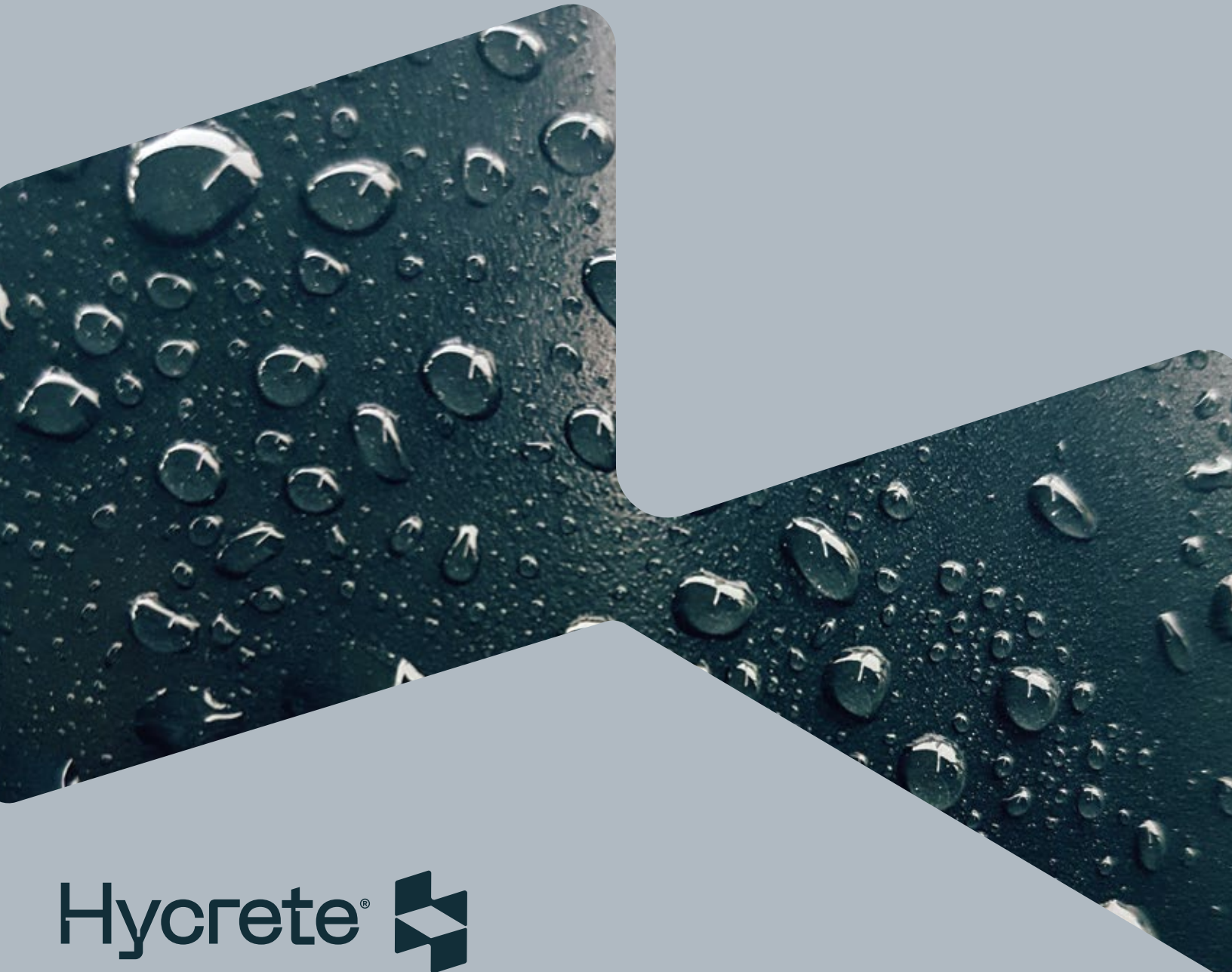

Hycrete Testing Summary

Simply Better Concrete Protection



Hycrete® 

Hycrete Testing Summary

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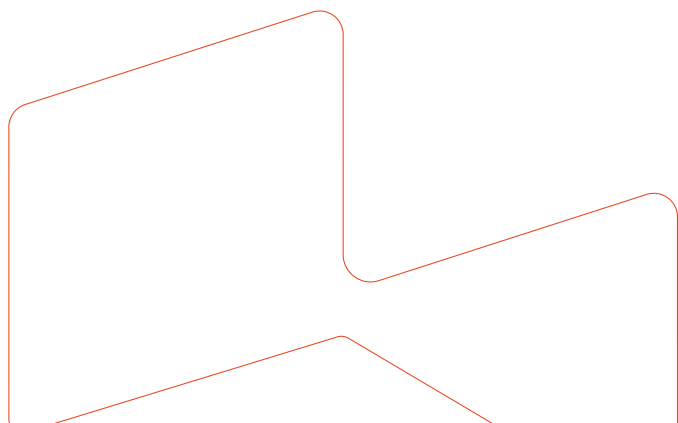
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I. Waterproofing and Hydrophobic Properties

Concrete with Hycrete admixtures achieves the highest waterproofing performance ratings of waterproof concrete mix designs.

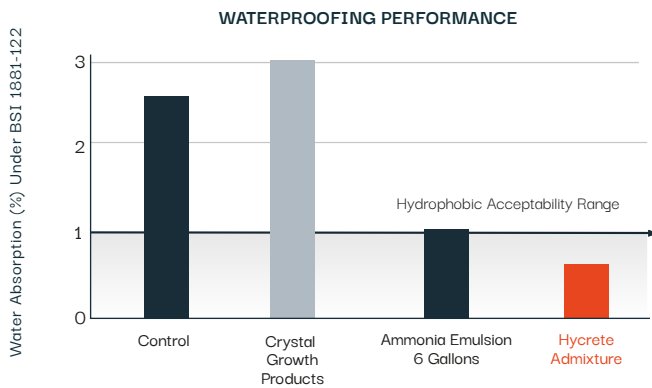
I-a. Absorption (BSI 1881-122)

BSI 1881-122 is a standard method for the measurement of capillary absorption in concrete. Capillary absorption is a powerful water transport mechanism in concrete that can result in water, chloride, and sulfate absorption, concrete surface degradation, and increased interior moisture vapor levels.

Concrete specimens are cast and cured, and then weighed. Specimens are then immersed in water for 30 minutes to simulate a typical wetting event. Finally, samples are re-weighed to measure water absorption.

Part 1 – Low w/c Ratio

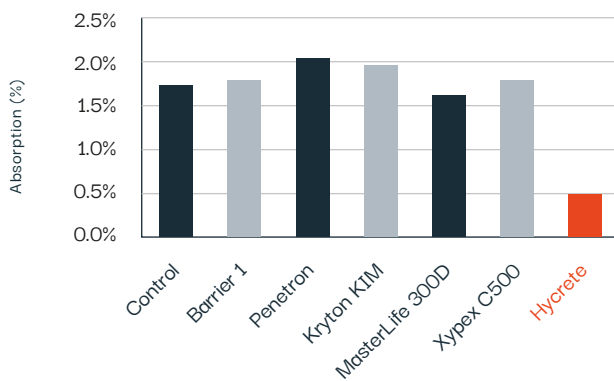
Unparalleled: This test is used as the benchmark for hydrophobic concrete. Low w/c concrete typically tests in the 2%-4% absorption range under BSI 1881-122 testing. Hydrophobic concrete is specified at less than 1% absorption. Hycrete admixtures perform at the 0.3% to 0.9% range.



South Carolina Independent Lab Testing: 40/60 Structural Mix, 0.40 W/C - 611 Type I-II Cement Polycarboxylate Superplasticizer

Part 2 – Hycrete compared to other admixtures

Specimens with Hycrete outperformed both the control and the other waterproofing admixtures by a factor of 3.3-4.2.



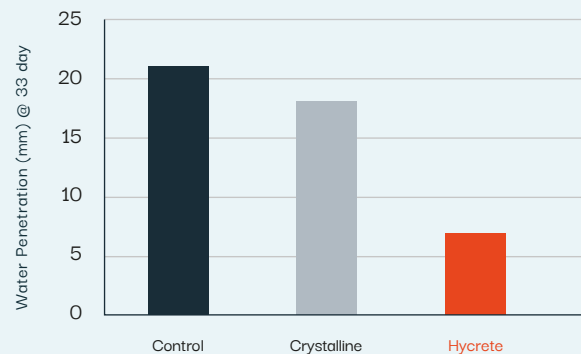
Performed by Tourney Consulting Group (TCG)

1-b. Depth of Penetration of Water Under Pressure (BS EN 12390-8)

BS EN 12390-8 is a widely used performance standard for applications requiring protection for concrete structures under hydrostatic pressure.

BS EN 12390-8 specifies a method for determining the depth of penetration of water under pressure in hardened concrete. Water is applied under pressure to the surface of hardened concrete. The specimen is then split and the depth of penetration of the waterfront is measured.

BS EN 12390-8 is conducted at the equivalent of a depth of 173 feet of water for 72 hours. Hycrete outperformed both the control and crystalline samples by a factor of 2-3.



Advanced Construction Technology Services (ACTS)

I-c. Hydrostatic Pressure Resistance (ASTM D 5385)

| | PSI | Head of Water Pressure | Result |
|-------------------|-----|------------------------|------------|
| Hycrete admixture | 100 | 231 Feet Resistance | No seepage |

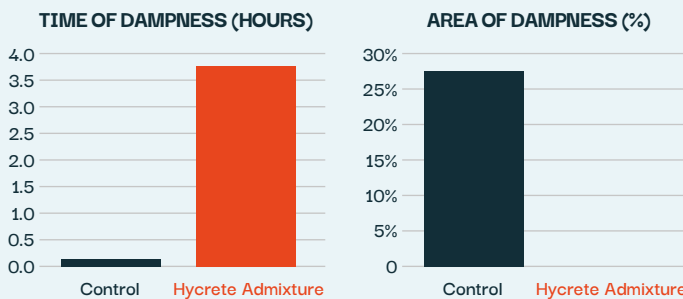
Nelson Testing Labs, Chicago, IL

I-h. Water Penetration of Masonry Walls with a Hydrophobic Additive (ASTM E514)

Masonry walls are a common construction material and are often susceptible to moisture intrusion and associated waterborne particles, which can cause corrosion of the reinforcement and promote mold growth in confined spaces. In this test masonry walls are constructed and exposed to a simulated wind-driven rain for a period of four hours.

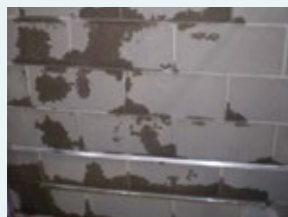
As the constructed walls with and without Hycrete Admixture were subjected to the simulated wind-driven rain, the "time of dampness" (the time it took for the first moisture to be seen on the back side of the wall) was measured. In addition, the area of dampness on the back side of the wall as a percent of the total area of the constructed wall was measured. Hycrete showed significant benefit in both cases.

The average time of dampness for the wall constructed with Hycrete was 3.75 hours compared to 8.5 minutes for the control wall.



Hycrete wall

Time of dampness: 3.75 hours
Area of dampness: 0.012%



Control wall

Time of dampness: 0.14 hours (8.5 minutes)
Area of dampness: 26.679%

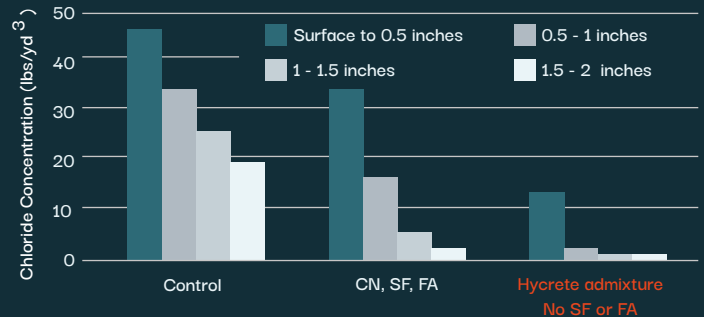
Water Penetration of Masonry Walls with a Hydrophobic Additive, US Army Engineer Research and Development Center

II. Corrosion Protection

II-a. Chloride Diffusion (ASTM G-109)

Excellent (Outperforms calcium nitrite/silica fume/fly ash mixes)

CHLORIDE DIFFUSION COMPARISON BETWEEN CALCIUM NITRITE/SF/FA COMBINATION AND CONCRETE WITH HYCRETE ADMIXTURE



University of Massachusetts: w/c 0.40, Admixture: Calcium Nitrite (3 gal./yd³), Silica Fume (6%), Fly Ash (15%), Hycrete admixture (2 gal./yd³) Double- ASTM G-109 blocks, Salt Ponding Regime 12 weeks of 4 day ponding, then 12 weeks of continuous ponding. Approximately 3 years ponding.

II-b. Corrosion Inhibition

Hycrete admixture and rebar in NaCl solution of pH 13 for 28 days illustrated below.



No rust

Rebar in 6% Hycrete admixture & NaCl Solution. No Damage Measured.



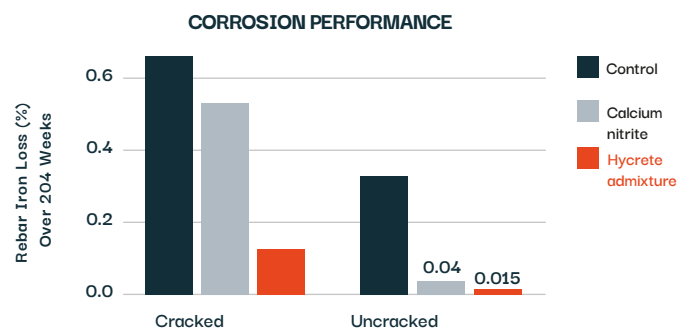
0.11% Steel Loss

NaCl Solution 0.11%. Steel Loss.

Materials Service Life, LLC

II-c. Corrosion Protection of Steel in Cracked Concrete

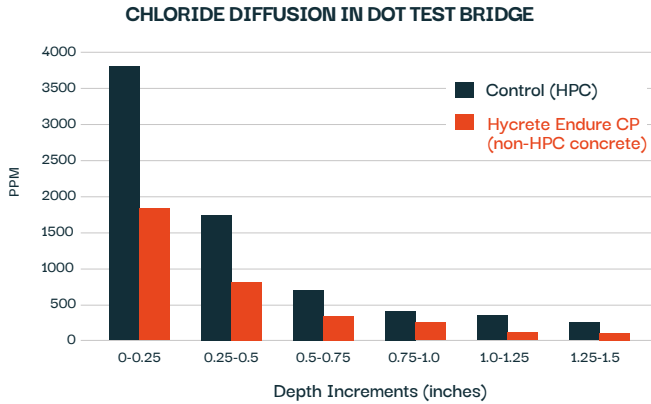
Hycrete admixtures have been the focus of a number of government commissioned corrosion inhibition studies. In one such study, 204 weeks of cycled ponding and drying in sodium chloride solution were evaluated for corrosion by macrocell measurements leading to a calculation of iron lost. Both uncracked and cracked specimens were evaluated, and a number of competitive corrosion inhibitors were studied. The results indicate that corrosion is accelerated by cracking and that Hycrete admixtures are able to inhibit corrosion compared to the controls and to calcium nitrite treated specimens in both uncracked and cracked concretes.



Hycrete effectively reduces rust even in cracked concrete.

University of Massachusetts

II-d. Chloride Diffusion in DOT Test Bridge



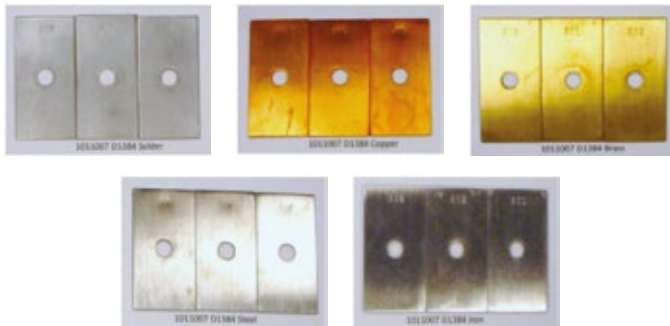
Hycrete reduces chloride penetration at all depths.

The New Jersey DOT installed test bridge decks on Route 130 in 2006. The control deck utilized the standard NJ DOT high performance concrete (HPC) mix; the test deck included Hycrete admixtures. Core samples taken in late 2009 show a dramatic benefit in chloride resistance in the Hycrete deck. Chloride concentrations in the Hycrete deck were up to 3.5 times lower; a Hycrete-treated deck could be expected to be considerably more durable than a deck constructed with the standard DOT HPC mix design.

Tourney Consulting Group (TCG), December, 2009

II-e. Corrosion on Metals (ASTM D1384)

Hycrete has been tested to evaluate its effectiveness in preventing corrosion on metals. Metal specimens are immersed in a solution with corrosive salts and Hycrete for 336 hours at 88°C. The corrosion inhibition properties of the test solution are evaluated on the basis of the weight changes incurred by the specimens. Hycrete has been shown to protect copper, solder, brass, steel, and iron, among other metals.

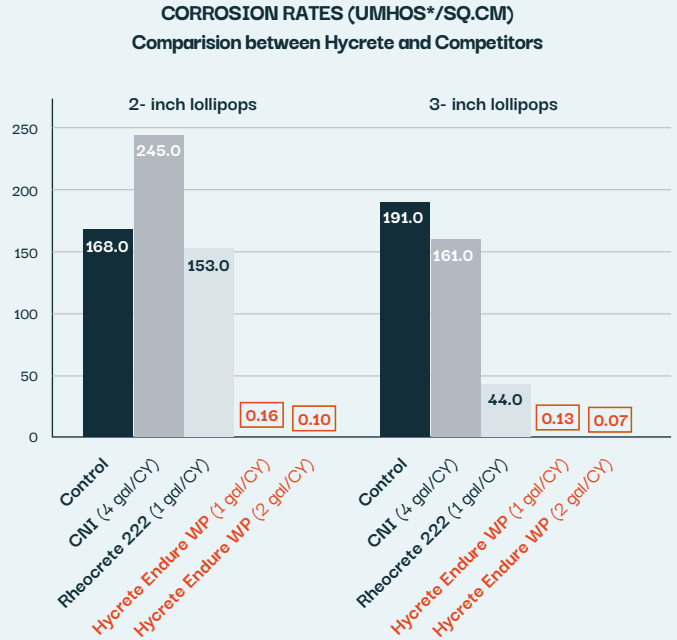


Hycrete stops corrosion in iron, steel, copper, brass and silver.

Source: ASTM D1384; Amalgamated Laboratories, Inc.

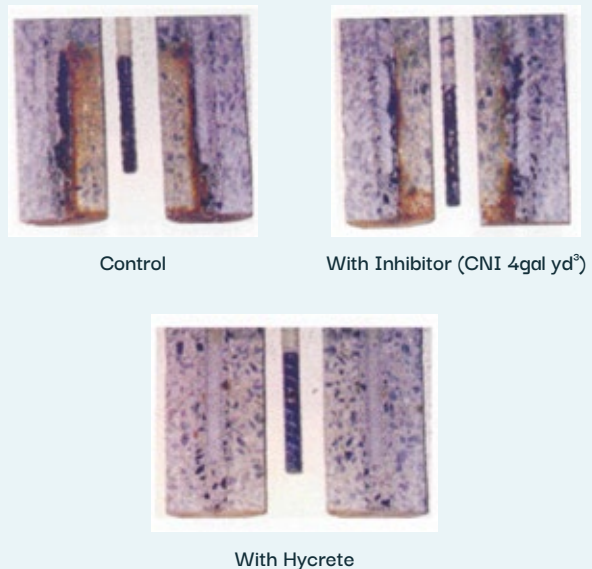
II-f. Corrosion Rates After 100 Weeks of Wet/Dry Cycling in 15% Salt Water

Hycrete stops corrosion by 99%+



* μmhos (micromhos) is a measure of the electrical conductivity of a solution.

After 100 weeks of wet/dry cycling in 15% salt water, visual inspection showed no brown staining on the Hycrete lollipop samples and no corrosion of the rebar. The Control, CNI, and Rheocrete 222 lollipops all showed brown staining on the concrete surface and significant corrosion of the rebar.



University of Connecticut "Protection of Reinforcement with Corrosion Inhibitors" by Professors Gregory C. Frantz and Jack E. Stephens

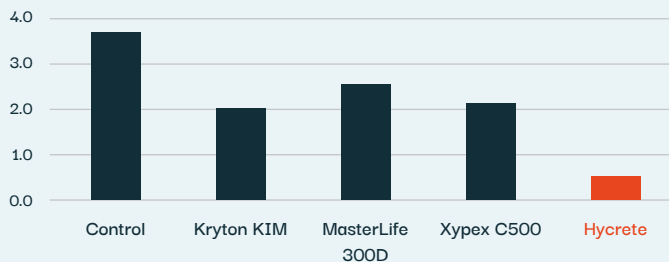
III. Moisture Protection For Flooring, Coatings, And Sealants

II-g. Bulk Chloride Diffusion (ASTM C1556)

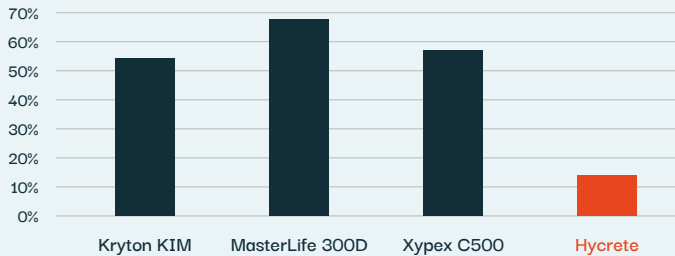
In independent testing performed by Tourney Consulting Group (TCG), the chloride diffusion performance of concrete with four concrete admixtures (including Hycrete admixture) was evaluated alongside a control according to modified ASTM C1556. TCG followed modified-ASTM C1556 Apparent Chloride Diffusion Coefficient to estimate chloride penetration into cementitious mixtures that are in a saturated condition. Concrete samples are moist-cured for 28 days prior to drying for four weeks. Then the samples undergo a cycle of one week of chloride soaking followed by one week of ambient drying for a period of 90 days.

Specimens with Hycrete admixture outperformed both the control and the other waterproofing admixtures by a factor of 3.8-7.0.

MODIFIED ASTM C1556 BULK CHLORIDE DIFFUSION
Mean D_a m^2/s ($\times 10^{-11}$)



MODIFIED ASTM C1556 BULK CHLORIDE DIFFUSION
as a % of Control



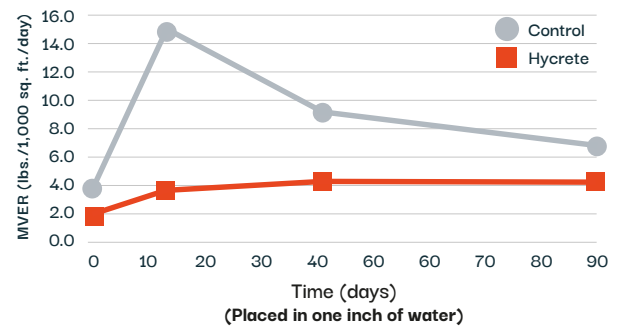
Tourney Consulting Group (TCG)

III-a. Moisture Vapor Transmission (ASTM F1869)

Modified Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride.

Specimens are moist cured for seven days followed by 50% RH drying for a period of 94 days to observe drying rates. Specimens are then oven dried for three days followed by one day of cooling. Then the specimens are placed in containers with water such that the bottom one-inch of the slab is constantly immersed in water and a 50% RH atmosphere is maintained on the top surface. Measurements were taken at 1, 13, 41, and 90 days.

SLAB MOISTURE VAPOR EMISSION WITH SIMULATED GROUNDWATER EXPOSURE
Moisture vapor measurements at dry surface of concrete slab



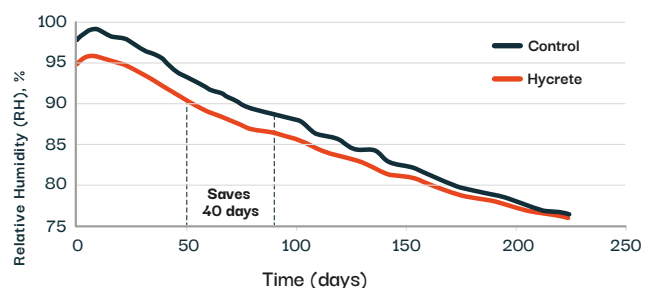
CTL Group, Skokie, IL: w/c 0.39; 700 lbs cementitious; 15% fly ash

III-b. Relative Humidity (RH) (ASTM F2170)

Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using in situ Probes.

Concrete slabs are cast and instrumented with relative humidity (RH) probes to measure internal relative humidity over time. A probe is suspended in air close to the slabs to record ambient temperature and relative humidity. The slabs are exposed to ambient temperature and relative humidity, which is meant to mimic typical field construction exposure conditions.

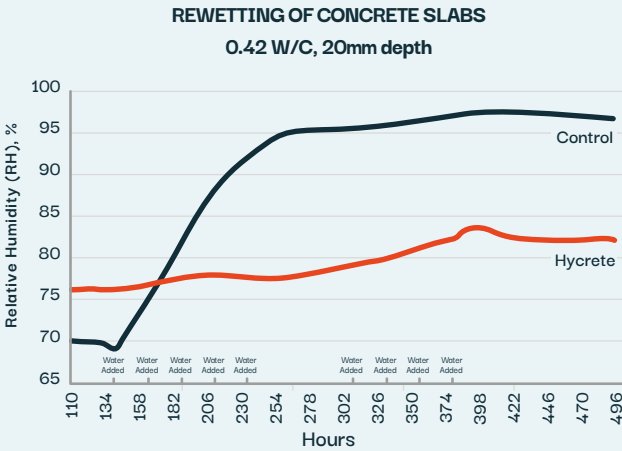
RELATIVE HUMIDITY
0.50 W/C Control, 0.42 W/C Hycrete, 40mm depth



CTLGroup, Skokie, IL

III-c. Concrete Rewetting (ASTM F2170)
 Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using in situ Probes.

Samples are soaked in 1/2 inch of water for one hour each day and then dried to simulate real-world conditions. Relative humidity is measured at a depth of 20mm using in situ probes.

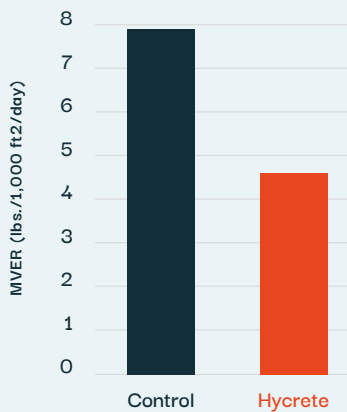


CTLGroup, Skokie, IL

III-d. Absorption Upon Rewetting of Concrete (ASTM F1869)
 Modified Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride.

Specimens are moist cured for seven days followed by 50% RH drying for a period of 94 days to observe drying rates. Specimens are then oven dried for three days followed by one day of cooling. Then the specimens are immersed in water for 15 minutes to simulate a rain (or other wetting) event. Finally, the specimens are dried at 50% RH for 15 hours.

SLAB MOISTURE VAPOR EMISSION RATE AFTER SIMULATED RAIN

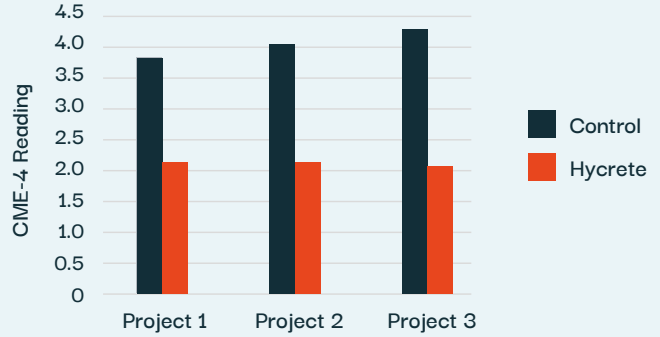


CTLGroup, Skokie, IL

III-e. Moisture Content

Moisture readings were taken at several completed projects using a CME-4 meter. Results indicate significantly lower moisture content in concrete containing Hycrete admixtures compared to control concrete.

CME-4 MOISTURE READINGS

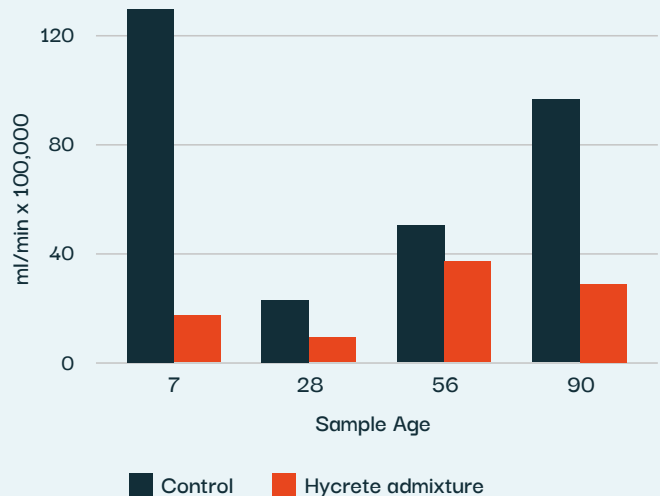


Southwest Inspection and Testing, Inc., La Habra, CA; samples were taken from three projects with different mix designs

III-f. Evapo-Transpiration Relative Permeability

Hycrete admixtures demonstrated a 68% vapor transpiration reduction compared to the control at 90 days. Resistance to capillary flow of water through the concretes was measured using the Kansas evapo-transpiration test, in which a desiccant on one side of a one-inch-thick sample draws water from the other side.

EVAPO-TRANSPARATION RELATIVE PERMEABILITY TEST

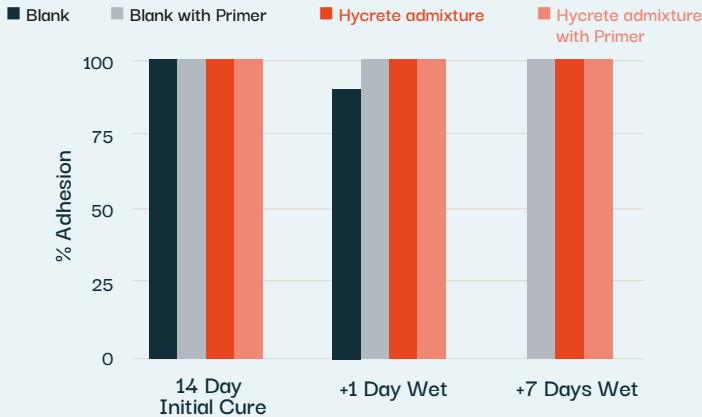


Kansas Department of Transportation: 0.42 w/c 600 lbs cement Hycrete 2 gal./yd³

III-g. Adhesion

Hycrete admixtures are compatible with most concrete admixtures and coatings and are not known to affect adhesion. For specific questions relating to your project please contact Technical Services.

SILICONE ADHESION TO HYCRETE TREATED CONCRETE

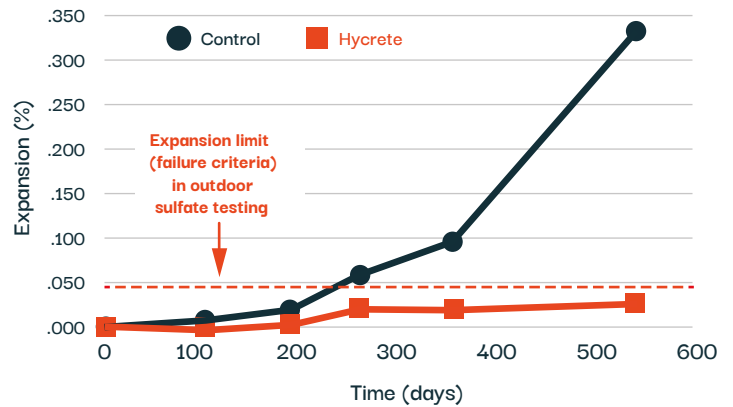


GE Silicones Construction Laboratory, Waterford, NY

IV-b. Sulfate Protection

The influence of Hycrete admixtures on the durability of concrete exposed to sulfates was examined at the University of Texas at Austin, Concrete Durability Center, in a study funded by the United States Army Corps of Engineers. Concrete with Hycrete admixture was exposed to sulfates in both outdoor and laboratory sodium sulfate exposure sites. The outdoor study includes exposure to a sodium sulfate pond with a concentration greater than 2% by mass (this condition is consistent with class three sulfate exposure per ACI 318-08). In the outdoor sulfate testing, an expansion limit of 0.04% is the failure criteria. The control mixture at 18 months expanded 0.33% while the Hycrete mixture had only expanded 0.03%.

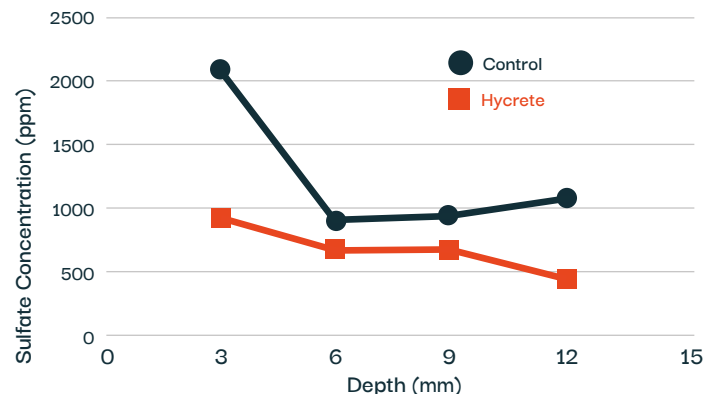
EXPANSION OF 0.7 W/CM MIXTURES IN THE OUTDOOR SULFATE EXPOSURE



Hycrete retards cracking due to soil, seawater and sewage borne sulfates.

Sulfate penetration was also tested in the outdoor sulfate exposure site. In every case tested, the sulfate concentration was lower in the mixtures containing Hycrete. Mixtures containing Hycrete outperformed control mixtures.

SULFATE PENETRATION IN THE OUTDOOR SULFATE EXPOSURE

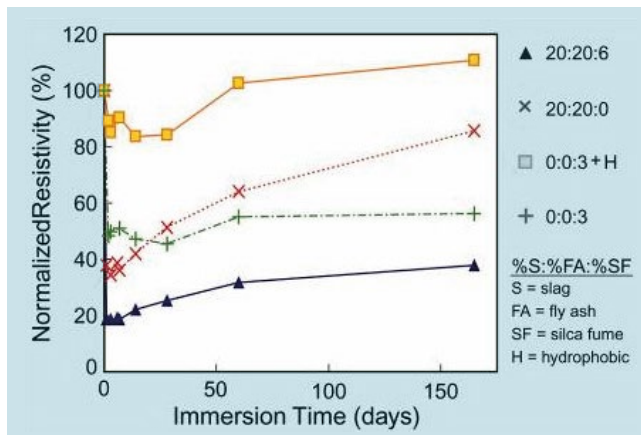


Hycrete slows the penetration of sulfates

IV. Electrical Resistance and Sulfate Protection

IV-a. Electrical Resistivity

Concrete with Hycrete admixture was measured with the intent of maximizing resistivity to prevent the transmission of stray current from an electric trolley line from corroding underground piping. Hycrete admixture (designated "H" here) was shown to resist the decrease in resistivity shown by alternative concretes when exposed to water, which is critical to controlling stray currents in environments where rain occurs.



Hycrete maintains concrete's resistivity. Slag, fly ash and silica fume do not when exposed to water.

Figure reproduced with permission and gratitude to John S. Tinnea & Associates and NACE International from Burke, et. al., Materials Performance, September 2007, pp. 2-8. © NACE International 2007.

External sulfates are known to cause deterioration to concrete through chemical reactions. X-Ray diffraction (XRD) was used to determine the chemical reaction changes that are occurring in concrete. The XRD is occurring on samples after 18 months of storage in the sulfate outdoor exposure site in Austin, TX.

Figure 1 provides the XRD patterns at different depths for the submerged Control prism. In the outer 0-3mm, the calcium hydroxide has been depleted. Further into the specimen the calcium hydroxide amount has increased. In addition, ettringite formation has formed within each interval along with a small amount of gypsum. Figure 2 shows the XRD pattern for the submerged prism for Hycrete. Calcium hydroxide has not been depleted at any depth within this sample, and ettringite formation has not occurred.

Mixtures with Hycrete did not show the calcium hydroxide depletion and ettringite formation that was seen in the control mixtures. Overall, the mixtures with Hycrete provided a higher tolerance to sulfate attack.

FIGURE 1: X-RAY DIFFRACTION AT DIFFERENT DEPTHS FOR SUBMERGED CONTROL SPECIMEN

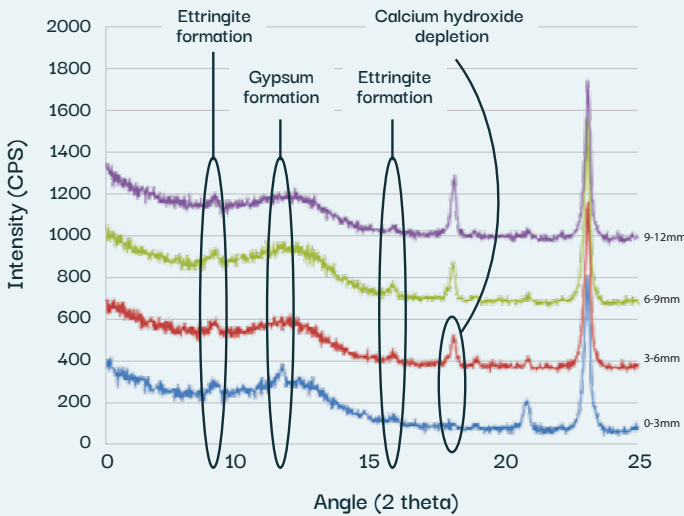
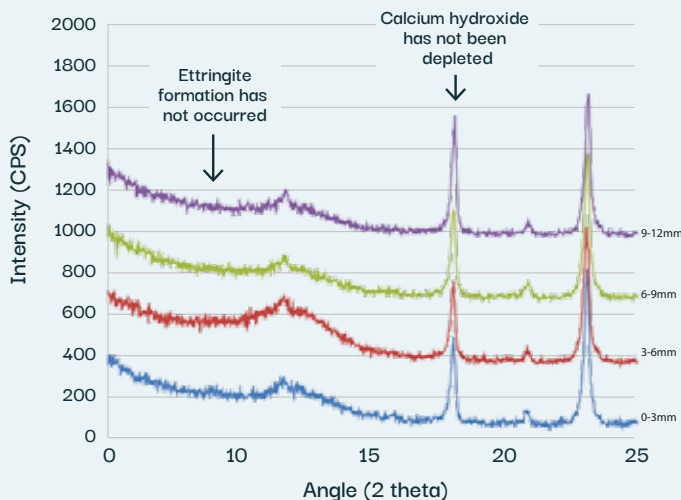


FIGURE 2: X-RAY DIFFRACTION AT DIFFERENT DEPTHS FOR SUBMERGED HYCRETE SPECIMEN



The Calcium Hydroxide that protects concrete from sulfate cracking and pitting is not consumed when Hycrete is incorporated

Visual signs of chemical and physical sulfate attack were also documented. Hycrete treated specimens showed less distress versus control specimens.



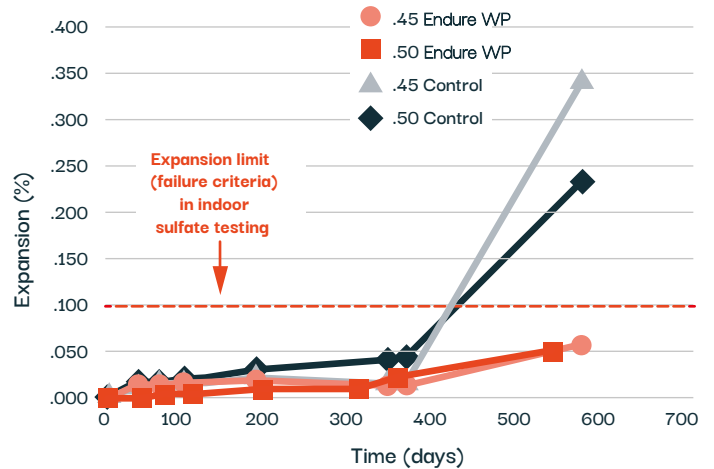
Control prisms after 18 months of exposure



Hycrete prisms after 18 months of exposure

Hycrete was also tested in a laboratory static immersion test according to ASTM C1012 Modified. A failure criterion of 0.10% expansion is shown in the following graph as it is the failure criterion in most guidelines (e.g., ACI). The modification employs cyclic immersion as a way of accelerating deterioration and for better elucidating the effects of integral water repellents on sulfate resistance. Several specimens with different water-cement ratios were used. Hycrete specimens had lower expansion values than control specimens in all instances.

EXPANSION OF CONCRETES AT .45 AND .50 WATER/CEMENT



Control

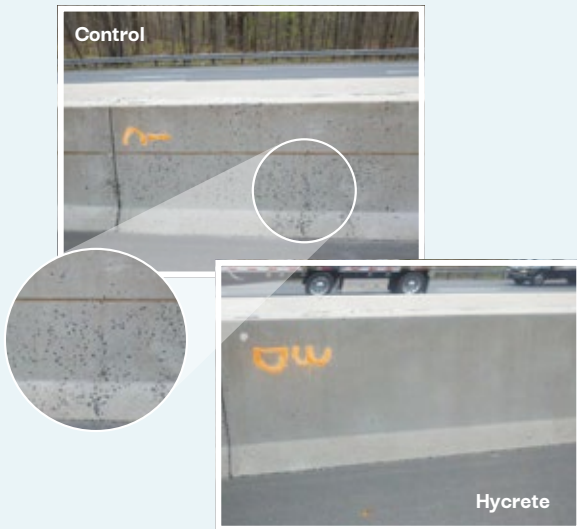
Hycrete

INDOOR SPECIMENS AFTER 18 MONTHS OF EXPOSURE TO SODIUM SULFATE SOLUTION.

The visual inspection of all the mixtures showed that Hycrete was performing better than the control.

IV-c. Surface Protection

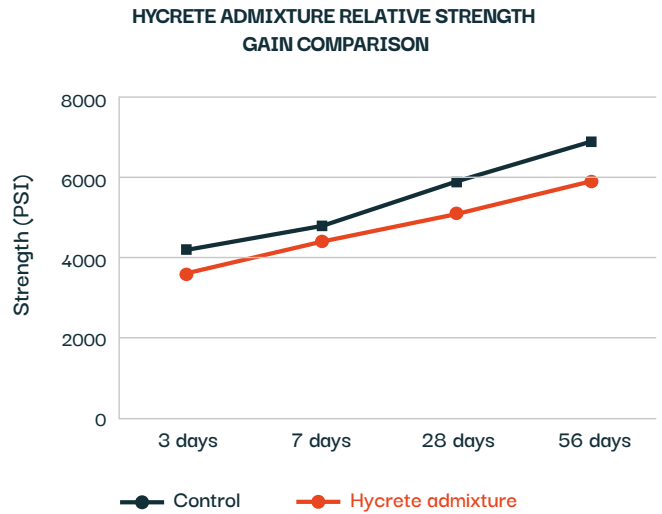
In 2003 Connecticut DOT constructed highway barriers with and without Hycrete admixture along Interstate 84 in Connecticut to test the effectiveness of Hycrete in protecting the concrete from corrosion and exposure to the elements. The same mix design was used in both cases and the Control and Hycrete barriers were alternated to account for potential differences in field conditions. After eight years in service the barriers were tested and photographed. The Control barriers showed signs of spalling and exterior deterioration; the Hycrete barriers are intact.



Hycrete greatly reduces spalling due to freeze thaw cycles.

V-c. Hardened Concrete Properties

Compressive Strength: Concrete treated with Hycrete admixture meets ACI strength guidelines for structural concrete.



Kansas Independent Lab Testing: 40/60 Structural Mix 0.40 W/C - 600 lbs Type I - II OPC

V. General Concrete Properties

V-a. Plastic Concrete Properties

Workability & Cohesion: **Excellent**
Slump Retention: **Excellent - Neutral**

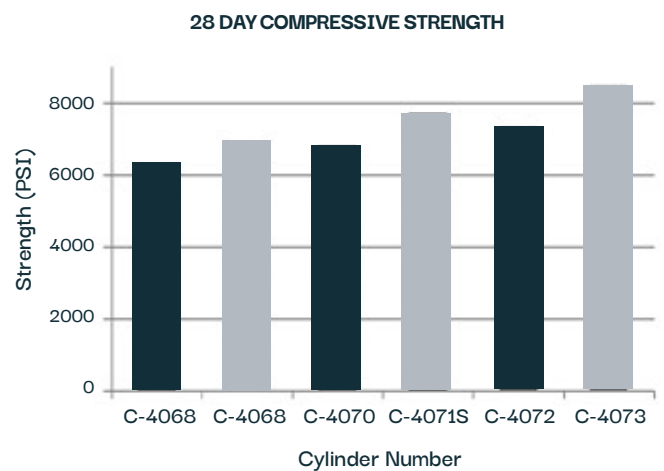
V-b. Setting Time

Set Neutral Typically +/- 30mins of Control

| | Control | Hycrete admixture |
|------------------------|---------|-------------------|
| Set Time, Initial, hrs | 4:59 | 4:39 |
| Set Time, Final, hrs | 6:05 | 5:47 |

New Jersey Department of Transportation Data

V-d. Setting Time



Meritage Project: Seattle, WA 0.40 wc, 655 cementitious, Hycrete admixture

V-e. Freeze-Thaw (ASTM C666)

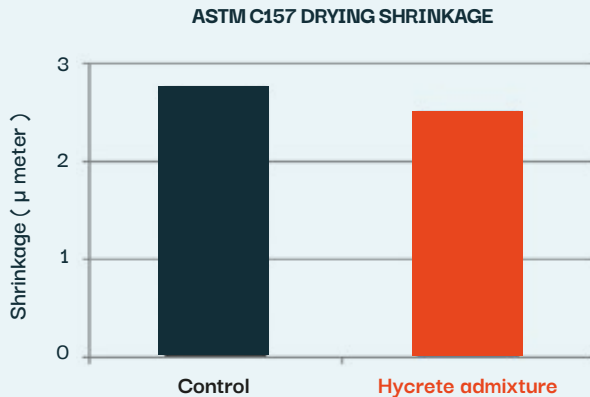
Standard Test Method for Resistance of Concrete to Rapid Freezing and Thawing.

Concrete with Hycrete admixture is air entrainable and meets the vigorous demands placed on concretes used in severe winter weather conditions. (Result: Pass; 300+ cycles with durability readings of 90+)

New England Transportation Consortium

V-f. Drying Shrinkage (ASTM C157)

Shrinkage of concrete is dependent upon numerous factors. Hycrete admixtures have generally been shrink neutral.



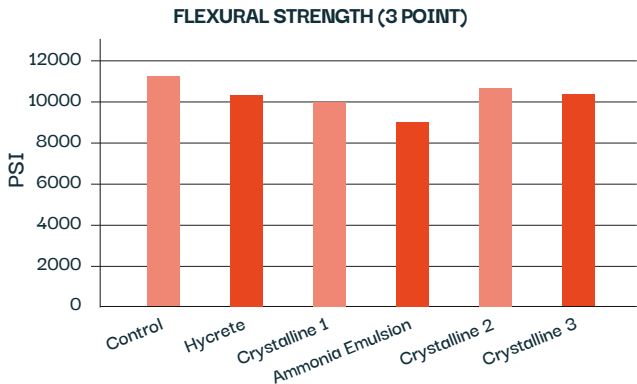
Nelson Testing Labs, Chicago, IL: 40/60 Structural Mix .40 W/C 565 lbs Cementitious 24% Type F Flyash Water Reducer

V-g. Shotcrete Performance

| | |
|--------------------------|----------------------|
| Rebound: Excellent | Stand up: Excellent |
| Odor: Neutral | Set Time: Neutral |
| Consolidation: Excellent | Absorption: Superior |

Northern California Independent Lab Testing: 70/30 Shotcrete Mix 780 lbs Cementitious - 25% Slag 0.38 W/C Polycarboxylate Water Reducer

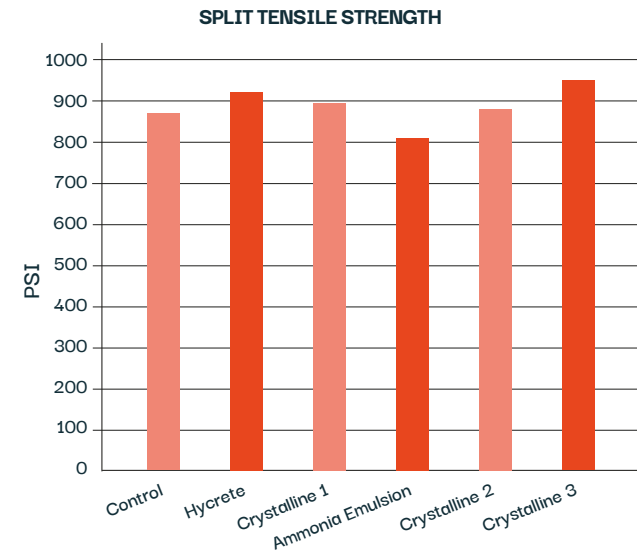
V-h. Flexural Strength Testing (ASTM C78)



Internal testing conducted by Hycrete correlates Hycrete flexural strengths to compressive strengths in accordance with standard engineering relationships. This testing demonstrates that Hycrete admixtures have negligible impact on flexural strength in concrete.

Conducted by Hycrete, 2007

V-i. Split Tensile Strength (ASTM C496)



Testing conducted at the New Jersey Institute of Technology shows negligible impact on tensile strength in concrete incorporating Hycrete admixtures.

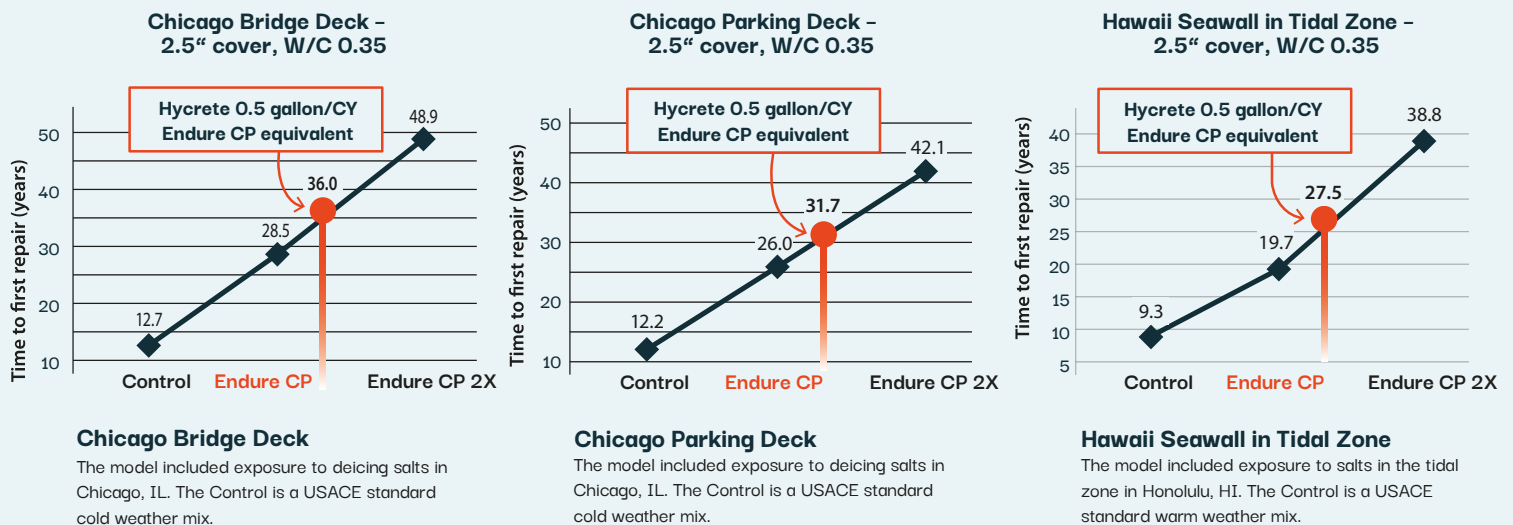
NJIT, 2007

VI. U.S. Army Corps of Engineers Life 365™ Modeling in Various Applications and Climates

Hycrete more than triples the structural and cosmetic life of concrete.

In independent modeling performed by Tourney Consulting Group (TCG) for the U.S. Army Corps of Engineers (USACE), the durability of concrete with Hycrete admixtures was compared to standard control concrete mixes used by USACE. The analysis includes modeling conducted using Life 365™, an open software program. This Life 365™ analysis predicted the time in years until the first repair and the cost effectiveness when using Hycrete. It concluded that in all scenarios Hycrete significantly increased the time until first repair and provided significant cost savings. Here are summarized results from the study.

FORECASTED TIME TO INITIAL REPAIR - COMPARISON BETWEEN USACE CONTROL AND HYCRETE



VII. Environmental

VI-a. Contributions to LEED

MR 2.1 - Construction Waste Management

Hycrete admixtures have zero construction site waste, eliminating the waste streams from traditional membranes.

MR 4.1/2 - Recycled Materials

Hycrete admixtures contain 80% preconsumer recycled materials.

MR 5.1/2 - Sourced Locally within 500 Miles

Hycrete admixtures are manufactured in Newark, NJ.

Innovation in Design - "Membrane-Free Construction"

Hycrete materials offer the opportunity to eliminate the use of membranes, providing substantial reduction in jobsite material used, pollutants emitted, non-recyclables consumed, and labor used. Based solely on the use of the Hycrete System, this Innovation In Design credit has been successfully submitted and approved by the USGBC in previous projects.

Innovation in Design - 2.5% of Building Materials Cradle to CradleCM Certified

An ID point can be achieved for a total of 2.5% of a building's material use Cradle to CradleCM Certified. Hycrete admixtures are Cradle to CradleCM Certified Gold.

VI-b. Cradle to CradleCM Certified Gold

The Cradle to CradleCM philosophy embraces a fundamental change in our disposable society - from cradle to grave to Cradle to CradleCM. Hycrete admixtures are Cradle to CradleCM Certified Gold.

VI-c. NSF/ANSI 61 Certified

Drinking Water System Components -Hycrete admixtures have been tested and approved for use in potable water applications.



Hycrete® 

Simply Better Concrete Protection