

# Environmentally Intelligent Integral Waterproofing and Corrosion Protection for Concrete

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## ABSTRACT

Hycrete Admixture™ is an additive to fresh concrete that makes the concrete waterproof and protects the steel reinforcement from corrosion. The material is a nanotechnology and is Cradle-to-Cradle certified as an environmentally intelligent product. Concrete is the most widely used construction material in the world, but has a major flaw—it's porous and absorbs water like a sponge (capillary absorption). Water and dissolved salts readily enter the concrete and corrode the steel reinforcement. The Hycrete material is unique because it is water based and yet repels other water. This occurs because the Hycrete material reacts with calcium in the concrete and takes on properties of a water repellent oil. Another end of the molecule bonds to polar particles, such as iron in the steel reinforcement and creates a monolayer of protection.

**Keywords:** concrete, waterproof, admixture, hydrophobic, Cradle-to-Cradle, membrane-free



## 1 TECHNOLOGY PIONEERS

Hycrete, Inc. is greening an area commonly overlooked in sustainable construction, and was recently named a 2008 Technology Pioneer by the World Economic Forum.

Conventional waterproofing methods typically involve attaching a protective membrane/coating to the concrete and may be comprised of recycled material. However, these membranes are often petroleum-based and applied using high VOC adhesives, which can cause the concrete itself to lose its sustainable characteristics as the ability to recycle the concrete becomes more difficult. Membranes can be replaced by Hycrete Admixture's integral protection, which occurs real-time when concrete is poured.

Besides providing a superior concrete waterproofing system, the use of Hycrete Admixture significantly accelerates construction by eliminating an entire time-consuming step and subcontractor. From an environmental perspective, [1] construction and demolition debris accounts for nearly 1/3 or 140 million tons of total U.S. landfill, 40% of which is concrete. Membrane-tainted waste represents a significant portion of this number.

Hycrete's proprietary nanotechnology goes back to the early 1950s when one of Hycrete's inventors, Michael S. Rhodes (grandfather of founder and CEO David Rosenberg), developed a class of rust inhibitors. Michael Rhodes also worked closely with NASA on programs such as the development of solid rocket fuels, for which he received an award at the launch of the Titan 3C rocket booster, and the heat shield for the Apollo series. In the mid 90s, Mr. Rhodes' focus shifted back to corrosion technology, and he invented Hycrete Admixture. This invention proved to be highly effective as an anti-corrosion agent and moisture blocker in concrete.

The material has been in over 10 years of extensive independently sponsored and conducted tests, most of which was paid for by the US Federal Highway Administration. David Rosenberg joined the family business in 2002 to build a company around this innovative product. Raising money from two of the world's leading cleantech and advanced material venture capital firms, he incorporated Hycrete, Inc. in 2005. Today, Hycrete Admixture is offered as a part of the Hycrete Elite™ Waterproofing System, a comprehensive solution for membrane replacement. Design review, waterstop detailing, and concrete plant and jobsite inspections supplement Hycrete Admixture as components of a successful system enabling Hycrete, Inc. to address its customers' waterproofing problems.

Hycrete Admixture was first used in several DOT (Department of Transportation) projects because of its favorable corrosion resistance and freeze thaw properties. Projects include bridge overpasses for the Kansas and New Jersey DOTs and precast barriers for the Connecticut and

Ohio DOTs. After successful completion of these projects, focus then shifted to larger commercial work targeting the \$15+ billion membrane waterproofing industry worldwide due to the tremendous market opportunity and shorter sales cycle.

In terms of installed base, Hycrete’s customers are the largest builders, developers, architects, engineers, and concrete producers in the world - and they are raving fans of Hycrete’s System. The Hycrete approach provides great benefits including: speed of construction (by offering real-time performance and eliminating the waterproofing sub-contractor), reduced risk with the best system in class, and staggering environmental benefits. To date Hycrete has been in over 75 projects and is expanding its domestic and international presence with a range of product offerings pertaining to integral waterproofing and corrosion protection.

## 2 SIGNIFICANT VALUE PROPOSITION

Hycrete admixtures are exceptional technologies that integrally combine functionality of products used in construction – waterproofing + corrosion defense + concrete. Overall, the value proposition is compelling throughout the value chain:

- The Hycrete Elite Waterproofing System provides a dry structure and enhanced durability, thereby reducing long term operating costs and increasing service life for building owners.
- Hycrete admixtures offer real-time performance, meaning that waterproofing is achieved at the time of concrete placement. Membranes and coatings typically require an additional sub-contractor and may take weeks or months to apply. Using Hycrete admixtures removes this entire step and allows general contractors to accelerate project timelines and allows building owners to potentially open early. Architects/Engineers are able to bring greater value to their clients since time saved is also translated into lower project costs.
- Hycrete technology eliminates the need for millions of square feet of membrane, thus significantly reducing material demand, carbon emissions, and construction waste.
- On average, the Hycrete Elite Waterproofing System costs 40% less per square foot than the installed cost of membrane solutions, thus offering added performance at lower cost.

## 3 TESTED PERFORMANCE

Extended testing at leading private labs, universities, and state transportation departments has consistently shown that the use of Hycrete Admixtures adds significant durability to steel reinforced structures. Hycrete admixtures have undergone over 12 years of independent testing and the results are undeniable.

**Moisture Blocking** – Hycrete waterproofing admixtures perform at less than 1% water absorption under BSI 1881-122, which is often denoted as the “British Standard Absorption Test”. This test consists of taking concrete samples and putting them through a three day oven dry at 100°C, one-day cool, and then a thirty minute water immersion. The absorption measurement is based on the percentage of weight pick up in the concrete sample after being placed in water. “Hydrophobic Concrete” is defined by the industry as less than 1% absorption under this test. Hycrete treated concrete’s results are as follows for various doses of Hycrete Admixture per cubic yard of concrete:

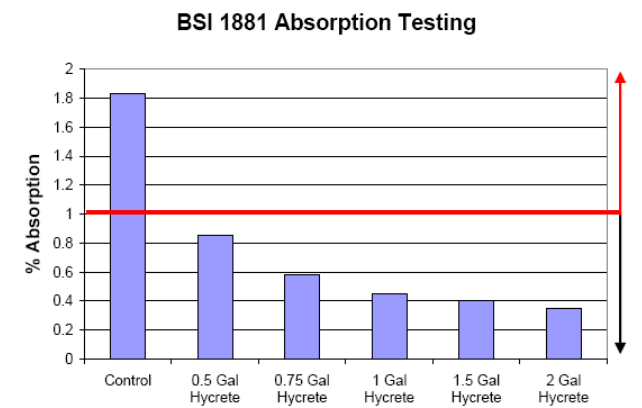


Figure 1: Absorption Testing, Gallons /Cubic Yard [2]

**Corrosion Defense** - Most concrete contains some form of steel reinforcement. Corrosion of this steel is well known to lead to premature concrete failures and increased life cycle costs. Chloride diffusion, or transport, is the primary source and mechanism of corrosion, and Hycrete admixtures inhibit this impact in two ways. Because Hycrete treated concrete is hydrophobic, this limits water absorption and the transport of chloride ions. The second line of defense that Hycrete admixtures offer is that they are attracted to metallic particles and therefore form a monolayer of protection on the surface of the reinforcing steel. The following graph shows untreated concrete, calcium nitrite/silica fume/fly ash (a popular corrosion protection mix design), and Hycrete treated concrete.

## 4 GREEN IMPACT

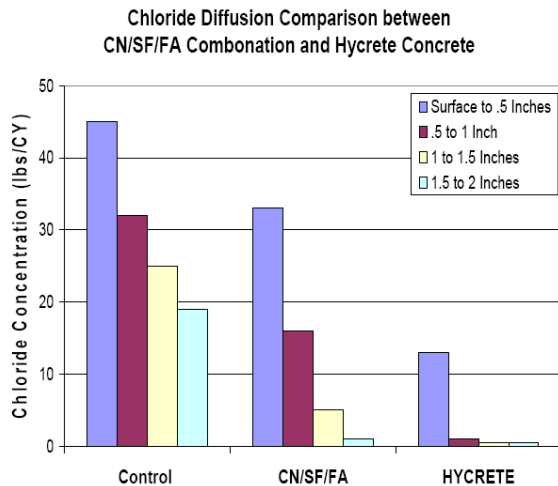


Figure 2: Chloride Diffusion in Concretes [3]

To further emphasize the Hycrete admixture anti-corrosion performance, the graph below shows results from government funded, independent laboratory accelerated corrosion analysis over a four-year period of chloride solution ponded samples. Specimens with Hycrete Admixture remain waterproofed and corrosion inhibited after this long-term, harsh condition, accelerated testing. Even in cracked concrete where salts had direct access to the steel, Hycrete Admixture greatly reduced corrosion.

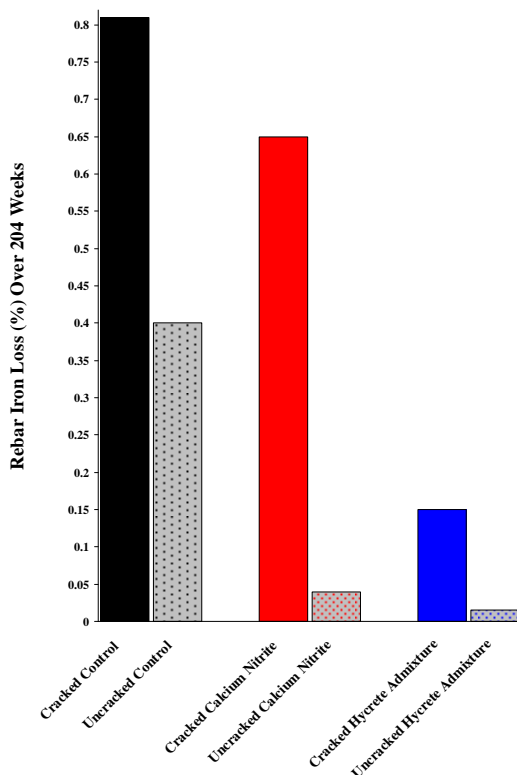


Figure 3: Rebar Corrosion Protection [4]

Hycrete Admixtures meet arguably the highest environmental standards for consumer and commercial products under the Cradle to Cradle (C2C) protocol. C2C is a nature-inspired design protocol that evaluates, optimizes, and certifies materials, products, and manufacturing processes for their human health, ecological, and life cycle impacts. Hycrete is a unique technology for construction that has been rated as a Silver Cradle to Cradle product and enables concrete to remain a sustainable building material. Hycrete admixtures allow concrete to be recycled in its normal fashion so that Hycrete concrete can be crushed and reused as coarse aggregate rather than being sent to landfill.

“Do More With Less” - an underlying philosophy of sustainability. Hycrete’s nano properties allow for relatively low dosing (only 1 gallon per cubic yard of concrete) due to its excellent dispersion qualities and uniform performance. This in turn requires less material, fewer man hours, less jobsite clutter/waste, and lower project costs. Environmentally, to date, the use of Hycrete Admixture will allow over 225 tons of membranes and approximately 56,000 tons of concrete from ultimately going into the waste stream. Few technologies have brought this sort of impact to the concrete industry since the Romans invented concrete over 2,000 years ago.

Hycrete admixtures have many applications, such as below grade foundations, below water table envelopes, shotcrete walls, water treatment facilities, podium decks, parking structures, bridge decks, precast barriers, elevator pits, fountains, green roofs, and stucco. Hycrete, Inc. is in an excellent position to capture a significant portion of the market, reduce landfill, and help the environment along the way. There is a tremendous amount of pain in waterproofing construction, and Hycrete, Inc. is forging long term relationships throughout the industry due to its technology and service platform.

## REFERENCES

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