



Delivering Concrete Performance

Hycrete Extends the Structural and Cosmetic Life of Concrete!

Hycrete Testing Summary

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I. Waterproofing and Hydrophobic Properties

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

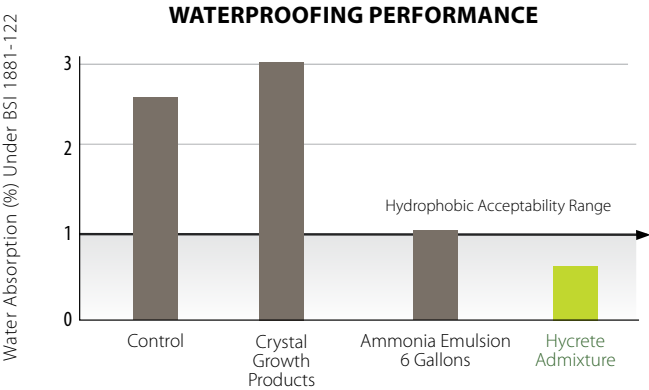
I-a. Absorption (BSI 1881-122)

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

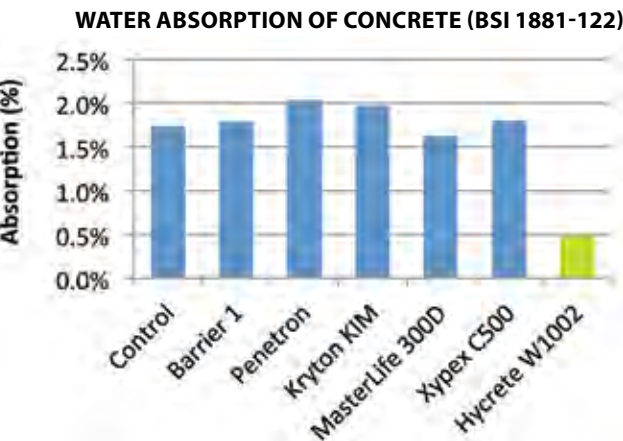
Unparalleled: This test is used as the benchmark for hydrophobic concrete. Low w/c concrete typically tests in the 2%-4% absorption range under BSI 1881-122 testing. Hydrophobic concrete is specified at less than 1% absorption. Hycrete admixtures perform at the 0.3% to 0.9% range.



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 W1002 outperformed both the control and the other waterproofing admixtures by a factor of 3.3-4.2.



Performed by Tourney Consulting Group (TCG)

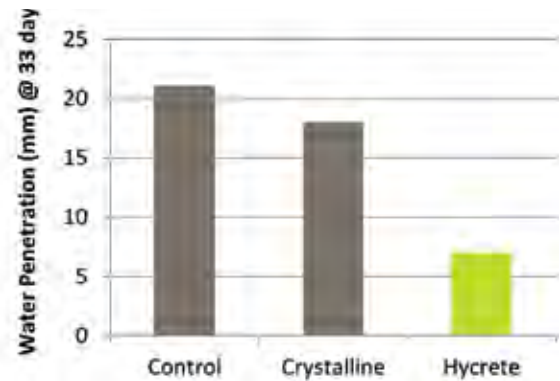
1-b. Depth of Penetration of Water Under Pressure (BS EN 12390-8)

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.

DEPTH OF PENETRATION OF WATER UNDER PRESSURE 173 FT OF WATER PRESSURE (BS EN 12390-8)



Advanced Construction Technology Services (ACTS)

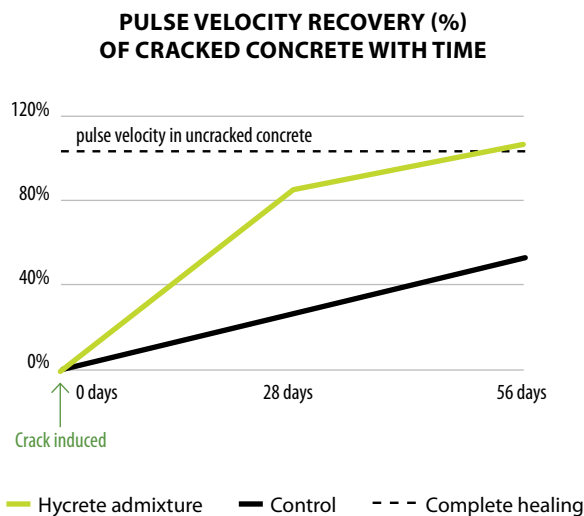
I-c. Hydrostatic Pressure Resistance (ASTM D 5385)

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

Nelson Testing Labs, Chicago, IL

I-d. Self-Healing of Cracks

Excellent: Hycrete admixtures have been tested under numerous scenarios in cracked concrete. In a test conducted by Materials Service Life, LLC, a Portable Ultrasonic Non-Destructive Digital Indicating Tester (PUNDIT device) was used to record pulse velocity through concrete. Sound waves travel faster in uncracked concrete than they do in cracked concrete. The study deliberately cracked the concrete and measured pulse velocity. As cracks heal, velocity of pulses will rise towards the velocity measured in uncracked concrete. As shown in the figure below, concrete with Hycrete admixtures fosters faster and 100% complete healing compared to the untreated control sample.



Materials Service Life, LLC

I-e. Chloride Transmission

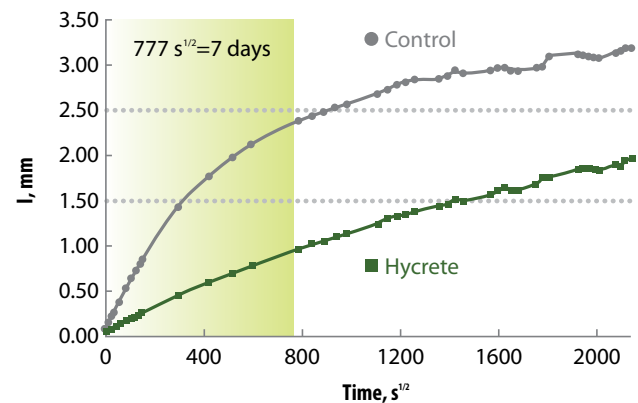
Cups made of concrete with Hycrete admixture and a control. NaCl solution was poured into the cups for a 5 week period. As seen, salt leaching was observed through the control and not through the Hycrete admixed sample.



Kansas Department of Transportation

I-f. Impact of Hycrete on Absorption (ASTM C1585) in High Performance Concrete

DETERMINATION OF CAPILLARY ABSORPTION ASTM C1585



The VTRC of the Virginia DOT conducted extensive testing of Hycrete admixtures. Hycrete performance in the ASTM C1585 absorption test demonstrates up to six times lower absorption. The testing was conducted with the Virginia DOT's standard A4 high performance concrete mixes with variations in Hycrete dosage and the inclusion of fly ash.

Virginia Transportation Research Council (VTRC), Virginia Dept of Transportation, May, 2007

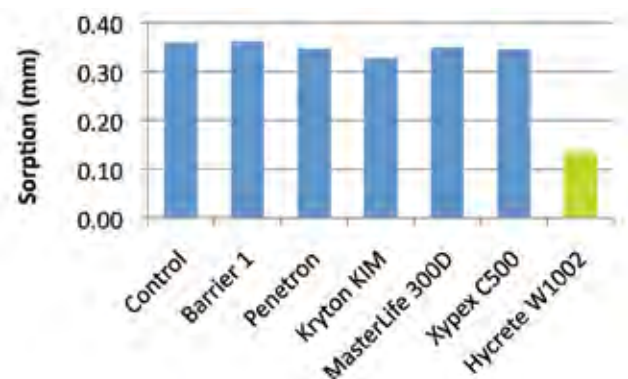
I-g. Water Sorption (ASTM 1757)

ASTM C1757 is a standard method for the measurement of one-point, bulk water sorption of dried concrete, an important measure of concrete durability.

Concrete specimens are cast and cured, and then immersed in water for 30 minutes. The specimen's gain in mass is measured and the depth to which water is absorbed in millimeters is calculated.

Specimens with Hycrete W1002 outperformed both the control and the other waterproofing admixtures by a factor of 2.4-2.7.

WATER SORPTION OF CONCRETE (ASTM C1757)



Performed by Tourney Consulting Group (TCG)

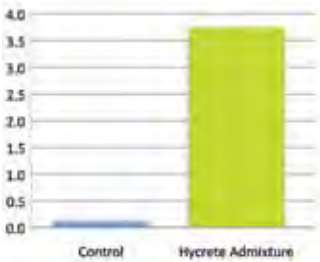
I-h. Water Penetration of Masonry Walls with a Hydrophobic Additive (ASTM E514)

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.

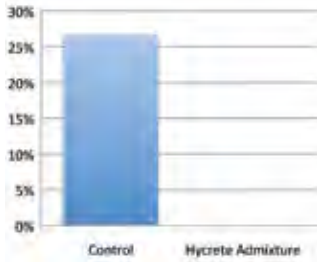
As the constructed walls with and without Hycrete Admixture were subjected to the simulated wind-driven rain, the “time of dampness” (the time it took for the first moisture to be seen on the back side of the wall) was measured. In addition, the area of dampness on the back side of the wall as a percent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

TIME OF DAMPNES (HOURS)



AREA OF DAMPNES (%)



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%

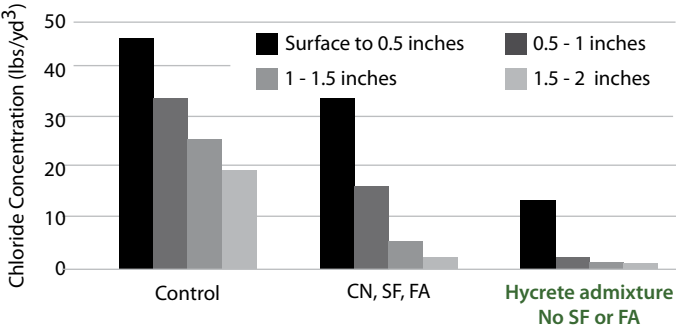
Water Penetration of Masonry Walls with a Hydrophobic Additive,
US Army Engineer Research and Development Center

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.



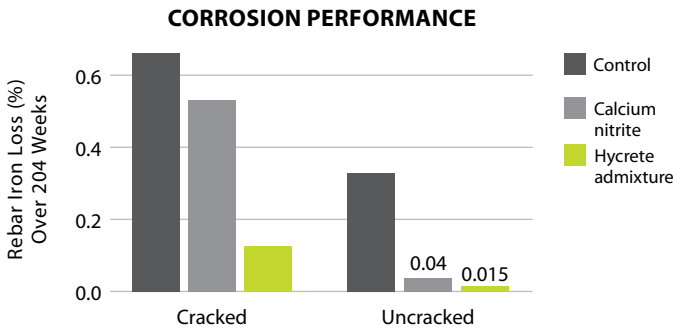
0.11% Steel Loss

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.

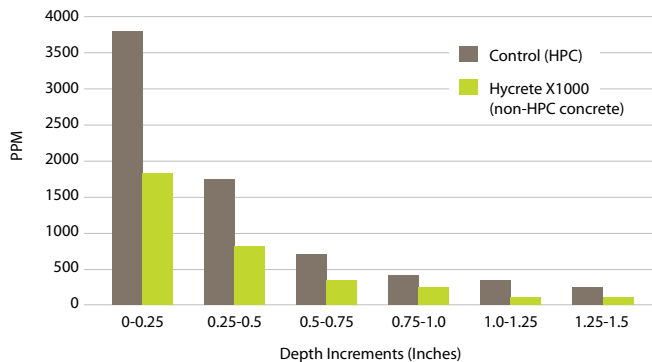


Hycrete effectively reduces rust even in cracked concrete.

University of Massachusetts

II-d. Chloride Diffusion in DOT Test Bridge

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.



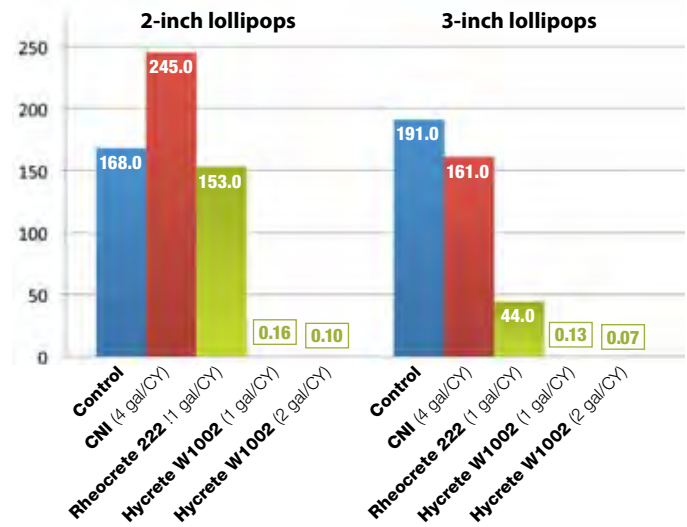
Hycrete stops corrosion in iron, steel, copper, brass and silver.

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%+

CORROSION RATES (UMHOS*/SQ. CM)
Comparison between Hycrete and Competitors



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

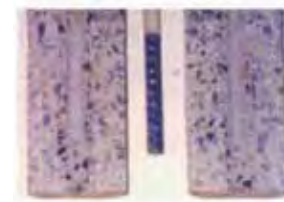
After 100 weeks of wet/dry cycling in 15% salt water, visual inspection showed no brown staining on the Hycrete lollipop samples and no corrosion of the rebar. The Control, CNI, and Rheocrete 222 lollipops all showed brown staining on the concrete surface and significant corrosion of the rebar.



Control



With Inhibitor (CNI 4gal/yd³)



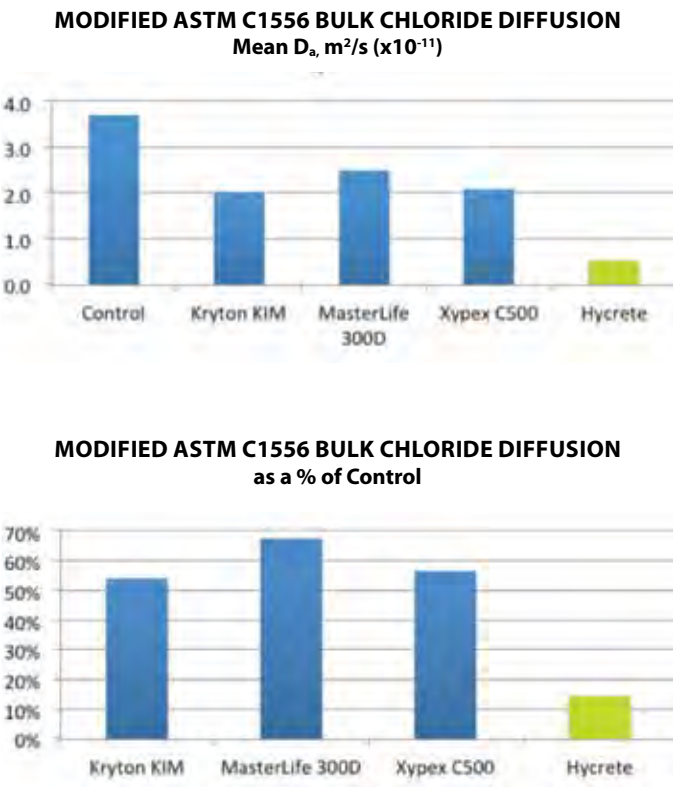
With Hycrete

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

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.



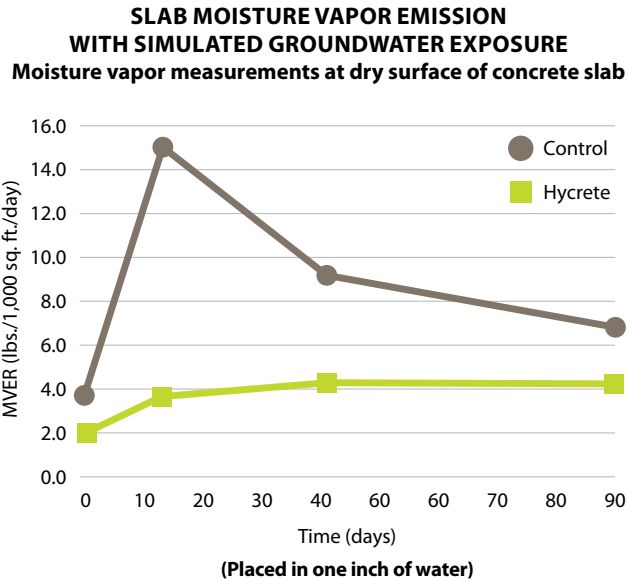
Tourney Consulting Group (TCG)

III. Moisture Protection For Flooring, Coatings, And Sealants

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.

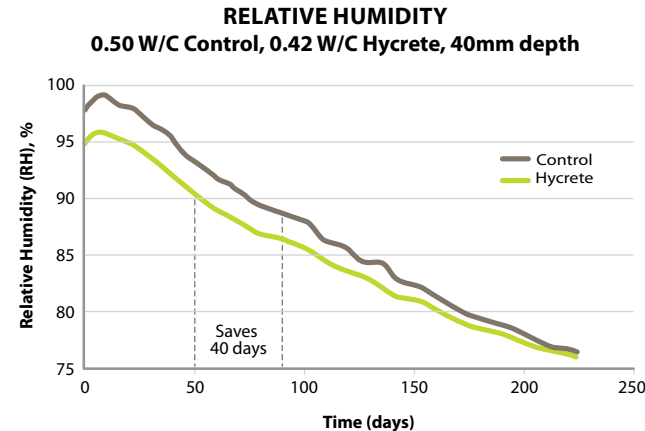


CTL Group, Skokie, IL: w/c 0.39; 700 lbs cementitious; 15% fly ash

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.

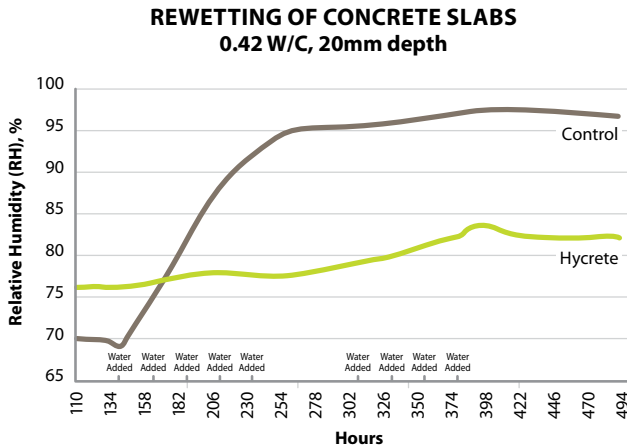


CTLGroup, Skokie, IL

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 ½ 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.



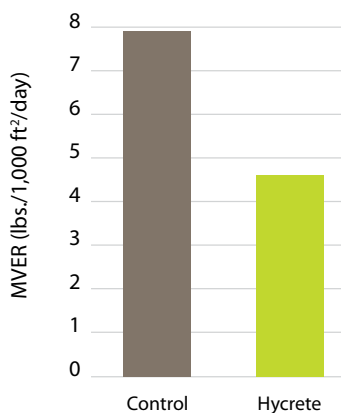
CTLGroup, Skokie, IL

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.

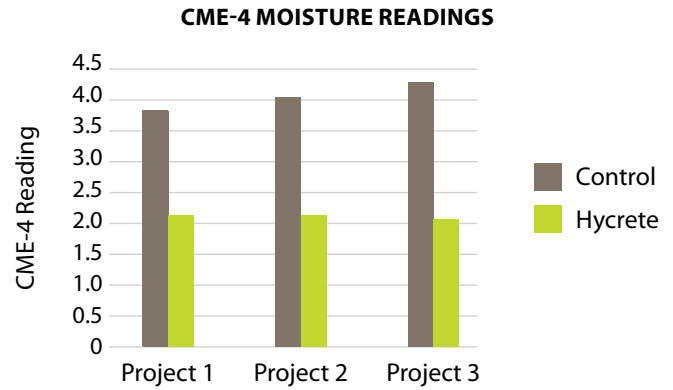
SLAB MOISTURE VAPOR EMISSION RATE AFTER SIMULATED RAIN



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.

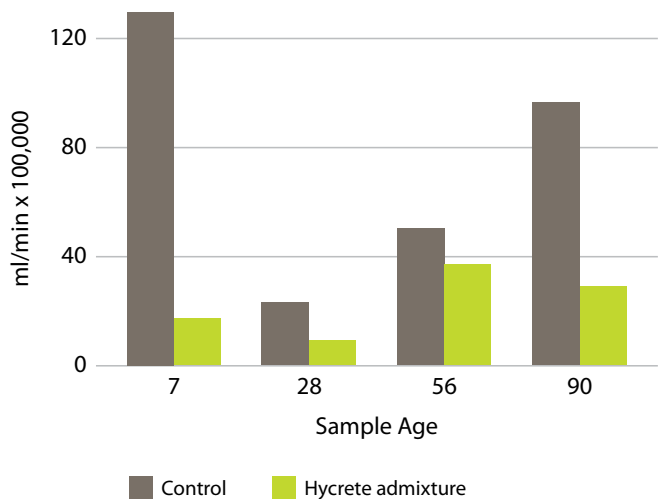


Southwest Inspection and Testing, Inc., La Habra, CA; samples were taken from three projects with different mix designs

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

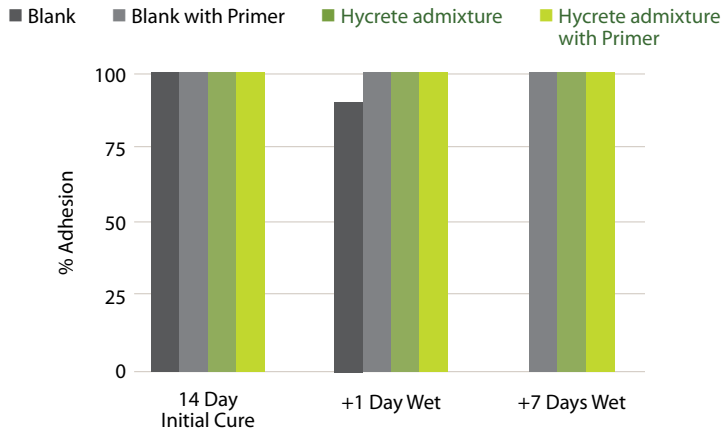


Kansas Department of Transportation: 0.42 w/c 600 lbs cement
Hycrete 2 gal./yd³

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

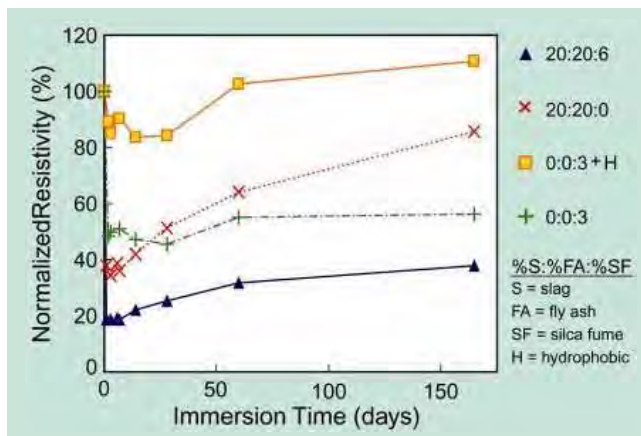


GE Silicones Construction Laboratory, Waterford, NY

IV. 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.

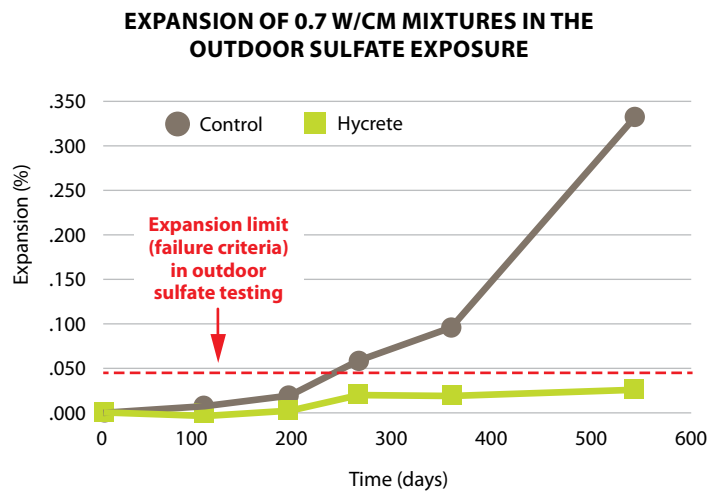


Hycrete maintains concrete's resistivity. Slag, fly ash and silica fume do not when exposed to water.

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.

IV-b. Sulfate Protection

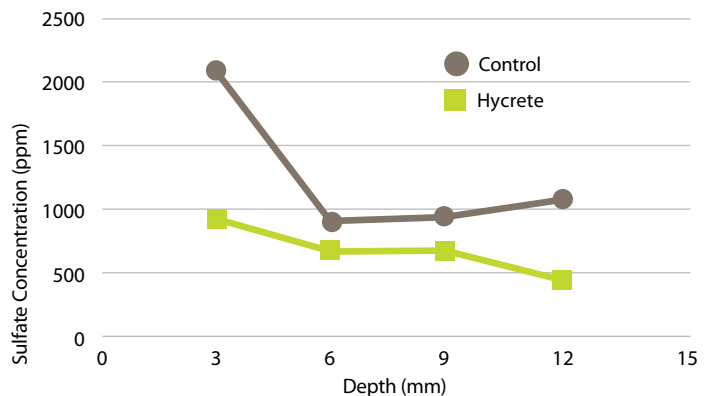
The influence of Hycrete admixtures on the durability of concrete exposed to sulfates was examined at the University of Texas at Austin, Concrete Durability Center, in a study funded by the United States Army Corps of Engineers. Concrete with Hycrete admixture was exposed to sulfates in both outdoor 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%.



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

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

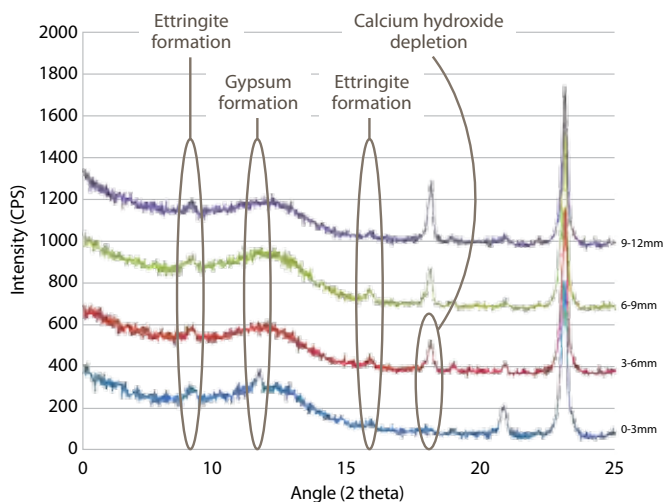
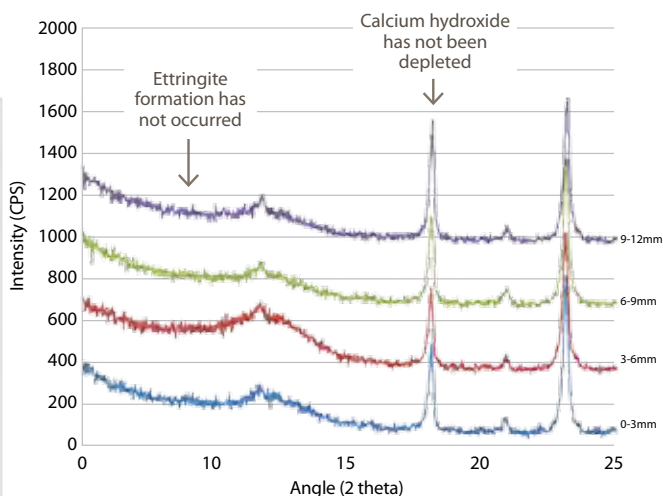


FIGURE 2: X-RAY DIFFRACTION AT DIFFERENT DEPTHS FOR SUBMERGED HYCRETE SPECIMEN



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.



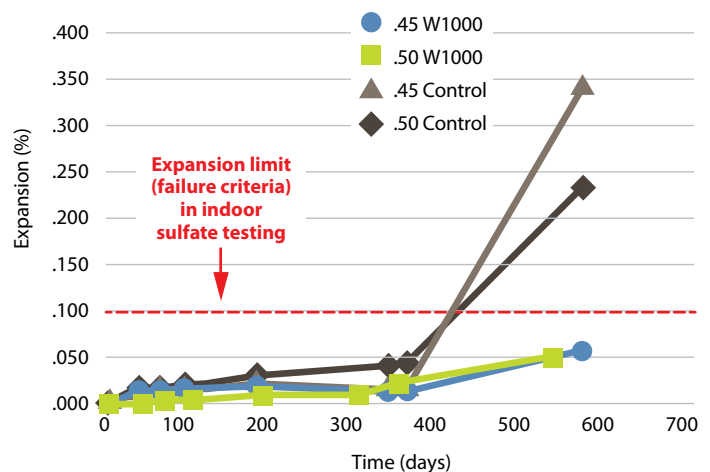
Control prisms after 18 months of exposure



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.

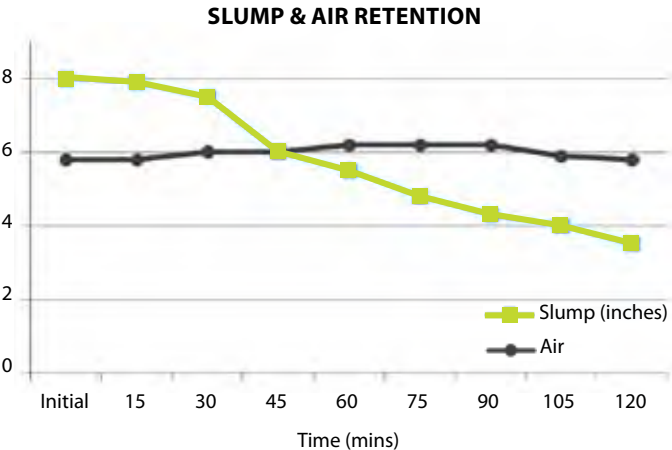


Hycrete greatly reduces spalling due to freeze thaw cycles.

V. General Concrete Properties

V-a. Plastic Concrete Properties

Workability & Cohesion: Excellent
Slump Retention: Excellent – Neutral
Air Content: Highly Stable – Neutral



Pacific NW Independent Lab Testing: 40/60 Structural Mix .42 W/C - 590 lbs Cementitious 20% Class F Flyash Polycarboxylate Superplasticizer

V-b. Setting Time

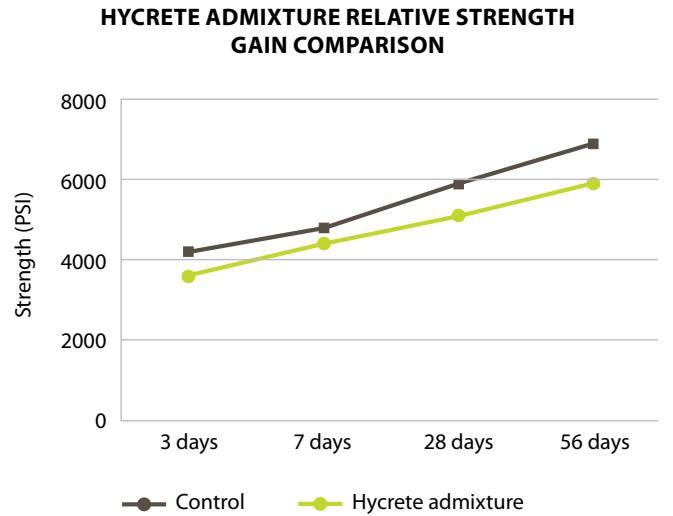
Set Neutral Typically +/- 30mins of Control

	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

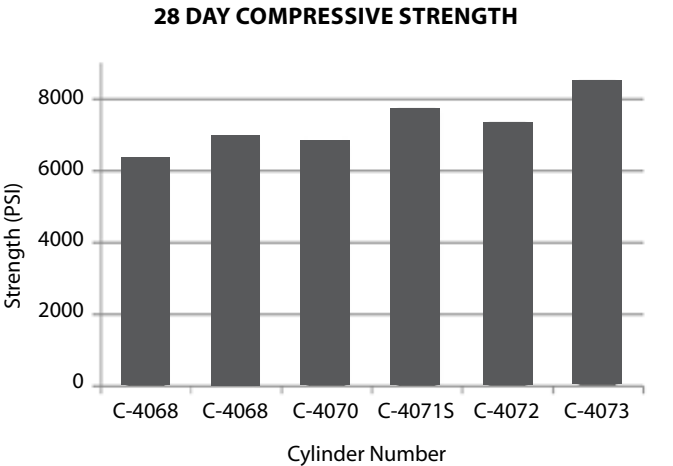
V-c. Hardened Concrete Properties

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-d. Production Strengths



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

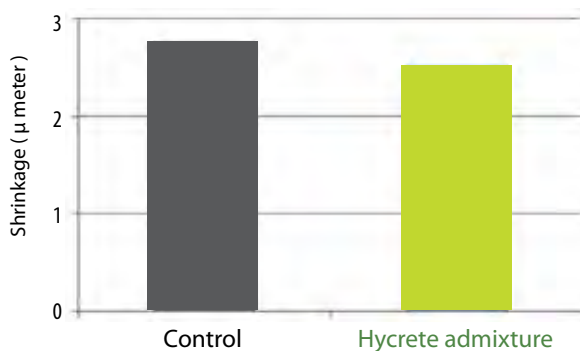
Concrete with Hycrete admixture is air entrainable and meets the vigorous demands placed on concretes used in severe winter weather conditions. (Result: Pass; 300+ cycles with durability readings of 90+)

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.

ASTM C157 DRYING SHRINKAGE



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

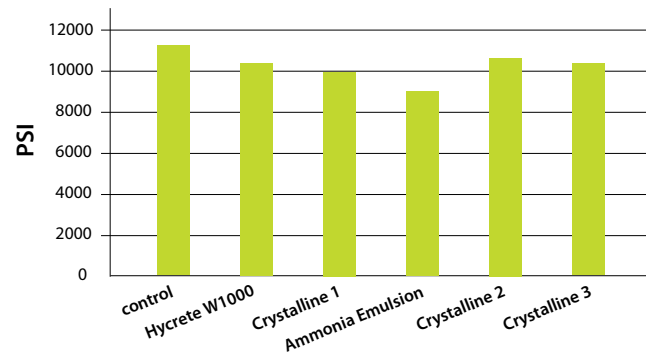
V-g. Shotcrete Performance

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)

FLEXURAL STRENGTH (3 POINT)

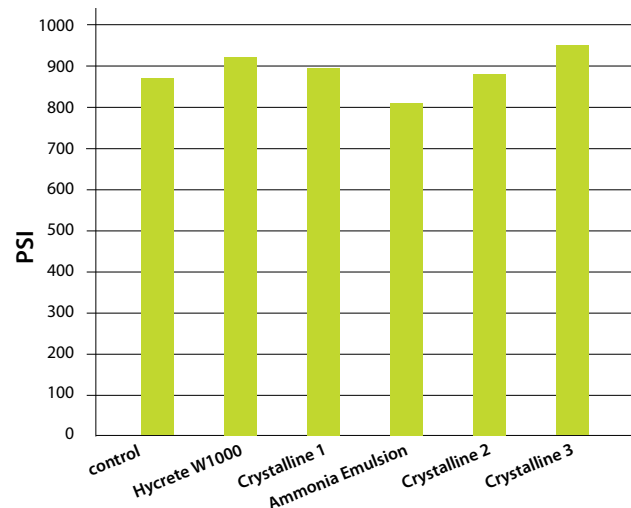


Internal testing conducted by Hycrete correlates Hycrete flexural strengths to compressive strengths in accordance with standard engineering relationships. This testing demonstrates that Hycrete admixtures have negligible impact on flexural strength in concrete.

Conducted by Hycrete, 2007

V-i. Split Tensile Strength (ASTM C496)

SPLIT TENSILE STRENGTH



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

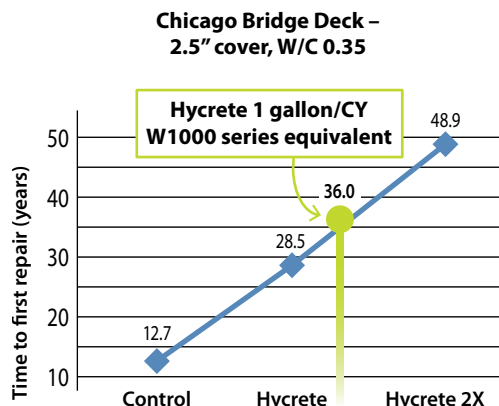
NJIT, 2007

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

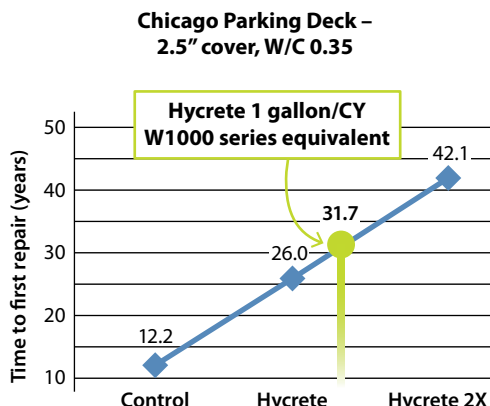
Hycrete more than triples the structural and cosmetic life of concrete.

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 repairs and provided significant cost savings. Here are summarized results from the study.

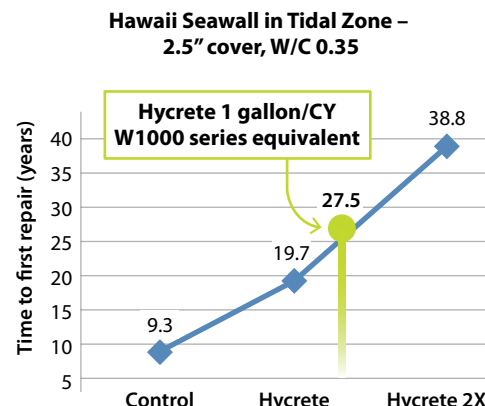
FORECASTED TIME TO INITIAL REPAIR – COMPARISON BETWEEN USACE CONTROL AND HYCRETE



Chicago Bridge Deck – The model included exposure to deicing salts in Chicago, IL. The Control is a USACE standard cold weather mix.



Chicago Parking Deck – The model included exposure to deicing salts in Chicago, IL. The Control is a USACE standard cold weather mix.



Hawaii Seawall in Tidal Zone – The model included exposure to salts in the tidal zone in Honolulu, HI. The Control is a USACE standard warm weather mix.

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% pre-consumer 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 Cradle™ Certified

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

VI-b. Cradle to Cradle™ Certified Gold

The Cradle to Cradle™ philosophy embraces a fundamental change in our disposable society – from cradle to grave to Cradle to Cradle™. Hycrete admixtures are Cradle to Cradle™ 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.

Results shown are actual test results. Hycrete, Inc. provides no warranty, expressed or implied, based on the findings in this document.

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