (untreated) and dosed mix were created. The dosed mix contained 2% Pavix MCE internal by weight of cementitious. Specimens were cast into 3 x 3 x 16 inch beams, to fit the freeze/thaw chamber. Thermal probes were placed into the specimens at two depths. The depths were 0.5 inches and 1.5 inches below the surface of the concrete. After initial casting of specimens, the specimens were placed immediately into the freeze/thaw chamber for thermal cycling. This chamber is commonly used for ASTM C-666 testing. This chamber cycles the ambient temperatures between -20 to 40 °F (-29 to 4 °C), when using for ASTM C-666. For this study, the temperature range was increased to cycle between -64 to 77 °F (-53 to 22 °C).

At this extreme temperature, the concrete matrix did not have time to fully hydrate all the free water. The specimens froze within a 85 minute time frame, with visible frozen crystals of water on the surface of the specimen and low internal temperatures. This is an indication that in order for the product to produce it's thermal resistivity, the concrete must be protected from extreme temperatures through the initial set time of the concrete. The higher the water/cementitious ration, the more time necessary. The product protects the concrete only after initial hydration has been completed. This is a re-test of a previous study that yielded similar results (90 mins).

Please feel free to call should you have questions or if we may be of further assistance.

Sincerely,

Doug Clement
President/CEO

Sybil K. Ferrier, P.E.
Principal Engineer

DC/SF

1610 East Madison Ave. • Des Moines, Iowa 50313
(515) 263-0794 • Fax (515) 263-0851
www.cmt-iowa.com

Construction Materials Testing

May 16, 2019

Project No: 1906004ICC

International ChemCrete
Attn: Mr. Radi Al-Rashed
800 Security Row
Richardson, TX 75081

RE: Time of Set
2% Internal Study
Pavix MCE

Dear Mr. Al-Rashed,

As per your request, CMT completed a time of set study designed to determine the freeze/thaw characteristic of normal concrete and concrete treated internally with 2% Pavix MCE. The concrete mix design chosen for this study was similar to an IDOT C4 mix design, enclosed for your review. The mix was comprised of 491 lbs of Type I/II cement, 123 lbs of Class C fly ash, and a 50/50 blend of fine to coarse aggregates. The fine aggregate are silica based sands and the coarse aggregate was one inch limestone. The mix was created at a water to cementitious ratio of 0.40.

A baseline mix (untreated) and dosed mix were created. The dosed mix contained 2% Pavix MCE internal by weight of cementitious. Specimens were cast into 3 x 3 x 16 inch beams, to fit the freeze/thaw chamber. Thermal probes were placed into the specimens at two depths. The depths were 0.5 inches and 1.5 inches below the surface of the concrete. After initial casting of specimens, the specimens were placed immediately into the freeze/thaw chamber for thermal cycling. This chamber is commonly used for ASTM C-666 testing. This chamber cycles the ambient temperatures between -20 to 40 °F (-29 to 4 °C), when using for ASTM C-666. For this study, the temperature range was increased to cycle between -64 to 77 °F (-53 to 22 °C).

At this extreme temperature, the concrete matrix did not have time to fully hydrate all the free water. The specimens froze within a 90 minute time frame, with visible frozen crystals of water on the surface of the specimen and low internal temperatures. This is an indication that in order for the product to produce it's thermal resistivity, the concrete must be protected from extreme temperatures through the initial set time of the concrete. The higher the water/cementitious ration, the more time necessary. The product protects the concrete only after initial hydration has been completed.

Please feel free to call should you have questions or if we may be of further assistance.

Sincerely,

Doug Clement
President/CEO

Sybil K. Ferrier, P.E.
Principal Engineer

DC/SF

1610 East Madison Ave. • Des Moines, Iowa 50313
(515) 263-0794 • Fax (515) 263-0851
www.cmt-iowa.com

Construction Materials Testing

November 12, 2019

Project No: 1906004ICC

International ChemCrete
Attn: Mr. Radi Al-Rashed
800 Security Row
Richardson, TX 75081

RE: Pavix MCE Thermal Study
Re-verification

Dear Mr. Al-Rashed,

As per your request, CMT completed a study designed to determine the thermal conductivity and freeze/thaw characteristic of normal concrete and concrete treated with Pavix MCE. The concrete mix design chosen for this study was similar to an IDOT C4 mix design, enclosed for your review. The mix was comprised of 491 lbs of Type I/II cement, 123 lbs of Class C fly ash, and a 50/50 blend of fine to coarse aggregates. The fine aggregate are silica based sands and the coarse aggregate was one inch limestone. The mix was created at a water to cementitious ratio of 0.40.

A baseline mix (untreated) and dosed mix were created. Specimens were cast on August 12, 2019. The dosed mix contained 2% Pavix MCE internal by weight of cementitious. Specimens were cast into 3 x 3 x 16 inch beams, to fit the freeze/thaw chamber. Thermal probes were placed into the specimens at two depths. The depths were 0.5 inches and 1.5 inches below the surface of the concrete. After initial curing (24 hrs), the specimens were placed into the freeze/thaw chamber for thermal testing. This chamber is commonly used for ASTM C-666 testing. This chamber cycles the ambient temperatures between -20 to 40 °F (-29 to 4 °C), when using for ASTM C-666. For this study, the temperature range was lowered and held at a constant -50 °F (-45 °C). The samples were maintained at this ambient temperature and monitored for internal temperature fluctuations. Listed below is a summary of the thermal readings taken periodically throughout the testing.

Table 1. Non-Treated Specimens (Baseline)

Specimen	Non Treated 1 Top/Middle	Non Treated 2 Top/Middle	Average Top Temperature	Average Middle Temperature
Temperature at Casting, °F	77/74	77/74	77	74.0
Temperature at Immersion, °F,	77/74	77/75	77	74.5
Temperature at 1 day, °F, Freeze	34/36	34/35	34	35.5
Temperature at 2 days, °F, Freeze	33/34	33/33	33	33.5
Temperature at 3 days, °F, Freeze	29/33	30/32	29.5	32.5
Temperature at 7 days, °F, Freeze	24/25	24/27	24	26.0
Temperature at 14 days, °F, Freeze	21/22	22/26	21.5	24.0
Temperature at 21 day, °F, Freeze	20/20	20/21	20.0	20.5
Temperature at 28 days, °F, Freeze	21/22	22/23	21.5	22.5
Temperature at 56 days, °F, Freeze	20/22	21/20	21.0	20.5
Temperature at 90 days, °F, Freeze	21/21	22/21	21.0	21.5

1610 East Madison Ave. • Des Moines, Iowa 50313
(515) 263-0794 • Fax (515) 263-0851
www.cmt-iowa.com

Construction Materials Testing

Table 2. Treated Specimens (2% Internal)

Specimen	Treated 1 Top/Middle	Treated 2 Top/Middle	Average Top Temperature	Average Middle Temperature
Temperature at Casting, °F	77/74	77/74	77.0	74.0
Temperature at Immersion, °F,	76/73	76/74	76.0	73.5
Temperature at 1 day, °F, Freeze	38/40	39/41	38.5	40.5
Temperature at 2 days, °F, Freeze	36/37	36/39	36.0	38.0
Temperature at 3 days, °F, Freeze	33/34	34/35	33.5	34.5
Temperature at 7 days, °F, Freeze	32/34	33/35	32.5	34.5
Temperature at 14 days, °F, Freeze	31/34	32/33	31.5	33.5
Temperature at 21 day, °F, Freeze	31/33	32/33	31.5	33.0
Temperature at 28 days, °F, Freeze	32/33	33/34	32.5	33.5
Temperature at 56 days, °F, Freeze	30/32	32/31	31	31.5
Temperature at 90 days, °F, Freeze	30/30	32/31	30	31.5

These specimens were monitored for temperatures through the 90 day reading. The specimens will be retained at CMT for 30 days. Please feel free to call should you have questions or if we may be of further assistance.

Sincerely,

Doug Clement
President/CEO

Sybil K. Ferrier, P.E.
Principal Engineer

DC/SF

1610 East Madison Ave. • Des Moines, Iowa 50313
(515) 263-0794 • Fax (515) 263-0851
www.cmt-iowa.com

Construction Materials Testing

November 4, 2019

Project No: 1906004ICC

International ChemCrete
Attn: Mr. Radi Al-Rashed
800 Security Row
Richardson, TX 75081

RE: Pavix MCE Thermal Study
Re-verification

Dear Mr. Al-Rashed,

As per your request, CMT completed a study designed to determine the thermal conductivity and freeze/thaw characteristic of normal concrete and concrete treated with Pavix MCE. The concrete mix design chosen for this study was similar to an IDOT C4 mix design, enclosed for your review. The mix was comprised of 491 lbs of Type I/II cement, 123 lbs of Class C fly ash, and a 50/50 blend of fine to coarse aggregates. The fine aggregate are silica based sands and the coarse aggregate was one inch limestone. The mix was created at a water to cementitious ratio of 0.40.

A baseline mix (untreated) and dosed mix were created. Specimens were cast on August 12, 2019. The dosed mix contained 2% Pavix MCE internal by weight of cementitious. Specimens were cast into 3 x 3 x 16 inch beams, to fit the freeze/thaw chamber. Thermal probes were placed into the specimens at two depths. The depths were 0.5 inches and 1.5 inches below the surface of the concrete. After initial curing (24 hrs), the specimens were placed into the freeze/thaw chamber for thermal testing. This chamber is commonly used for ASTM C-666 testing. This chamber cycles the ambient temperatures between -20 to 40 °F (-29 to 4 °C), when using for ASTM C-666. For this study, the temperature range was lowered and held at a constant -50 °F (-45 °C). The samples were maintained at this ambient temperature and monitored for internal temperature fluctuations. Listed below is a summary of the thermal readings taken periodically throughout the testing.

Table 1. Non-Treated Specimens (Baseline)

Specimen	Non Treated 1 Top/Middle	Non Treated 2 Top/Middle	Average Top Temperature	Average Middle Temperature
Temperature at Casting, °F	77/74	77/74	77	74.0
Temperature at Immersion, °F,	77/74	77/75	77	74.5
Temperature at 1 day, °F, Freeze	34/36	34/35	34	35.5
Temperature at 2 days, °F, Freeze	33/34	33/33	33	33.5
Temperature at 3 days, °F, Freeze	29/33	30/32	29.5	32.5
Temperature at 7 days, °F, Freeze	24/25	24/27	24	26.0
Temperature at 14 days, °F, Freeze	21/22	22/26	21.5	24.0
Temperature at 21 day, °F, Freeze	20/20	20/21	20.0	20.5
Temperature at 28 days, °F, Freeze	21/22	22/23	21.5	22.5
Temperature at 56 days, °F, Freeze	20/22	21/20	21.0	20.5
Temperature at 60 days, °F, Freeze				

1610 East Madison Ave. • Des Moines, Iowa 50313
(515) 263-0794 • Fax (515) 263-0851
www.cmt-iowa.com

Construction Materials Testing

Table 2. Treated Specimens (2% Internal)

Specimen	Treated 1 Top/Middle	Treated 2 Top/Middle	Average Top Temperature	Average Middle Temperature
Temperature at Casting, °F	77/74	77/74	77.0	74.0
Temperature at Immersion, °F,	76/73	76/74	76.0	73.5
Temperature at 1 day, °F, Freeze	38/40	39/41	38.5	40.5
Temperature at 2 days, °F, Freeze	36/37	36/39	36.0	38.0
Temperature at 3 days, °F, Freeze	33/34	34/35	33.5	34.5
Temperature at 7 days, °F, Freeze	32/34	33/35	32.5	34.5
Temperature at 14 days, °F, Freeze	31/34	32/33	31.5	33.5
Temperature at 21 day, °F, Freeze	31/33	32/33	31.5	33.0
Temperature at 28 days, °F, Freeze	32/33	33/34	32.5	33.5
Temperature at 56 days, °F, Freeze	30/32	32/31	31	31.5
Temperature at 90 days, °F, Freeze				

These specimens will be monitored for temperatures through the 90 day reading. Please feel free to call should you have questions or if we may be of further assistance.

Sincerely,

Doug Clement
President/CEO

Sybil K. Ferrier, P.E.
Principal Engineer

DC/SF

1610 East Madison Ave. • Des Moines, Iowa 50313
(515) 263-0794 • Fax (515) 263-0851
www.cmt-iowa.com

Construction Materials Testing

October 8, 2019

Project No: 1906004ICC

International ChemCrete
Attn: Mr. Radi Al-Rashed
800 Security Row
Richardson, TX 75081

RE: Pavix MCE Thermal Study
Re-verification

Dear Mr. Al-Rashed,

As per your request, CMT completed a study designed to determine the thermal conductivity and freeze/thaw characteristic of normal concrete and concrete treated with Pavix MCE. The concrete mix design chosen for this study was similar to an IDOT C4 mix design, enclosed for your review. The mix was comprised of 491 lbs of Type I/II cement, 123 lbs of Class C fly ash, and a 50/50 blend of fine to coarse aggregates. The fine aggregate are silica based sands and the coarse aggregate was one inch limestone. The mix was created at a water to cementitious ratio of 0.40.

A baseline mix (untreated) and dosed mix were created. Specimens were cast on August 12, 2019. The dosed mix contained 2% Pavix MCE internal by weight of cementitious. Specimens were cast into 3 x 3 x 16 inch beams, to fit the freeze/thaw chamber. Thermal probes were placed into the specimens at two depths. The depths were 0.5 inches and 1.5 inches below the surface of the concrete. After initial curing (24 hrs), the specimens were placed into the freeze/thaw chamber for thermal testing. This chamber is commonly used for ASTM C-666 testing. This chamber cycles the ambient temperatures between -20 to 40 °F (-29 to 4 °C), when using for ASTM C-666. For this study, the temperature range was lowered and held at a constant -50 °F (-45 °C). The samples were maintained at this ambient temperature and monitored for internal temperature fluctuations. Listed below is a summary of the thermal readings taken periodically throughout the testing.

Table 1. Non-Treated Specimens (Baseline)

Specimen	Non Treated 1 Top/Middle	Non Treated 2 Top/Middle	Average Top Temperature	Average Middle Temperature
Temperature at Casting, °F	77/74	77/74	77	74.0
Temperature at Immersion, °F,	77/74	77/75	77	74.5
Temperature at 1 day, °F, Freeze	34/36	34/35	34	35.5
Temperature at 2 days, °F, Freeze	33/34	33/33	33	33.5
Temperature at 3 days, °F, Freeze	29/33	30/32	29.5	32.5
Temperature at 7 days, °F, Freeze	24/25	24/27	24	26.0
Temperature at 14 days, °F, Freeze	21/22	22/26	21.5	24.0
Temperature at 21 day, °F, Freeze	20/20	20/21	20.0	20.5
Temperature at 28 days, °F, Freeze	21/22	22/23	21.5	22.5

1610 East Madison Ave. • Des Moines, Iowa 50313
(515) 263-0794 • Fax (515) 263-0851
www.cmt-iowa.com

Construction Materials Testing

Table 2. Treated Specimens (2% Internal)

Specimen	Treated 1 Top/Middle	Treated 2 Top/Middle	Average Top Temperature	Average Middle Temperature
Temperature at Casting, °F	77/74	77/74	77.0	74.0
Temperature at Immersion, °F,	76/73	76/74	76.0	73.5
Temperature at 1 day, °F, Freeze	38/40	39/41	38.5	40.5
Temperature at 2 days, °F, Freeze	36/37	36/39	36.0	38.0
Temperature at 3 days, °F, Freeze	33/34	34/35	33.5	34.5
Temperature at 7 days, °F, Freeze	32/34	33/35	32.5	34.5
Temperature at 14 days, °F, Freeze	31/34	32/33	31.5	33.5
Temperature at 21 day, °F, Freeze	31/33	32/33	31.5	33.0
Temperature at 28 days, °F, Freeze	32/33	33/34	32.5	33.5

These specimens will be monitored for temperatures through the 28 day reading. Please feel free to call should you have questions or if we may be of further assistance.

Sincerely,

Doug Clement
President/CEO

Sybil K. Ferrier, P.E.
Principal Engineer

DC/SF

1610 East Madison Ave. • Des Moines, Iowa 50313
(515) 263-0794 • Fax (515) 263-0851
www.cmt-iowa.com

Construction Materials Testing

May 14, 2019

Project No: 1906004ICC

International ChemCrete
Attn: Mr. Radi Al-Rashed
800 Security Row
Richardson, TX 75081

RE: Pavix MCE Thermal Study
Re-verification

Dear Mr. Al-Rashed,

As per your request, CMT completed a study designed to determine the thermal conductivity and freeze/thaw characteristic of normal concrete and concrete treated with Pavix MCE. The concrete mix design chosen for this study was similar to an IDOT C4 mix design, enclosed for your review. The mix was comprised of 491 lbs of Type I/II cement, 123 lbs of Class C fly ash, and a 50/50 blend of fine to coarse aggregates. The fine aggregate are silica based sands and the coarse aggregate was one inch limestone. The mix was created at a water to cementitious ratio of 0.40.

A baseline mix (untreated) and dosed mix were created. The dosed mix contained 2% Pavix MCE internal by weight of cementitious. Specimens were cast into 3 x 3 x 16 inch beams, to fit the freeze/thaw chamber. Thermal probes were placed into the specimens at two depths. The depths were 0.5 inches and 1.5 inches below the surface of the concrete. After initial curing (24 hrs), the specimens were placed into the freeze/thaw chamber for thermal cycling. This chamber is commonly used for ASTM C-666 testing. This chamber cycles the ambient temperatures between -20 to 40 °F (-29 to 4 °C), when using for ASTM C-666. For this study, the temperature range was increased to cycle between -64 to 77 °F (-53 to 22 °C). The samples were cycled through 300 freeze/thaw cycles, averaging 8 hours per cycle. Listed below is a summary of the thermal readings taken periodically throughout the testing.

Table 1. Non-Treated Specimens (Baseline)

Specimen	Non Treated 1 Top/Middle	Non Treated 2 Top/Middle	Non Treated 3 Top/Middle	Average Top Temperature	Average Middle Temperature
Temperature at Immersion, °F	75	75	75	---	---
Temperature at 100 cycles, °F, Thaw	62/62	63/61	63/61	62.7	61.3
Temperature at 100 cycles, °F, Freeze	18/19	14/18	16/19	16.7	18.7
Temperature at 200 cycles, °F, Thaw	70/73	75/73	73/77	72.7	74.3
Temperature at 200 cycles, °F, Freeze	17/18	16/19	16/19	16.3	18.7
Temperature at 300 cycles, °F, Thaw	75/70	76/73	78/72	76.3	71.7
Temperature at 300 cycles, °F, Freeze	16/19	13/14	16/19	15.0	17.3

1610 East Madison Ave. • Des Moines, Iowa 50313
(515) 263-0794 • Fax (515) 263-0851
www.cmt-iowa.com

Construction Materials Testing

Table 2. 2% Internal Treated Specimens

Specimen	Treated 1 Top/Middle	Treated 2 Top/Middle	Treated 3 Top/Middle	Average Top Temperature	Average Middle Temperature
Temperature at Immersion, °F	78	76	75	---	---
Temperature at 100 cycles, °F, Thaw	65/69	66/69	70/72	67.0	70.0
Temperature at 100 cycles, °F, Freeze	39/42	39/41	40/42	39.3	41.7
Temperature at 200 cycles, °F, Thaw	73/74	39/71	66/70	69.3	71.7
Temperature at 200 cycles, °F, Freeze	42/44	40/40	42/40	41.3	41.3
Temperature at 300 cycles, °F, Thaw	72/74	71/74	73/76	72.0	74.7
Temperature at 300 cycles, °F, Freeze	36/38	37/38	38/40	37.0	38.7

Based on the above results, the treated samples never became completely frozen. The temperatures during the thaw cycle were consistent between both treated and untreated samples.

Please feel free to call should you have questions or if we may be of further assistance.

Sincerely,

Doug Clement
President/CEO

Sybil K. Ferrier, P.E.
Principal Engineer

DC/SF

1610 East Madison Ave. • Des Moines, Iowa 50313
(515) 263-0794 • Fax (515) 263-0851
www.cmt-iowa.com

Construction Materials Testing

March 19, 2019

Project No: 1906004ICC

International ChemCrete
Attn: Mr. Radi Al-Rashed
800 Security Row
Richardson, TX 75081

RE: Pavix MCE Thermal Study

Dear Mr. Al-Rashed,

As per your request, CMT completed a study designed to determine the thermal conductivity and freeze/thaw characteristic of normal concrete and concrete treated with Pavix MCE. The concrete mix design chosen for this study was similar to an IDOT C4 mix design, enclosed for your review. The mix was comprised of 491 lbs of Type I/II cement, 123 lbs of Class C fly ash, and a 50/50 blend of fine to coarse aggregates. The fine aggregate are silica based sands and the coarse aggregate was one inch limestone. The mix was created at a water to cementitious ratio of 0.40.

A baseline mix (untreated) and dosed mix were created. The dosed mix contained 2% Pavix MCE internal by weight of cementitious. Specimens were cast into 3 x 3 x 16 inch beams, to fit the freeze/thaw chamber. Thermal probes were placed into the specimens at two depths. The depths were 0.5 inches and 1.5 inches below the surface of the concrete. After initial curing (24 hrs), the specimens were placed into the freeze/thaw chamber for thermal cycling. This chamber is commonly used for ASTM C-666 testing. This chamber cycles the ambient temperatures between -20 to 40 °F (-29 to 4 °C), when using for ASTM C-666. For this study, the temperature range was increased to cycle between -64 to 77 °F (-53 to 22 °C). The samples were cycled through 300 freeze/thaw cycles, averaging 8 hours per cycle. Listed below is a summary of the thermal readings taken periodically throughout the testing.

Table 1. Non-Treated Specimens

Specimen	Non Treated 1 Top/Middle	Non Treated 2 Top/Middle	Non Treated 3 Top/Middle	Average Top Temperature	Average Middle Temperature
Temperature at Immersion, °F	77	76	77	---	---
Temperature at 100 cycles, °F, Thaw	63/62	62/62	63/63	62.6	62.3
Temperature at 100 cycles, °F, Freeze	11/13	12/13	11/11	11.3	12.3
Temperature at 200 cycles, °F, Thaw	76/76	77/73	77/77	76.6	75.3
Temperature at 200 cycles, °F, Freeze	12/12	11/12	11/11	11.3	11.6
Temperature at 300 cycles, °F, Thaw	76/76	77/77	77/77	76.6	76.6
Temperature at 300 cycles, °F, Freeze	11/11	12/11	12/12	11.6	11.3

1610 East Madison Ave. • Des Moines, Iowa 50313
(515) 263-0794 • Fax (515) 263-0851
www.cmt-iowa.com

Construction Materials Testing

Table 2. 2% Internal Treated Specimens

Specimen	Treated 1 Top/Middle	Treated 2 Top/Middle	Treated 3 Top/Middle	Average Top Temperature	Average Middle Temperature
Temperature at Immersion, °F	77	77	77	---	---
Temperature at 100 cycles, °F, Thaw	63/64	63/63	63/63	63	63.3
Temperature at 100 cycles, °F, Freeze	46/48	47/48	48/47	47	47.6
Temperature at 200 cycles, °F, Thaw	77/76	77/77	77/77	77	76.6
Temperature at 200 cycles, °F, Freeze	41/43	42/43	41/43	41.3	43
Temperature at 300 cycles, °F, Thaw	77/77	76/77	77/77	76.6	77
Temperature at 300 cycles, °F, Freeze	43/42	41/41	41/42	41.6	41.6

Based on the above results, the treated samples never became completely frozen. The temperatures during the thaw cycle were consistent between both treated and untreated samples.

Please feel free to call should you have questions or if we may be of further assistance.

Sincerely,

Doug Clement
President/CEO

Sybil K. Ferrier, P.E.
Principal Engineer

DC/SF

1610 East Madison Ave. • Des Moines, Iowa 50313
(515) 263-0794 • Fax (515) 263-0851
www.cmt-iowa.com

Construction Materials Testing

August 29, 2019

Project No: 1906004ICC

International ChemCrete
Attn: Mr. Radi Al-Rashed
800 Security Row
Richardson, TX 75081

RE: Thermal Conductivity / Resistivity
2% internal Pavix MCE
Re-evaluation

Dear Mr. Al-Rashed,

As per your request, CMT completed the study to compare K-value and R-value readings on standard exterior concrete and the same mix dosed with 2% internal Pavix MCE. The mix design utilized is an IDOT C4 mix, comprised of 491 lbs Type I/II cement, 123 lbs class C fly ash, and a 50/50 blend of coarse/fine aggregate. The fine aggregate is a natural sand and the coarse aggregate was a ¾ inch limestone. The mix was created at a water to cementitious ratio (w/cm) of 0.45. This mix has been utilized extensively in previous studies provided to you for your Pavix MCE product.

To understand the K-value, CMT referenced ASTM C-168, which defines the K-value as thermal conductivity. The value is defined as the time rate of steady state heat flow through a unit area of homogenous material (in this case, PCC), induced by a unit temperature gradient in a direction perpendicular to that area. In essence, the amount of heat that can be transferred through a particular material at a rate defined by area and speed. The R-value, as determined by ASTM C-168, is a reading of thermal resistance. It is the quantity determined by the temperature difference at a steady state between two defined surfaces of a material or construction package that induces a heat flow through a unit area. R-value is affected by thickness and can be calculated using multiple layers of materials, as in the exterior PCC, wood, insulation and drywall of home construction. For this study, CMT was verifying the PCC portion of this, as noted above.

Sample ID	K-value (inch/hr per sq ft per °F)	R-Value (°F • sq ft • hr / BTUs)
Non-Treated (Baseline) Mix	1.92	0.52
2% internal Pavix MCE Mix	1.61	0.62

The results noted above are the average of multiple tests on one inch thick panels, in order to establish reasonably consistent readings. The internal moisture of the concrete has been noted to affect the tests conducted by other laboratories in previous studies. It appears the Pavix MCE usage of moisture increases the performance of the PCC as an insulator by lowering the K-value and raising the R-value. It should be noted the increase in performance (16% in K-value, 15% in R-value) will be magnified as thickness is increased. These values fall within normal parameters of previous studies conducted on similar concrete mixes. This study was conducted in conjunction with Element Laboratories of Des Moines, Iowa.

Please feel free to call should you have questions or if we may be of further assistance.

Sincerely,

Doug Clement
President/CEO

Sybil K. Ferrier, P.E.
Principal Engineer

DC/SF

1610 East Madison Ave. • Des Moines, Iowa 50313
(515) 263-0794 • Fax (515) 263-0851
www.cmt-iowa.com

Construction Materials Testing

June 14, 2019

Project No: 1906004ICC

International ChemCrete
Attn: Mr. Radi Al-Rashed
800 Security Row
Richardson, TX 75081

RE: Thermal Conductivity / Resistivity
2% internal Pavix MCE

Dear Mr. Al-Rashed,

As per your request, CMT completed the study to compare K-value and R-value readings on standard exterior concrete and the same mix dosed with 2% internal Pavix MCE. The mix design utilized is an IDOT C4 mix, comprised of 491 lbs Type I/II cement, 123 lbs class C fly ash, and a 50/50 blend of coarse/fine aggregate. The fine aggregate is a natural sand and the coarse aggregate was a ¾ inch limestone. The mix was created at a water to cementitious ratio (w/cm) of 0.45. This mix has been utilized extensively in previous studies provided to you for your Pavix MCE product.

To understand the K-value, CMT referenced ASTM C-168, which defines the K-value as thermal conductivity. The value is defined as the time rate of steady state heat flow through a unit area of homogenous material (in this case, PCC), induced by a unit temperature gradient in a direction perpendicular to that area. In essence, the amount of heat that can be transferred through a particular material at a rate defined by area and speed. The R-value, as determined by ASTM C-168, is a reading of thermal resistance. It is the quantity determined by the temperature difference at a steady state between two defined surfaces of a material or construction package that induces a heat flow through a unit area. R-value is affected by thickness and can be calculated using multiple layers of materials, as in the exterior PCC, wood, insulation and drywall of home construction. For this study, CMT was verifying the PCC portion of this, as noted above.

Sample ID	K-value (inch/hr per sq ft per °F)	R-Value (°F • sq ft • hr / BTUs)
Non-Treated (Baseline) Mix	1.96	0.08
2% internal Pavix MCE Mix	1.67	0.09

The results noted above are the average of multiple tests on one inch thick panels, in order to establish reasonably consistent readings. The internal moisture of the concrete has been noted to affect the tests conducted by other laboratories in previous studies. It appears the Pavix MCE usage of moisture increases the performance of the PCC as an insulator by lowering the K-value and raising the R-value. It should be noted the increase in performance (15% in K-value, 0.9% in R-value) will be magnified as thickness is increased. These values fall within normal parameters of previous studies conducted on similar concrete mixes. This study was conducted in conjunction with Element Laboratories of Des Moines, Iowa.

Please feel free to call should you have questions or if we may be of further assistance.

Sincerely,

Doug Clement
President/CEO

Sybil K. Ferrier, P.E.
Principal Engineer

DC/SF

1610 East Madison Ave. • Des Moines, Iowa 50313
(515) 263-0794 • Fax (515) 263-0851
www.cmt-iowa.com

Construction Materials Testing

February 4, 2019

Project No: 1906004ICC

International ChemCrete
Attn: Mr. Radi Al-Rashed
800 Security Row
Richardson, TX 75081

RE: Pavix MCE Product Review

Dear Mr. Al-Rashed,

This letter is a review of CMT's research to date. As you know, the Pavix MCE product is being researched through a variety of concrete tests at the CMT laboratory in Des Moines, Iowa, and in conjunction with Iowa State University. The product has been introduced into typical PCC mixes that are used around the state of Iowa and the Midwest for a variety of applications, from paving to structural placements. These mixes generally utilized limestone aggregates, local sand sources and varying amounts of cement. Our results have indicated superior performance in all mixes which utilized the Pavix MCE product at a 2% internal dosage rate.

The concrete mixes have been evaluated with regards to compressive strength, flexural strength, permeability, time of set, alkali silica reactivity (ASR) and consistencies/workability. Both compressive and flexural strengths were increased. The greatest improvements were noted over longer time periods (over 56 days of age) due to the continued hydration of the cement within the mix. Each treated (dosed) mix indicated lower permeability than the baseline mixes (non-dosed) and indicated a significantly better surface abrasion (resistance to wear). ASR is an issue that plagues the concrete industry and the Pavix MCE has shown the ability to reduce these tendencies as well. CMT tested PCC mixes that utilized highly reactive aggregates and local aggregates which have a minimal reaction. At the completion of the ASR study, the dosed mixes performed significantly better than the baseline mixes.

When using the Pavix MCE product, the time of set is slightly slower however, mix consistencies and workability are increased. The product appears to react chemically and at a cellular level, to utilize cement in a way that promotes total hydration. The effect on the aggregates and the additional hydration produce a higher strength, more durable and more resistant concrete than any normal mix being produced in our area today. Studies continue to determine various chemical reactions and how to improve the product as we move forward. Overall, CMT is very optimistic about the product's ability to improve concrete's performance in all phases of it's lifespan.

Please feel free to call should you have questions or if we may be of further assistance.

Sincerely,

Doug Clement
President/CEO

Sybil K. Ferrier, P.E.
Principal Engineer

DC/SF

1610 East Madison Ave. • Des Moines, Iowa 50313
(515) 263-0794 • Fax (515) 263-0851
www.cmt-iowa.com

Construction Materials Testing

February 26, 2019

Project No: 1906004ICC

International ChemCrete
Attn: Mr. Radi Al-Rashed
800 Security Row
Richardson, TX 75081

RE: Pavix MCE Product Review

Dear Mr. Al-Rashed,

In the fall of 2018, CMT conducted testing on concrete mixtures which utilized the Pavix MCE (dual crystalline enhancer). This product was introduced internally into the concrete. CMT's study utilized both a straight cement mix and a mix containing a 20% class C fly ash substitution. The CMT study included a temperature/humidity test at various elevations of the sample to evaluate the humidity of the concrete and a temperature time factor (TTF) flexural strength test. The CMT study (both with and without fly ash), showed significant reductions in moisture emissions (34-55%) while flexural strength increased when treated with the Pavix MCE product.

Additional samples were cast and submitted to Iowa State University (ISU) Engineering Department for void and comparison analysis. ISU's study focused on air content, voids, void size and distribution. The ISU study indicated the total air content increased on straight cement samples and decreased on the 20% fly ash samples. This trend was also substantiated when the size of the air voids followed a similar pattern. Voids appeared to increase in straight cement mixtures and decrease in fly ash mixes. Spacing (distribution) was also affected in accordance with void size. ISU also conducted compressive strength tests which followed the CMT trend on flexural strength increases. The changes in void structure appear to be the result of further hydration and a more controlled use of the water within the mix. Crystallization is occurring throughout the matrix of the mix, densifying and lowering permeability of the sample. The enhancer appears to increase hydration or hydration efficiency based on the lower CH and $CaCO_3$ contents exhibited in the ISU study. The overall result is a lower permeability, increased strength and more economically efficient concrete.

Please feel free to call should you have questions or if we may be of further assistance.

Sincerely,

Doug Clement
President/CEO

Sybil K. Ferrier, P.E.
Principal Engineer

DC/SF

1610 East Madison Ave. • Des Moines, Iowa 50313
(515) 263-0794 • Fax (515) 263-0851
www.cmt-iowa.com

Construction Materials Testing

May 17, 2019

Project No: 1906004ICC

International ChemCrete
Attn: Mr. Radi Al-Rashed
800 Security Row
Richardson, TX 75081

RE: Pavix MCE Thermal Study
ASTM C 666
Durability Testing

Dear Mr. Al-Rashed,

As per your request, CMT has completed testing on three concrete samples created at CMT's lab to assess the durability of concrete treated internally with 2% Pavix MCE. The concrete mix design chosen for this study was similar to an IDOT C4 mix design, enclosed for your review. The mix was comprised of 491 lbs of Type I/II cement, 123 lbs of Class C fly ash, and a 50/50 blend of fine to coarse aggregates. The fine aggregate are silica based sands and the coarse aggregate was one inch limestone. The mix was created at a water to cementitious ratio of 0.40.

A dosed mix was created by utilizing 2% Pavix MCE internal by weight of cementitious. Specimens were cast into 3 x 3 x 16 inch beams, to fit the freeze/thaw chamber. These bars were used to assess mass change, relative dynamic modulus and length change of the concrete. After initial curing (24 hrs), the specimens were placed into the freeze/thaw chamber for thermal cycling. This chamber traditionally cycles the ambient temperatures between -20 to 40 °F (-29 to 4 °C), when using for ASTM C-666. For this study, ASTM C-666 was modified to utilize more extreme temperatures. The temperature range was increased to cycle between -64 to 77 °F (-53 to 22 °C). The samples were cycled through 300 freeze/thaw cycles, averaging 8 hours per cycle. Listed below is a summary of the thermal readings taken periodically throughout the testing. The test is continued through 300 cycles or failure, whichever comes first, per the ASTM procedure. According to the test results, these materials passed the ASTM C-666 test.

Enclosed you will also find comparative data, with regards to a standard mix of the same design, without the 2% internal treatment. Based on the non-treated data, the 2% internal application reduced the mass loss by 91.6%, the length change by 14.8% and increased the relative dynamic modulus by 20.3%.

Please feel free to call should you have questions or if we may be of further assistance.

Sincerely,

Doug Clement
President/CEO

Sybil K. Ferrier, P.E.
Principal Engineer

DC/SF

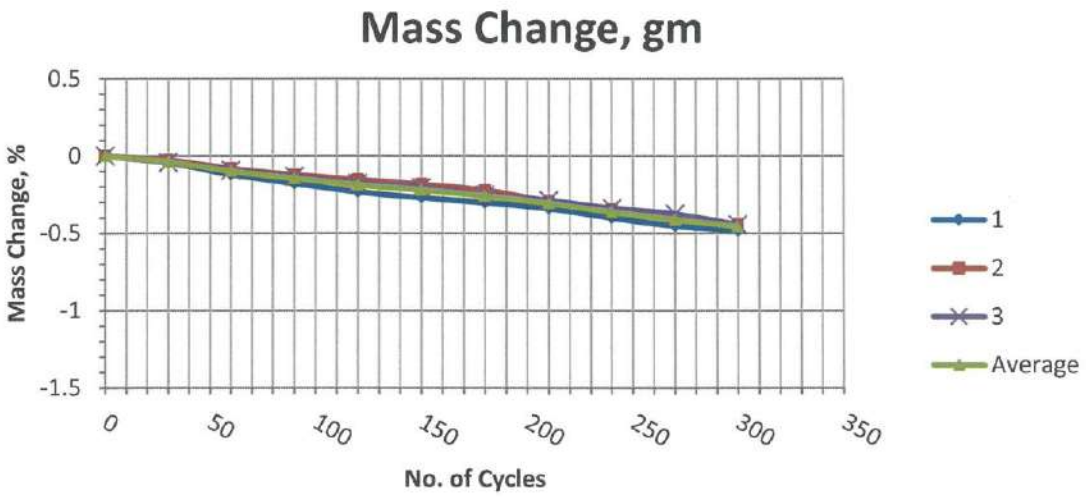
1610 East Madison Ave. • Des Moines, Iowa 50313
(515) 263-0794 • Fax (515) 263-0851
www.cmt-iowa.com

Construction Materials Testing

Table 1. Mass Change - Treated Mix - 2% Internal

No. of Cycles	Sample 1 Weight, gm	Sample 2 Weight, gm	Sample 3 Weight, gm	Average Mass Change, %
0	3986.4	4028.7	3880.5	0
30	3984.7	4027.6	3878.8	-0.038
60	3981.6	4025.4	3876.9	-0.098
90	3979.3	4023.8	3875.3	-0.145
120	3977.1	4022.5	3873.6	-0.188
150	3975.6	4021.3	3872.5	-0.220
180	3974.3	4019.7	3870.7	-0.260
210	3972.8	4016.9	3869.3	-0.308
240	3970.4	4014.7	3867.3	-0.363
270	3968.3	4012.3	3865.9	-0.413
300	3967.1	4010.9	3863.2	-0.457

*ASTM C666 states that failure of the specimen is indicated when the mass change reaches 60% of the initial mass or when the test is terminated at 300 cycles.



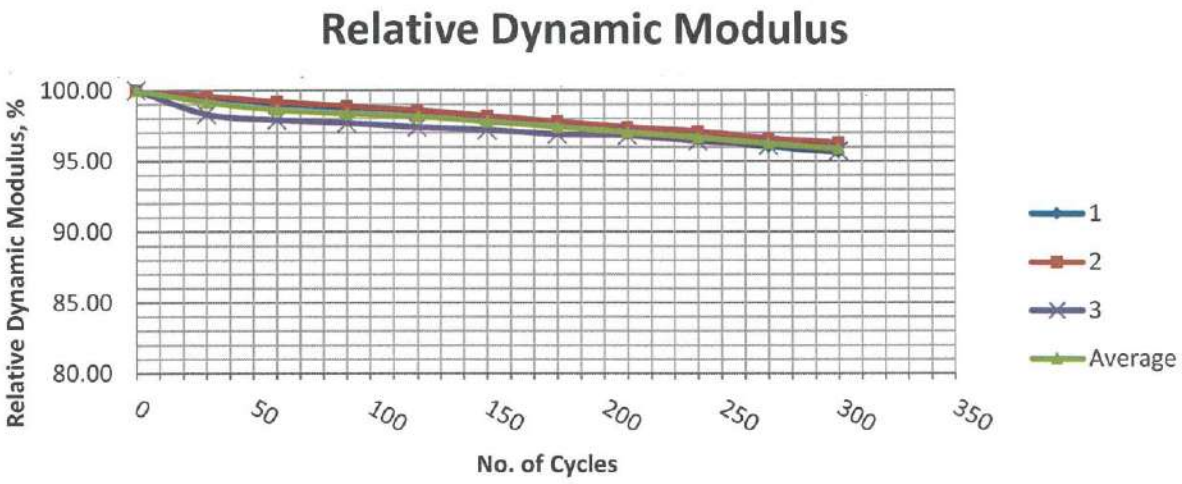
1610 East Madison Ave. • Des Moines, Iowa 50313
(515) 263-0794 • Fax (515) 263-0851
www.cmt-iowa.com

Construction Materials Testing

Table 2. Relative Dynamic Modulus - Treated Mix - 2% Internal

No. of Cycles	Sample 1	Sample 2	Sample 3	Average Relative Dynamic Modulus, %
0	48.7	46.1	47.9	100.00
30	46.7	45.7	46.2	99.17
60	46.3	45.3	45.8	98.63
90	45.5	45.0	45.6	98.37
120	45.2	44.7	45.3	98.17
150	44.7	44.3	45.1	97.80
180	44.3	43.9	44.8	97.43
210	43.6	43.5	44.7	97.03
240	43.2	43.2	44.3	96.67
270	42.7	42.7	44.0	96.23
300	42.3	42.4	43.6	95.87

*ASTM C666 states that failure of the specimen is indicated when the relative dynamic modulus of elasticity reaches 60% of the initial modulus or when the test is terminated at 300 cycles.



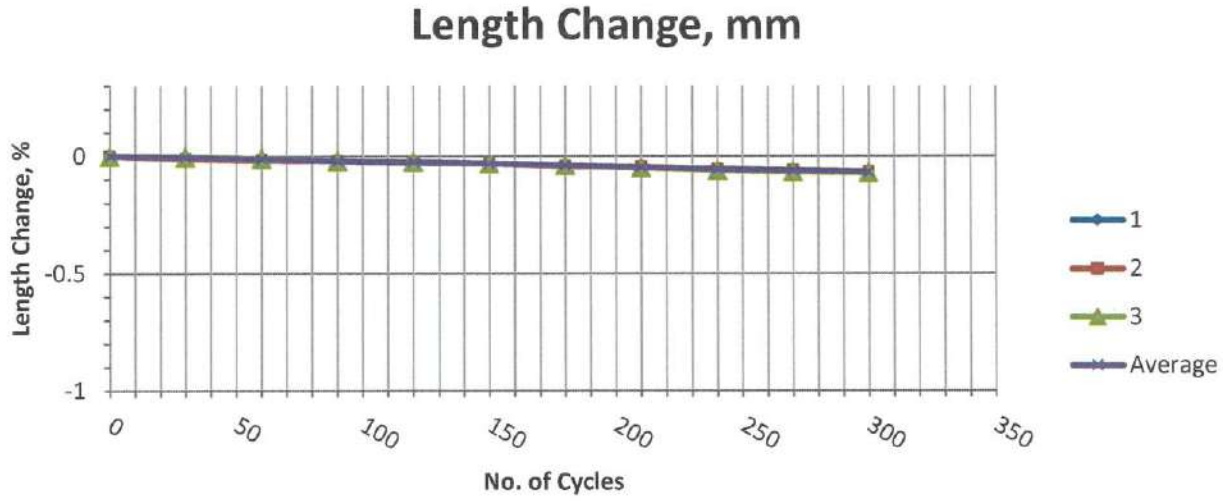
1610 East Madison Ave. • Des Moines, Iowa 50313
(515) 263-0794 • Fax (515) 263-0851
www.cmt-iowa.com

Construction Materials Testing

Table 3. Length Change - Treated Mix - 2% Internal

No. of Cycles	Sample 1 Length, mm	Sample 2 Length, mm	Sample 3 Length, mm	Average Length Change, %
0	281.36	285.95	284.42	0.000
30	281.35	285.92	284.41	-0.006
60	281.33	285.90	284.39	-0.013
90	281.30	285.89	284.36	-0.021
120	281.28	285.88	284.35	-0.026
150	281.27	285.86	284.33	-0.032
180	281.25	285.83	284.31	-0.040
210	281.22	285.82	284.28	-0.048
240	281.21	285.79	284.25	-0.056
270	281.19	285.78	284.23	-0.062
300	281.16	285.76	284.22	-0.069

*ASTM C666 states that failure of the specimen is indicated when the length change is greater than 0.10% of the initial length.



1610 East Madison Ave. • Des Moines, Iowa 50313
(515) 263-0794 • Fax (515) 263-0851
www.cmt-iowa.com

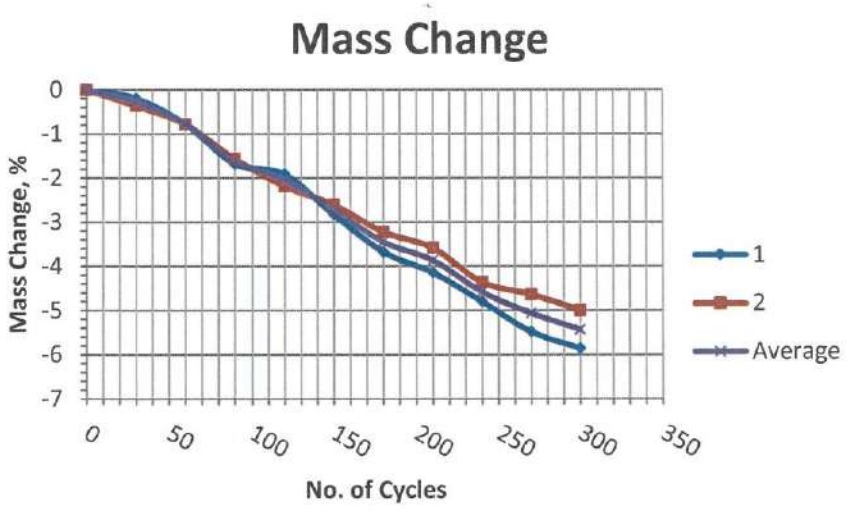
Construction Materials Testing

Comparative Data
Untreated Mix

Table 1. Mass Change - Untreated Mix

No. of Cycles	Weight, gm 1	Weight, gm 2	Average Weight	Mass Change, %
0	7947.3	7856.2	7901.75	0
30	7931.2	7827.4	7879.30	-0.284
60	7884.9	7794.6	7839.75	-0.785
90	7813.2	7732.8	7773.00	-1.629
120	7794.6	7684.3	7739.45	-2.054
150	7721.8	7651.7	7686.75	-2.721
180	7654.7	7603.2	7628.95	-3.452
210	7617.5	7574.5	7596.00	-3.869
240	7565.3	7513.7	7539.50	-4.584
270	7511.4	7492.1	7501.75	-5.062
300	7481.2	7463.6	7472.40	-5.434

*ASTM C666 states that failure of the specimen is indicated when the mass change reaches 60% of the initial mass or when the test is terminated at 300 cycles.



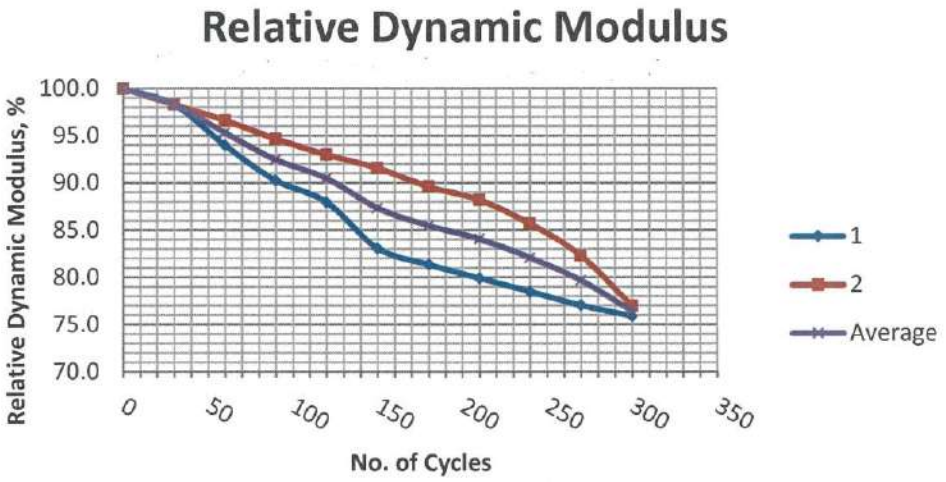
1610 East Madison Ave. • Des Moines, Iowa 50313
(515) 263-0794 • Fax (515) 263-0851
www.cmt-iowa.com

Construction Materials Testing

Table 2. Relative Dynamic Modulus - Untreated Mix

No. of Cycles	1	2	Relative Dynamic Modulus, %
0	34.8	35.6	100.00
30	34.2	35.0	98.30
60	32.7	34.4	95.30
90	31.4	33.7	92.45
120	30.6	33.1	90.45
150	28.9	32.6	87.31
180	28.3	31.9	85.46
210	27.8	31.4	84.04
240	27.3	30.5	82.06
270	26.8	29.3	79.66
300	26.4	27.4	76.41

*ASTM C666 states that failure of the specimen is indicated when the relative dynamic modulus of elasticity reaches 60% of the initial modulus or when the test is terminated at 300 cycles.



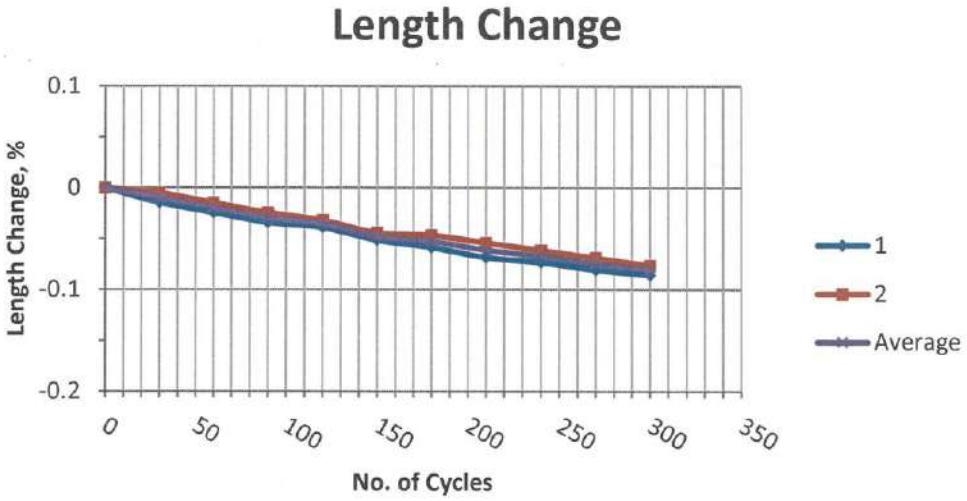
1610 East Madison Ave. • Des Moines, Iowa 50313
(515) 263-0794 • Fax (515) 263-0851
www.cmt-iowa.com

Construction Materials Testing

Table 3. Length Change - Untreated Mix

No. of Cycles	Length, mm 1	Length, mm 2	Average Length, mm	Length Change, %
0	408.13	406.87	407.50	0.000
30	408.07	406.85	407.46	-0.010
60	408.03	406.81	407.42	-0.020
90	407.99	406.77	407.38	-0.029
120	407.97	406.74	407.36	-0.036
150	407.92	406.69	407.31	-0.048
180	407.89	406.68	407.29	-0.053
210	407.85	406.65	407.25	-0.061
240	407.83	406.62	407.23	-0.067
270	407.80	406.59	407.20	-0.075
300	407.78	406.56	407.17	-0.081

*ASTM C666 states that failure of the specimen is indicated when the length change is greater than 0.10% of the initial length.



1610 East Madison Ave. • Des Moines, Iowa 50313
(515) 263-0794 • Fax (515) 263-0851
www.cmt-iowa.com

Construction Materials Testing

November 25, 2019

Project No.: 1906004ICC

International ChemCrete
Attn: Mr. Radi Al-Rashed
800 Security Row
Richardson, TX 75081

RE: Pavix MCE Study
Concrete Strength Evaluation
Freeze/Thaw Durability of PCC

Dear Mr. Al-Rashed,

Our lab has completed testing on concrete samples created in CMT's laboratory. This testing was done to evaluate the Pavix MCE product with regards to strength gain after experiencing freeze/thaw cycles. Two samples were tested, a baseline, and a treated Pavix MCE sample, 2% internal. The concrete mix design chosen for this study was similar to an IDOT C4 mix design. The mix was comprised of 593 lbs of Type I/II cement, and a 50/50 blend of fine to coarse aggregates. The fine aggregate is a silica-based sand and the coarse aggregate was one inch limestone. The mix was created at a water to cementitious ratio of 0.42. The specimens were aged to 90 days in a freezer chamber and then coupons were cut from the specimens. The coupons were tested for compressive strength and flexural strength (center point loading). Listed below are the results of the tests at 90 days.

Test Method	Baseline*	Pavix MCE, 2% Internal*
Compressive Strength, psi (2 x 2 inch cube)	4,720	5,640
Flexural Strength, psi (Center Point Loading)	630	805

*Average of two specimens.

It should be noted the specimens were frozen for 90 days prior to testing. The strength results indicated approximately a 20% increase in compressive strength and approximately a 30% increase in flexural strength at the end of the freeze/thaw cycles.

Please feel free to call should you have questions or if we may be of further assistance.

Sincerely,

Doug Clement
President/CEO
DC/SF

Sybil K. Ferrier, P.E.
Principal Engineer

1610 East Madison Ave. • Des Moines, Iowa 50313
(515) 263-0794 • Fax (515) 263-0851
www.cmt-iowa.com

Construction Materials Testing

March 19, 2019

Project No.: 1906004ICC

International ChemCrete
Attn: Mr. Radi Al-Rashed
800 Security Row
Richardson, TX 75081

RE: Pavix MCE Study
ASTM C-1202/AASHTO T-277 (Modified)
Resistance to Chloride Ion Penetration

Dear Mr. Al-Rashed,

Our lab has completed testing on concrete samples created in CMT's laboratory. This testing was done to evaluate the Pavix MCE product with regards to chloride ion penetration, ASTM C-1202. One sample was tested, a baseline, and a treated Pavix MCE sample. The Pavix MCE was applied topically on the two ends of the sample. This sample was compared to a baseline mix with no treatments. The treatments was applied topically after the initial 24 curing of the specimens in the molds.

The concrete mix design chosen for this study was similar to an IDOT C4 mix design, which is enclosed for your review. The mix was comprised of 491 lbs of Type I/II cement, 123 lbs of Class C fly ash, and a 50/50 blend of fine to coarse aggregates. The fine aggregate is a silica-based sand and the coarse aggregate was one inch limestone. The mix was created at a water to cementitious ratio of 0.40. The report indicates results after 7 days of curing at CMT, according to ASTM C-1202/AASHTO T-277 (modified). Listed below are the results of the test.

ASTM C-1202	Baseline	Pavix MCE, Topical, Both Sides
Charge Passed, Coulombs	646	65
Chloride Permeability Rating*	Very Low	Negligible
Reduction in Chloride Ion Penetration Over Control	---	89.9%

***Refer to Table X1.1 for Rating Assignments, ASTM C-1202.**

The material tested indicates results for PCC with very low range results. Lower readings indicate a lower penetrability and a denser concrete that is less susceptible to chemical attack. Please feel free to call should you have questions or if we may be of further assistance.

Sincerely,

Doug Clement
President/CEO
DC/SF

Sybil K. Ferrier, P.E.
Principal Engineer

1610 East Madison Ave. • Des Moines, Iowa 50313
(515) 263-0794 • Fax (515) 263-0851
www.cmt-iowa.com

Construction Materials Testing

March 19, 2019

Project No.: 1906004ICC

International ChemCrete
Attn: Mr. Radi Al-Rashed
800 Security Row
Richardson, TX 75081

RE: Pavix MCE Study
ASTM C-1202/AASHTO T-277 (Modified)
Resistance to Chloride Ion Penetration

Dear Mr. Al-Rashed,

Our lab has completed testing on concrete samples created in CMT's laboratory. This testing was done to evaluate the Pavix MCE product with regards to chloride ion penetration, ASTM C-1202. Three samples were tested, a baseline, and two treated Pavix MCE samples. The Pavix MCE was applied topically on one end of the two samples. Each sample was then placed in the testing apparatus to expose the treated sides to each ion solution. These were compared to a baseline mix with no treatments. All treatments were applied topically after the initial 24 curing of the specimens in the molds.

The concrete mix design chosen for this study was similar to an IDOT C4 mix design, which is enclosed for your review. The mix was comprised of 491 lbs of Type I/II cement, 123 lbs of Class C fly ash, and a 50/50 blend of fine to coarse aggregates. The fine aggregate is a silica-based sand and the coarse aggregate was one inch limestone. The mix was created at a water to cementitious ratio of 0.40. The report indicates results after 7 days of curing at CMT, according to ASTM C-1202/AASHTO T-277 (modified). Listed below are the results of the test.

ASTM C-1202	Baseline	Pavix MCE, NaCl Side	Pavix MCE, NaOH Side
Charge Passed, Coulombs	646	13	18
Chloride Permeability Rating*	Very Low	Negligible	Negligible
Reduction in Chloride Ion Penetration Over Control	---	97.9%	97.2%

***Refer to Table X1.1 for Rating Assignments, ASTM C-1202.**

The material tested indicates results for PCC with very low range results. Lower readings indicate a lower penetrability and a denser concrete that is less susceptible to chemical attack. Please feel free to call should you have questions or if we may be of further assistance.

Sincerely,

Doug Clement
President/CEO
DC/SF

Sybil K. Ferrier, P.E.
Principal Engineer

1610 East Madison Ave. • Des Moines, Iowa 50313
(515) 263-0794 • Fax (515) 263-0851
www.cmt-iowa.com

Construction Materials Testing

March 19, 2019

Project No.: 1906004ICC

International ChemCrete
Attn: Mr. Radi Al-Rashed
800 Security Row
Richardson, TX 75081

RE: Pavix MCE Study
ASTM C-1202/AASHTO T-277 (Modified)
Resistance to Chloride Ion Penetration

Dear Mr. Al-Rashed,

Our lab has completed testing on concrete samples created in CMT's laboratory. This testing was done to evaluate the Pavix MCE product with regards to chloride ion penetration, ASTM C-1202. Two samples were tested, a baseline, and treated Pavix MCE sample. The Pavix MCE was applied internally at a rate of 2%. This was compared to a baseline mix with no treatment.

The concrete mix design chosen for this study was similar to an IDOT C4 mix design, which is enclosed for your review. The mix was comprised of 491 lbs of Type I/II cement, 123 lbs of Class C fly ash, and a 50/50 blend of fine to coarse aggregates. The fine aggregate is a silica-based sand and the coarse aggregate was one inch limestone. The mix was created at a water to cementitious ratio of 0.40. The report indicates results after 7 days of curing at CMT, according to ASTM C-1202/AASHTO T-277 (modified). Listed below are the results of the test.

ASTM C-1202	Baseline	Pavix MCE, Internal
Charge Passed, Coulombs	646	60
Chloride Permeability Rating*	Very Low	Negligible
Reduction in Chloride Ion Penetration Over Control	---	90.7%

***Refer to Table X1.1 for Rating Assignments, ASTM C-1202.**

The material tested indicates results for PCC with very low range results. Lower readings indicate a lower penetrability and a denser concrete that is less susceptible to chemical attack. Please feel free to call should you have questions or if we may be of further assistance.

Sincerely,

Doug Clement
President/CEO
DC/SF

Sybil K. Ferrier, P.E.
Principal Engineer

1610 East Madison Ave. • Des Moines, Iowa 50313
(515) 263-0794 • Fax (515) 263-0851
www.cmt-iowa.com

Construction Materials Testing

March 15, 2019

Project No.: 1906004ICC

International ChemCrete
Attn: Mr. Radi Al-Rashed
800 Security Row
Richardson, TX 75081

RE: Pavix MCE Study
ASTM C-1202/AASHTO T-277 (Modified)
Resistance to Chloride Ion Penetration

Dear Mr. Al-Rashed,

Our lab has completed testing on concrete samples created in CMT's laboratory. This testing was done to evaluate the Pavix MCE product with regards to chloride ion penetration, ASTM C-1202. Five samples were tested, a baseline, and treated Pavix MCE samples. The Pavix MCE was applied internally (2%), topically on the end of two samples, and topically to both sides of a sample. These were compared to a baseline mix with no treatments. Aside from the internal application, all treatments were applied topically after the initial 24 curing of the specimens in the molds.

The concrete mix design chosen for this study was similar to an IDOT C4 mix design, which is enclosed for your review. The mix was comprised of 491 lbs of Type I/II cement, 123 lbs of Class C fly ash, and a 50/50 blend of fine to coarse aggregates. The fine aggregate is a silica-based sand and the coarse aggregate was one inch limestone. The mix was created at a water to cementitious ratio of 0.40. The report indicates results after 7 days of curing at CMT, according to ASTM C-1202/AASHTO T-277 (modified). Listed below are the results of the test.

ASTM C-1202	Baseline	Pavix MCE, Internal	Pavix MCE, Topical, Both Sides	Pavix MCE, NaCl Side	Pavix MCE, NaOH Side
Charge Passed, Coulombs	646	60	65	13	18
Chloride Permeability Rating*	Very Low	Negligible	Negligible	Negligible	Negligible
Reduction in Chloride Ion Penetration Over Control	---	90.7%	89.9%	97.9%	97.2%

***Refer to Table X1.1 for Rating Assignments, ASTM C-1202.**

The material tested indicates results for PCC with very low range results. Lower readings indicate a lower penetrability and a denser concrete that is less susceptible to chemical attack. Please feel free to call should you have questions or if we may be of further assistance.

Sincerely,

Doug Clement
President/CEO
DC/SF

Sybil K. Ferrier, P.E.
Principal Engineer

1610 East Madison Ave. • Des Moines, Iowa 50313
(515) 263-0794 • Fax (515) 263-0851
www.cmt-iowa.com

Construction Materials Testing

July 11, 2017

Project No: 17060031CC

International ChemCrete
800 Security Row
Richardson, TX 75081

Re: ASTM C-779
Abrasion Resistance of Concrete
Pavix MCE Study - Phase 2

Dear Mr. Al-Rashed,

As per your request, CMT has completed testing a concrete sample cast on May 16, 2017. Seven mix designs were created using a C4WRC20 with 1% and 2% Pavix MCE, with varying w/cm ratios. Our results were as follows:

Table 1. Depth of Wear - Mix #1 Baseline 0.37 w/cm 1% Pavix MCE

Elapsed Time, min	Depth of Wear (mm)
0	0
15	0.196
30	0.486
45	0.67
60	1.325

Table 2. Depth of Wear - Mix #2 0.44 w/cm 1% Pavix MCE

Elapsed Time, min	Depth of Wear (mm)
0	0
15	0.24
30	0.561
45	0.987
60	1.556

Table 3. Depth of Wear - Mix #3 0.49 w/cm 1% Pavix MCE

Elapsed Time, min	Depth of Wear (mm)
0	0
15	0.314
30	0.617
45	1.107
60	1.784

Table 4. Depth of Wear - Mix #4 0.54 w/cm 1% Pavix MCE

Elapsed Time, min	Depth of Wear (mm)
0	0
15	0.464
30	0.728
45	1.269
60	2.185

1610 East Madison Ave. • Des Moines, Iowa 50313
(515) 263-0794 • Fax (515) 263-0851
www.cmt-iowa.com

Construction Materials Testing

Table 5. Depth of Wear - Mix #5 0.44 w/cm 2% Pavix MCE

Elapsed Time, min	Depth of Wear (mm)
0	0
15	0.256
30	0.498
45	0.757
60	1.118

Table 6. Depth of Wear - Mix #6 0.49 w/cm 2% Pavix MCE

Elapsed Time, min	Depth of Wear (mm)
0	0
15	0.297
30	0.563
45	0.819
60	1.256

Table 7. Depth of Wear - Mix #7 0.54 w/cm 2% Pavix MCE

Elapsed Time, min	Depth of Wear (mm)
0	0
15	0.303
30	0.615
45	0.888
60	1.379

ASTM C-779 states that a failure is reached when the depth of wear on the horizontal concrete surface is equal to or greater than 3.0 mm. The materials presented for this test passed accordance with ASTM C-779. Refer to the attached pages for a graphical representation of the data. This test was conducted in general accordance with ASTM C-779, Procedure B. Please feel free to call me should you have any questions or if I may be of any further assistance.

Sincerely,

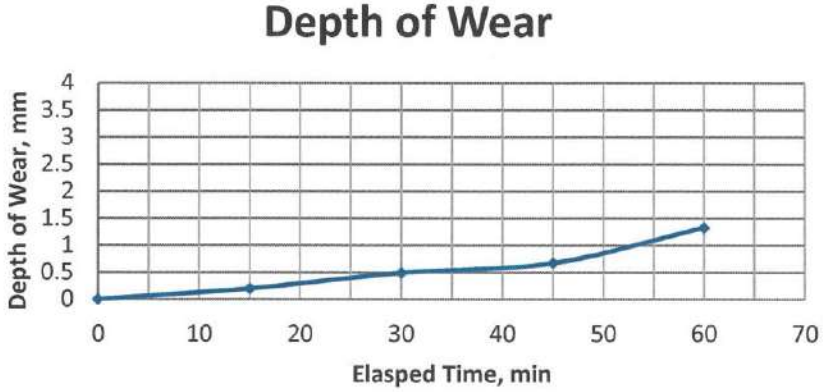
Doug Clement
President / CEO

mt/sf

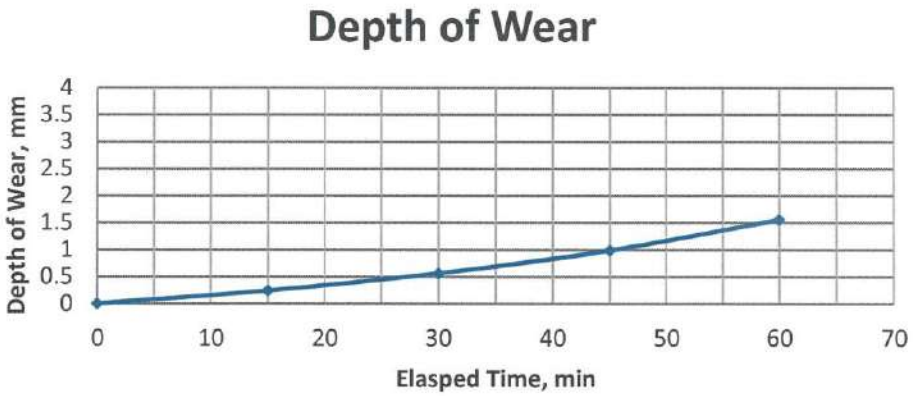
1610 East Madison Ave. • Des Moines, Iowa 50313
(515) 263-0794 • Fax (515) 263-0851
www.cmt-iowa.com

Construction Materials Testing

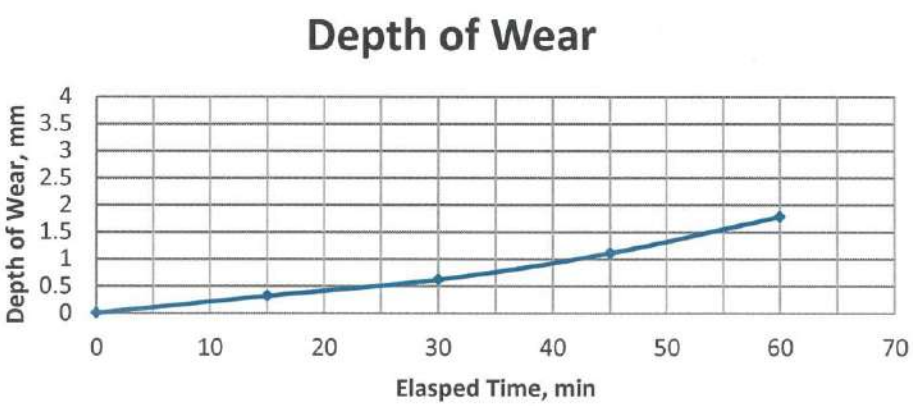
Mix #1 Baseline 0.37 w/cm 1% Pavix MCE



Mix #2 0.44 w/cm 1% Pavix MCE



Mix #3 0.49 w/cm 1% Pavix MCE

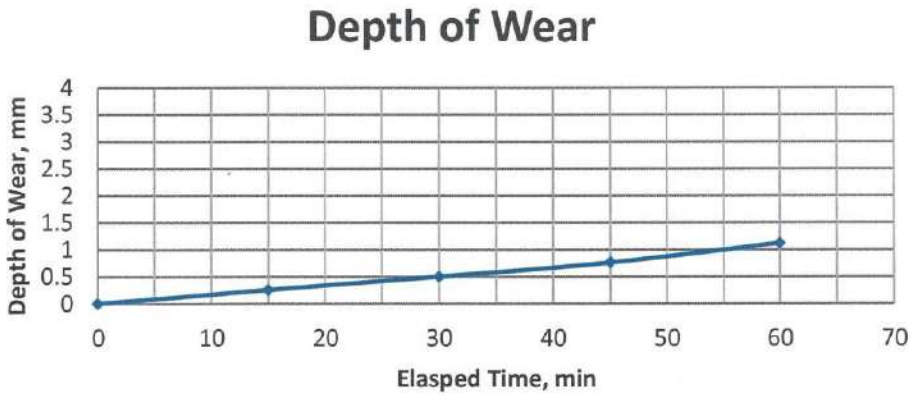


1610 East Madison Ave. • Des Moines, Iowa 50313
(515) 263-0794 • Fax (515) 263-0851
www.cmt-iowa.com

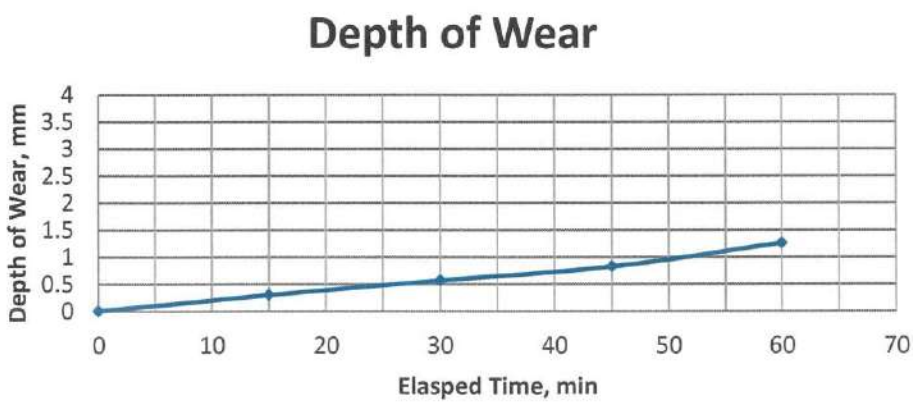
Construction Materials Testing

Mix #4 0.54 w/cm 1% Pavix MCE

Mix #5 0.44 w/cm 2% Pavix MCE



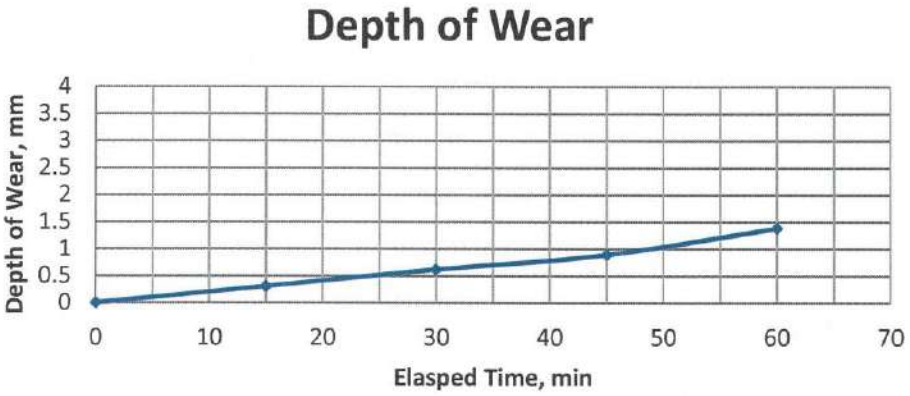
Mix #6 0.49 w/cm 2% Pavix MCE



1610 East Madison Ave. • Des Moines, Iowa 50313
(515) 263-0794 • Fax (515) 263-0851
www.cmt-iowa.com

Construction Materials Testing

Mix #7 0.54 w/cm 2% Pavix MCE



1610 East Madison Ave. • Des Moines, Iowa 50313
(515) 263-0794 • Fax (515) 263-0851
www.cmt-iowa.com

Construction Materials Testing

November 22, 2019

Project No.: 1906004ICC

International ChemCrete
Attn: Mr. Radi Al-Rashed
800 Security Row
Richardson, TX 75081

RE: Pavix MCE Study
ASTM C-666 Modified
Freeze/Thaw Durability of PCC

Dear Mr. Al-Rashed,

Our lab has completed testing on concrete samples created in CMT's laboratory. This testing was done to evaluate the Pavix MCE product with regards to freezing resistance, ASTM C-666 (modified). Two samples were tested, a baseline, and a treated Pavix MCE sample, 2% internal. The concrete mix design chosen for this study was similar to an IDOT C4 mix design, which is enclosed for your review. The mix was comprised of 593 lbs of Type I/II cement, and a 50/50 blend of fine to coarse aggregates. The fine aggregate is a silica-based sand and the coarse aggregate was one inch limestone. The mix was created at a water to cementitious ratio of 0.42. The specimens were aged to 90 days in a freezer chamber and then tested for mass, length and resilient modulus. Listed below are the results of the tests at 90 days.

ASTM C-666	Baseline*	Pavix MCE, 2% Internal*
Mass, gm	6596.5 gm	6487.0 gm
Length, mm	349.50 mm	347.30 mm
Resilient Modulus	34.06	39.06

*Average of two specimens.

It should be noted the specimens were frozen for 90 days and did not undergo the 300 freeze/thaw cycles as specified by a typical ASTM C-666 test method. Due to the fact no preliminary resilient modulus readings were taken to establish deterioration, no percentage of deterioration can be determined. Based on historical data with a similar mix design, the treated sample would be in the 99th percentile and the baseline reading would be in the 94th percentile, of a passing result. A traditional ASTM C-666 test fails when the resilient modulus drops below the 60th percentile. The difference in the observed resilient modulus readings represents a 15% increase in performance in the treated samples over the baseline.

Please feel free to call should you have questions or if we may be of further assistance.

Sincerely,

Doug Clement
President/CEO
DC/SF

Sybil K. Ferrier, P.E.
Principal Engineer

1610 East Madison Ave. • Des Moines, Iowa 50313
(515) 263-0794 • Fax (515) 263-0851
www.cmt-iowa.com

Construction Materials Testing

December 21, 2018

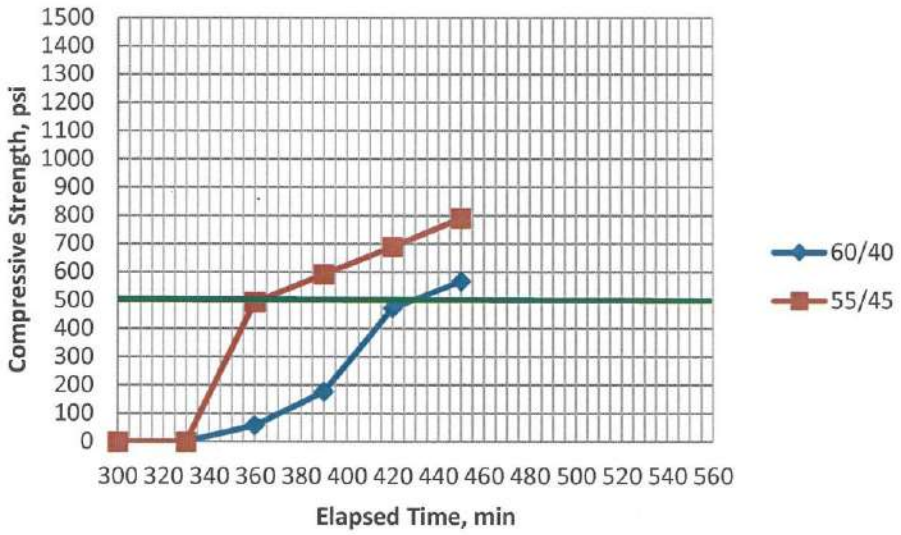
Project No: 1801593ICC

International ChemCrete
800 Security Row
Richardson, TX 75081

RE: Roof Decking Evaluation Test
Grout with 2% Pavix MCE
ASTM C-403 Time of Set

Attn: Mr. Radi Al-Rashed,

As per your request, CMT has completed testing of the two concrete mix designs for roof decking material. Two mixes were created according to the attached mix designs. Mix 1 utilized a 60/40 fine to coarse aggregate blend and Mix 2 utilized a 55/45 blend. The initial time of set is determined when the mix reaches a penetration resistance of 500 psi. At 70°, Mix #1 achieved 500 psi at approximately 459 minutes (7 hrs, 39 min). Mix #2 achieved 500 psi at approximately 392 minutes (6 hrs, 32 min). These tests were conducted in general accordance with ASTM C-403, C-143, C-172, C-192, C-231, and C-1064.



Sincerely,

Sybil K. Ferrier, P.E.
Principal Engineer

RC/SF

1610 East Madison Ave. • Des Moines, Iowa 50313
(515) 263-0794 • Fax (515) 263-0851
www.cmt-iowa.com

Construction Materials Testing

December 21, 2018

Project No: 1801593ICC

International ChemCrete
800 Security Row
Richardson, TX 75081

RE: Roof Decking Evaluation Test
Mix ID: 60/40 Grout with 2% Pavix MCE
ASTM C-1202/AASHTO T-277
Resistance to Chloride Ion Penetration

Attn: Mr. Radi Al-Rashed,

Our lab has completed testing on concrete samples that were created in CMT's laboratory. The grout mix contained 611 lbs of cement (per cubic yard) and utilized a 60/40 blend of fine/coarse aggregates. The fine aggregate was comprised of a typical concrete sand gradation and the coarse aggregate was a 3/8 inch limestone chip. The samples were made at a 0.45 water to cementitious materials ratio. The report indicates results after 28 days of curing per ASTM C-1202/AASHTO T-277. Listed below are the results of the test.

Mix ID: 60/40 Grout with 2% Pavix MCE

ASTM C-1202	
Charge Passed, Coulombs	542
Chloride Permeability Rating	Very Low

The material tested indicates better than average results for PCC with low to medium range water to cementitious ratios. Please feel free to call should you have questions or if I may be of further assistance.

Sincerely,

Doug Clement
President/CEO

Sybil K. Ferrier, P.E.
Principal Engineer

DC/SF

1610 East Madison Ave. • Des Moines, Iowa 50313
(515) 263-0794 • Fax (515) 263-0851
www.cmt-iowa.com

Construction Materials Testing

December 21, 2018

Project No: 1801593ICC

International ChemCrete
800 Security Row
Richardson, TX 75081

RE: Roof Decking Evaluation Test
Mix ID: 55/45 Grout with 2% Pavix MCE
ASTM C-1202/AASHTO T-277
Resistance to Chloride Ion Penetration

Attn: Mr. Radi Al-Rashed,

Our lab has completed testing on concrete samples that were created in CMT's laboratory. The grout mix contained 611 lbs of cement (per cubic yard) and utilized a 55/45 blend of fine/coarse aggregates. The fine aggregate was comprised of a typical concrete sand gradation and the coarse aggregate was a 3/8 inch limestone chip. The samples were made at a 0.45 water to cementitious materials ratio. The report indicates results after 28 days of curing per ASTM C-1202/AASHTO T-277. Listed below are the results of the test.

Mix ID: 55/45 Grout with 2% Pavix MCE

ASTM C-1202	
Charge Passed, Coulombs	277
Chloride Permeability Rating	Very Low

The material tested indicates better than average results for PCC with low to medium range water to cementitious ratios. Please feel free to call should you have questions or if I may be of further assistance.

Sincerely,

Doug Clement
President/CEO

Sybil K. Ferrier, P.E.
Principal Engineer

DC/SF

1610 East Madison Ave. • Des Moines, Iowa 50313
(515) 263-0794 • Fax (515) 263-0851
www.cmt-iowa.com

Construction Materials Testing

August 21, 2017

Project No: 1706003ICC

International ChemCrete
800 Security Row
Richardson, TX 75081

Re: ASTM C-1567
Alkali Silica Reactivity
Pavix MCE Study

Dear Mr. Al-Rashed,

As per your request, CMT has completed an Alkali Silica Reactivity study utilizing your Pavix MCE product. Two mix designs were created. The first is a typical Iowa Department of Transportation C4 PCC mix, utilizing Martin Marietta Ames Mine Coarse Aggregate and Hallett Materials North Des Moines fine aggregate. This mix is minimally reactive under normal circumstances. The second mix utilized a sand/gravel mixture with aggregates from the Platte River area, west of Omaha, Nebraska. The Platte River area is prone to significant ASR reactions.

For each mix, a control mix was created, then Pavix MCE was introduced utilizing three different w/cm ratios. In the first study, the Pavix MCE product was applied topically. Based on the surface area of the beams and the amount of liquid utilized, the application rate equaled approximately 1 gallon per 160 square feet. This application rate falls into the normal surface application rate of 1 gallon per 150-200 square feet. The topical samples were mixed at 0.39, 0.43 and 0.47 w/cm ratios. These ratios span the normal w/cm ratios being used in Iowa. The bars were compared to a control mix with no Pavix MCE applied. In the topical instances, the amount of reaction was reduced approximately 26-42%.

The second study utilized the Pavix MCE mixed internally at a rate of 2% by cementitious. This would equate to just over 11 pounds per cubic yard of Pavix MCE in typical concrete mix designs having a total cementitious content of 560 - 595 pounds per cubic yard (6 sack mix). The water to cementitious ratios chosen were also 0.39, 0.43 and 0.47. The reaction was reduced approximately 32-74% when used internally.

The mixes created with the Pavix MCE introduced internally performed slightly better than the topical application. In each case, the Pavix MCE treated samples showed a significant reduction in alkali silica reaction. In further studies, we hope to test varying dosage rates to set a standard pattern of "amount of reduction" based on dosage rate. With this information, concrete producers throughout the country can easily integrate into their current mix designs the product to mitigate the ASR problem.

Enclosed you will find the test results, both data and graphic. Please feel free to call should you have questions or if I may be of further assistance.

Sincerely,

Sybil K. Ferrier, P.E.
Principal Engineer
rc/sf

Doug Clement
President/CEO

1610 East Madison Ave. • Des Moines, Iowa 50313
(515) 263-0794 • Fax (515) 263-0851
www.cmt-iowa.com

Construction Materials Testing

December 20, 2017

Project No: 1706003ICC

Logan Contractor Supply
4101 106th Street
Urbandale, Iowa 50322

Re: ASTM C-1260
Alkali Silica Reactivity
Pavix MCE Study – Coated Aggregate Study

Dear Mr. Logan,

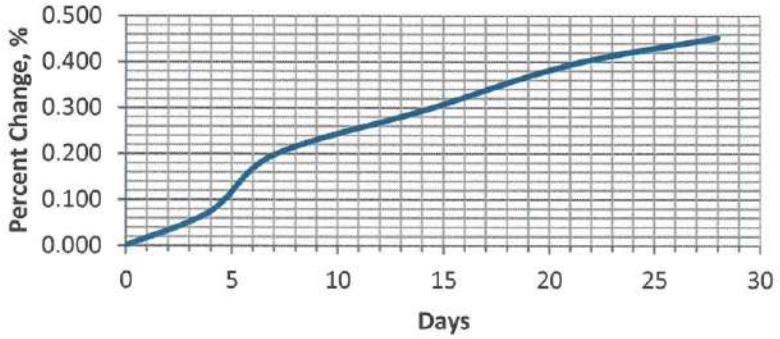
Our lab has completed testing of cement bar samples created on November 16, 2017. The reagent used was sodium hydroxide. Listed below are the parameters of the test method and results of the test.

MIX PROPERTIES

Material	Platte River Gravel – No Coating
Cement Type	Holcim Type I/II
Percentage of Fine/Coarse Aggregate, %	0/100
Mixing Temperature, °F	70

TEST RESULTS - 0.47 w/cm RATIO						
	Date	Specimen No. 1	Specimen No. 2	Specimen No. 3	Average	% Change
Initial Reading, inches	11/17/2017	11.0074	11.0033	11.0030	11.0046	0.000
4 Day Reading, inches*	11/21/2017	11.0161	11.0105	11.0116	11.0127	0.074
7 Day Reading, inches*	11/24/2017	11.0304	11.0257	11.0227	11.0263	0.197
14 Day Reading, inches*	12/1/2017	11.0412	11.0360	11.0334	11.0369	0.293
21 Day Reading, inches*	12/8/2017	11.0537	11.0437	11.0467	11.0480	0.393
28 Day Reading, inches*	12/15/2017	11.0613	11.0514	11.0509	11.0545	0.452
Average Expansion, %		0.452				

*Recorded after initial cure period.



Tests were conducted in general accordance with ASTM test methods and procedures, except when noted. Please feel free to call should you have questions or if I may be of further assistance.

Sincerely,

Sybil K. Ferrier, P.E.
Principal Engineer
rc/sf

Doug Clement
President/CEO

1610 East Madison Ave. • Des Moines, Iowa 50313
(515) 263-0794 • Fax (515) 263-0851
www.cmt-iowa.com

Construction Materials Testing

August 21, 2017

Project No: 1706003ICC

International ChemCrete
800 Security Row
Richardson, TX 75081

Re: ASTM C-1567
Alkali Silica Reactivity
Pavix MCE Study - Topical

Dear Mr. Al-Rashed,

Our lab has completed testing of cement bar samples created on July 1, 2017. The reagent used was sodium hydroxide. Listed below are the parameters of the test method and results of the test.

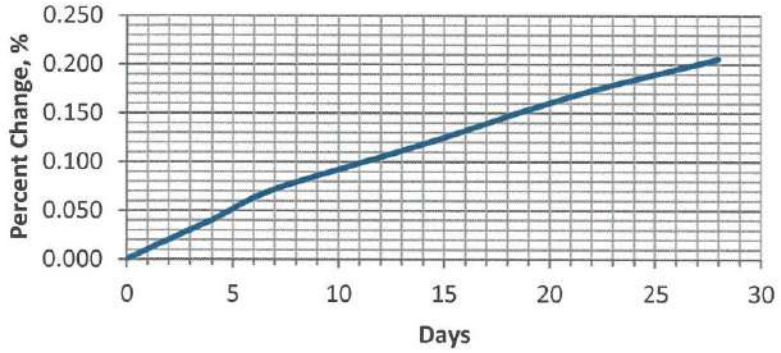
MIX PROPERTIES

Material	Platte River Gravel
Cement Type	Holcim Type I/II
Percentage of Fine/Coarse Aggregate, %	50/50
Mixing Temperature, °F	70

TEST RESULTS - 0.39 w/cm RATIO

	Date	Specimen No. 1	Specimen No. 2	Specimen No. 3	Average	% Change
Initial Reading, inches	7/1/2017	11.0108	11.0104	11.0090	11.0101	0.000
4 Day Reading, inches*	7/5/2017	11.0134	11.0163	11.0137	11.0145	0.040
7 Day Reading, inches*	7/8/2017	11.0162	11.0203	11.0174	11.0180	0.072
14 Day Reading, inches*	7/15/2017	11.0213	11.0256	11.0223	11.0231	0.118
21 Day Reading, inches*	7/22/2017	11.0287	11.0303	11.0264	11.0285	0.167
28 Day Reading, inches*	7/29/2017	11.0343	11.0325	11.0314	11.0327	0.205
Average Expansion, %		**0.205**				

*Recorded after initial cure period.



Tests were conducted in general accordance with ASTM test methods and procedures, except when noted. Please feel free to call should you have questions or if I may be of further assistance.

Sincerely,

Sybil K. Ferrier, P.E.
Principal Engineer
rc/sf

Doug Clement
President/CEO

1610 East Madison Ave. • Des Moines, Iowa 50313
(515) 263-0794 • Fax (515) 263-0851
www.cmt-iowa.com

Construction Materials Testing

August 21, 2017

Project No: 1706003ICC

International ChemCrete
800 Security Row
Richardson, TX 75081

Re: ASTM C-1567
Alkali Silica Reactivity
Pavix MCE Study - Control

Dear Mr. Al-Rashed,

Our lab has completed testing of cement bar samples created on July 5, 2017. The reagent used was sodium hydroxide. Listed below are the parameters of the test method and results of the test.

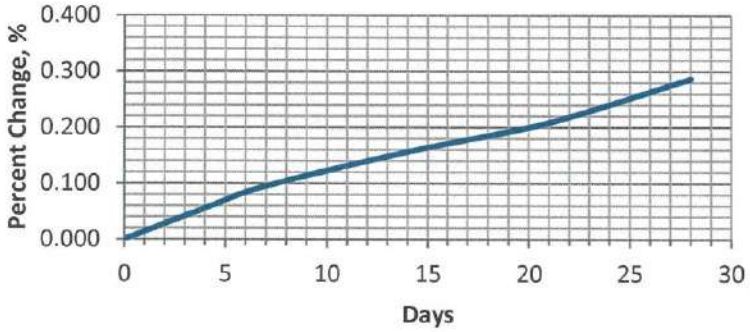
MIX PROPERTIES

Material	Platte River Gravel
Cement Type	Holcim Type I/II
Percentage of Fine/Coarse Aggregate, %	50/50
Mixing Temperature, °F	70

TEST RESULTS - 0.39 w/cm RATIO

	Date	Specimen No. 1	Specimen No. 2	Specimen No. 3	Average	% Change
Initial Reading, inches	7/5/2017	11.0088	11.0105	11.0080	11.0091	0.000
4 Day Reading, inches*	7/9/2017	11.0137	11.0177	11.0141	11.0152	0.055
7 Day Reading, inches*	7/12/2017	11.0186	11.0214	11.0186	11.0195	0.095
14 Day Reading, inches*	7/19/2017	11.0247	11.0286	11.0256	11.0263	0.156
21 Day Reading, inches*	7/26/2017	11.0313	11.0334	11.0314	11.0320	0.208
28 Day Reading, inches*	8/2/2017	11.0401	11.0423	11.0396	11.0407	0.286
Average Expansion, %		**0.286**				

*Recorded after initial cure period.



Tests were conducted in general accordance with ASTM test methods and procedures, except when noted. Please feel free to call should you have questions or if I may be of further assistance.

Sincerely,

Sybil K. Ferrier, P.E.
Principal Engineer
rc/sf

Doug Clement
President/CEO

1610 East Madison Ave. • Des Moines, Iowa 50313
(515) 263-0794 • Fax (515) 263-0851
www.cmt-iowa.com

Construction Materials Testing

August 21, 2017

Project No: 1706003ICC

International ChemCrete
800 Security Row
Richardson, TX 75081

Re: ASTM C-1567
Alkali Silica Reactivity
Pavix MCE Study - 2% Internal

Dear Mr. Al-Rashed,

Our lab has completed testing of cement bar samples created on July 3, 2017. The reagent used was sodium hydroxide. Listed below are the parameters of the test method and results of the test.

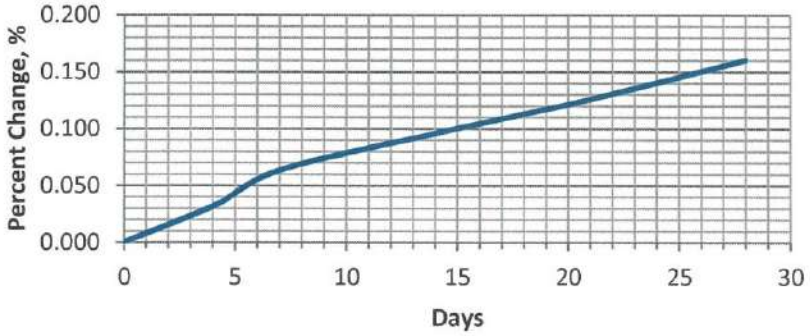
MIX PROPERTIES

Material	Platte River Gravel
Cement Type	Holcim Type I/II
Percentage of Fine/Coarse Aggregate, %	50/50
Mixing Temperature, °F	70

TEST RESULTS - 0.39 w/cm RATIO

	Date	Specimen No. 1	Specimen No. 2	Specimen No. 3	Average	% Change
Initial Reading, inches	7/3/2017	11.0090	11.0108	11.0010	11.0069	0.000
4 Day Reading, inches*	7/7/2017	11.0134	11.0141	11.0037	11.0104	0.031
7 Day Reading, inches*	7/10/2017	11.0161	11.0175	11.0081	11.0139	0.063
14 Day Reading, inches*	7/17/2017	11.0192	11.0206	11.0127	11.0175	0.096
21 Day Reading, inches*	7/24/2017	11.0207	11.0233	11.0184	11.0208	0.126
28 Day Reading, inches*	7/31/2017	11.0242	11.0271	11.0225	11.0246	0.160
Average Expansion, %		**0.160**				

*Recorded after initial cure period.



Tests were conducted in general accordance with ASTM test methods and procedures, except when noted. Please feel free to call should you have questions or if I may be of further assistance.

Sincerely,

Sybil K. Ferrier, P.E.
Principal Engineer
rc/sf

Doug Clement
President/CEO

1610 East Madison Ave. • Des Moines, Iowa 50313
(515) 263-0794 • Fax (515) 263-0851
www.cmt-iowa.com

Construction Materials Testing

August 21, 2017

Project No: 1706003ICC

International ChemCrete
800 Security Row
Richardson, TX 75081

Re: ASTM C-1567
Alkali Silica Reactivity
Pavix MCE Study - Control

Dear Mr. Al-Rashed,

Our lab has completed testing of cement bar samples created on July 5, 2017. The reagent used was sodium hydroxide. Listed below are the parameters of the test method and results of the test.

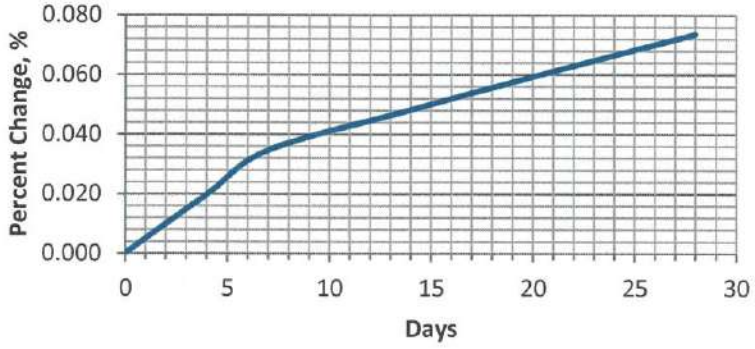
MIX PROPERTIES

Material	Ames Mine/NDM Sand
Cement Type	Holcim Type I/II
Percentage of Fine/Coarse Aggregate, %	50/50
Mixing Temperature, °F	70

TEST RESULTS - 0.39 w/cm RATIO

	Date	Specimen No. 1	Specimen No. 2	Specimen No. 3	Average	% Change
Initial Reading, inches	7/5/2017	11.0079	11.0081	11.0073	11.0078	0.000
4 Day Reading, inches*	7/9/2017	11.0107	11.0100	11.0091	11.0099	0.020
7 Day Reading, inches*	7/12/2017	11.0118	11.0117	11.0112	11.0116	0.035
14 Day Reading, inches*	7/19/2017	11.0129	11.0143	11.0120	11.0131	0.048
21 Day Reading, inches*	7/26/2017	11.0138	11.0168	11.0129	11.0145	0.061
28 Day Reading, inches*	8/2/2017	11.0157	11.0182	11.0137	11.0159	0.074
Average Expansion, %		**0.074**				

*Recorded after initial cure period.



Tests were conducted in general accordance with ASTM test methods and procedures, except when noted. Please feel free to call should you have questions or if I may be of further assistance.

Sincerely,

Sybil K. Ferrier, P.E.
Principal Engineer
rc/sf

Doug Clement
President/CEO

1610 East Madison Ave. • Des Moines, Iowa 50313
(515) 263-0794 • Fax (515) 263-0851
www.cmt-iowa.com

Construction Materials Testing

August 21, 2017

Project No: 1706003ICC

International ChemCrete
800 Security Row
Richardson, TX 75081

Re: ASTM C-1567
Alkali Silica Reactivity
Pavix MCE Study - Topical

Dear Mr. Al-Rashed,

Our lab has completed testing of cement bar samples created on July 1, 2017. The reagent used was sodium hydroxide. Listed below are the parameters of the test method and results of the test.

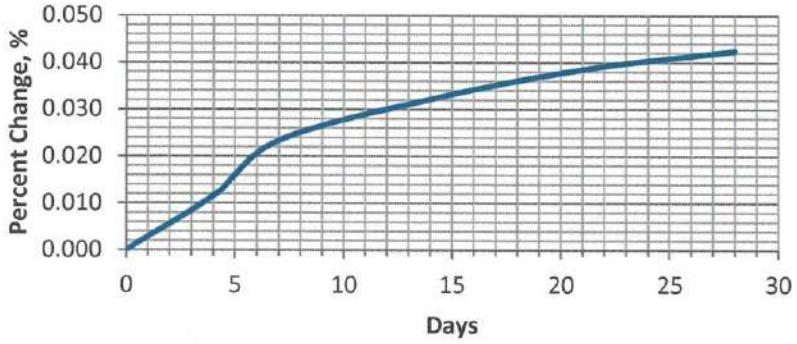
MIX PROPERTIES

Material	Ames Mine/NDM Sand
Cement Type	Holcim Type I/II
Percentage of Fine/Coarse Aggregate, %	50/50
Mixing Temperature, °F	70

TEST RESULTS - 0.39 w/cm RATIO

	Date	Specimen No. 1	Specimen No. 2	Specimen No. 3	Average	% Change
Initial Reading, inches	7/1/2017	11.0069	11.0063	11.0056	11.0063	0.000
4 Day Reading, inches*	7/5/2017	11.0081	11.0078	11.0067	11.0075	0.012
7 Day Reading, inches*	7/8/2017	11.0096	11.0084	11.0085	11.0088	0.023
14 Day Reading, inches*	7/15/2017	11.0103	11.0092	11.0099	11.0098	0.032
21 Day Reading, inches*	7/22/2017	11.0105	11.0103	11.0107	11.0105	0.038
28 Day Reading, inches*	7/29/2017	11.0107	11.0109	11.0112	11.0109	0.042
Average Expansion, %		**0.042**				

*Recorded after initial cure period.



Tests were conducted in general accordance with ASTM test methods and procedures, except when noted. Please feel free to call should you have questions or if I may be of further assistance.

Sincerely,

Sybil K. Ferrier, P.E.
Principal Engineer
rc/sf

Doug Clement
President/CEO

1610 East Madison Ave. • Des Moines, Iowa 50313
(515) 263-0794 • Fax (515) 263-0851
www.cmt-iowa.com

Construction Materials Testing

August 21, 2017

Project No: 1706003ICC

International ChemCrete
800 Security Row
Richardson, TX 75081

Re: ASTM C-1567
Alkali Silica Reactivity
Pavix MCE Study - 2% Internal

Dear Mr. Al-Rashed,

Our lab has completed testing of cement bar samples created on July 3, 2017. The reagent used was sodium hydroxide. Listed below are the parameters of the test method and results of the test.

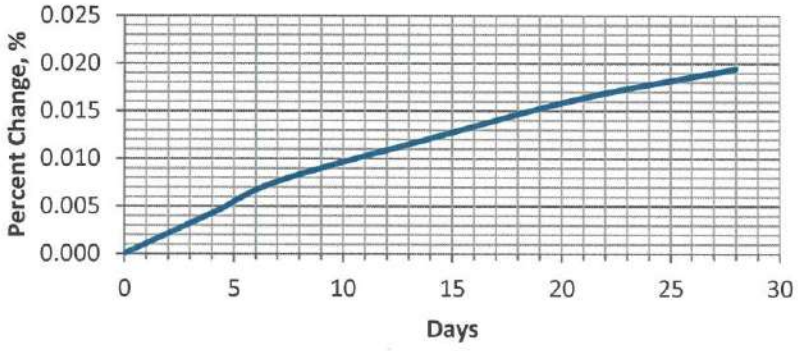
MIX PROPERTIES

Material	Ames Mine/NDM Sand
Cement Type	Holcim Type I/II
Percentage of Fine/Coarse Aggregate, %	50/50
Mixing Temperature, °F	70

TEST RESULTS - 0.39 w/cm RATIO

	Date	Specimen No. 1	Specimen No. 2	Specimen No. 3	Average	% Change
Initial Reading, inches	7/3/2017	11.0019	11.0037	11.0026	11.0027	0.000
4 Day Reading, inches*	7/7/2017	11.0026	11.0041	11.0029	11.0032	0.004
7 Day Reading, inches*	7/10/2017	11.0033	11.0043	11.0031	11.0036	0.008
14 Day Reading, inches*	7/17/2017	11.0042	11.0047	11.0033	11.0041	0.012
21 Day Reading, inches*	7/24/2017	11.0049	11.0051	11.0036	11.0045	0.016
28 Day Reading, inches*	7/31/2017	11.0051	11.0058	11.0037	11.0049	0.019
Average Expansion, %		**0.019**				

*Recorded after initial cure period.



Tests were conducted in general accordance with ASTM test methods and procedures, except when noted. Please feel free to call should you have questions or if I may be of further assistance.

Sincerely,

Sybil K. Ferrier, P.E.
Principal Engineer
rc/sf

Doug Clement
President/CEO

1610 East Madison Ave. • Des Moines, Iowa 50313
(515) 263-0794 • Fax (515) 263-0851
www.cmt-iowa.com

Construction Materials Testing

May 8, 2017

Project No: 1706003ICC

International ChemCrete
800 Security Row
Richardson, TX 75081

Re: ASTM C-642
Density, Absorption and Voids in Hardened Concrete
2 % Enhancer Study - Phase 1
Pavix MCE

Dear Mr. Al-Rashed,

Below you will find test results in general accordance ASTM C-642. Specimens were cast on April 20, 2017. The tests were conducted on concrete at 14 days of age. Our results are as follows;

ASTM C-642	C4 C20-0.37 2735	C4 C20-0.50 2734	Control C4WRC20*
Absorption after Immersion, %	0.1567	0.2195	0.2643
Absorption after Immersion and Boiling, %	0.3233	0.4263	0.8171
Bulk Dry Density	2.449	2.364	2.432
Bulk Density after Immersion	2.453	2.369	2.429
Bulk Density after Immersion and Boiling	2.457	2.374	2.443
Apparent Density	2.469	2.388	2.472
Volume of Permeable Pore Space, %	0.486	1.005	1.173

*Interpolated

Tests were conducted in general accordance with ASTM test methods and procedures. Please feel free to contact me should you have any further questions or if I may be of further assistance.

Sincerely,

Doug Clement
President / CEO

DC/SF

1610 East Madison Ave. • Des Moines, Iowa 50313
(515) 263-0794 • Fax (515) 263-0851
www.cmt-iowa.com

Construction Materials Testing

June 30, 2017

Project No: 1706003ICC

International ChemCrete
800 Security Row
Richardson, TX 75081

Re: ASTM C-642
Density, Absorption and Voids in Hardened Concrete
Enhancer Study - Phase 2
Pavix MCE

Dear Mr. Al-Rashed,

Below you will find test results in general accordance ASTM C-642. Specimens were cast on May 16, 2017. The tests were conducted on concrete at 28 days of age. Our results are as follows;

ASTM C-642	Mix 1 Baseline 0.37 1%	Mix 2 0.44 1%	Mix 3 0.49 1%	Mix 4 0.54 1%
Absorption after Immersion, %	0.1785	0.2041	0.2810	0.3324
Absorption after Immersion and Boiling, %	0.2550	0.4082	0.4577	0.6136
Bulk Dry Density	2.375	2.369	2.357	2.349
Bulk Density after Immersion	2.380	2.373	2.364	2.357
Bulk Density after Immersion and Boiling	2.383	2.379	2.368	2.363
Apparent Density	2.394	2.392	2.382	2.383
Volume of Permeable Pore Space, %	0.787	0.990	1.082	1.441

ASTM C-642	Mix 5 0.44 2%	Mix 6 0.49 2%	Mix 7 0.54 2%
Absorption after Immersion, %	0.0947	0.1247	0.1750
Absorption after Immersion and Boiling, %	0.1994	0.2240	0.3250
Bulk Dry Density	2.458	2.447	2.433
Bulk Density after Immersion	2.461	2.450	2.437
Bulk Density after Immersion and Boiling	2.463	2.452	2.441
Apparent Density	2.470	2.460	2.484
Volume of Permeable Pore Space, %	0.490	0.549	0.791

Tests were conducted in general accordance with ASTM test methods and procedures. Please feel free to contact me should you have any further questions or if I may be of further assistance.

Sincerely,

Doug Clement
President / CEO

1610 East Madison Ave. • Des Moines, Iowa 50313
(515) 263-0794 • Fax (515) 263-0851
www.cmt-iowa.com

المملكة العربية السعودية
الهيئة العامة للزكاة والدخل
GENERAL AUTHORITY OF ZAKAT & TAX
(١٨٥)

بسم الله الرحمن الرحيم

الهيئة العامة للزكاة والدخل
GENERAL AUTHORITY OF ZAKAT & TAX

فرع الطائف

رقم الشهادة : ١٠٧٠٣٣٩٠٢٠
التاريخ : ١٤٤٠/٠٦/٠٧ هـ
الرقم المميز : ٣٠٠٣٤٤٧٦١٣

شهادة
CERTIFICATE

تشهد الهيئة العامة للزكاة والدخل بأن المكلف / مؤسسة عبدالله جابر أسعد الفيفي للمقاولات العامة

سجل مدني رقم ١٠٠٧٠٣٢٥١٧ وسجل تجاري رقم ٤٠٣٢٠٢٢٨٤٥

قدم إقراره عن الفترة المنتهيه في ١٤٤٠/٠١/٢٩ هـ

وقد منح هذه الشهاده لتمكينه من إنهاء جميع معاملاته بما في ذلك صرف مستحقاته النهائية عن العقود.

يسري مفعول هذه الشهادة حتى تاريخ ١٤٤١/٠٥/٢٩ هـ الموافق ٢٠٢٠/٠١/٢٤م.

(التاسع و العشرون من جمادى الأولى ألف و أربعمائة و واحد و أربعون هجري)

الفروع (١) في النموذج المرفق

الهيئة العامة للزكاة والدخل
GENERAL AUTHORITY OF ZAKAT & TAX
الشهادات

الختم الرسمي

هذه الوثيقة مستخرجة من النظام الآلي ولا تحتاج إلى توقيع

لايعتد بهذه الشهادة إلا بعد التحقق من موقع الهيئة www.gazt.gov.sa