



**DURABLE CONCRETE STARTS WITH  
PENETRON ADMIX**

# Total Concrete Protection



## Water above and below:

Modera Coral Gables, Miami, Florida USA  
A 237-unit luxury apartment mid-rise building (with street-level retail shops), the Modera Coral Gables has six residential floors above three levels of parking and a large pool on the fourth floor. With a construction site 1.6m [5'] under the water table, PENETRON ADMIX was used on all below grade concrete structures: the three-level parking garage, the mat slab on grade and the perimeter walls. The 4th-floor pool was also treated with PENETRON ADMIX.

## Leading performance specs

Easily mixed in during batching and unaffected by climatic conditions, PENETRON ADMIX becomes an integral part of the concrete matrix and performs consistently during the life of the concrete. Constantly tested and improved, PENETRON ADMIX is designed to protect concrete in the most critical environments.

## PENETRON ADMIX performance highlights

- Resists high hydrostatic pressure
- Provides self-healing capabilities for cracks up to 0.5 mm
- Enhances the compressive strength of concrete
- Non-toxic and contains no VOCs (NSF 61-certified for potable water applications)
- Resists chemical attacks (pH3-11)
- Significantly reduces chloride penetration and carbonation
- Effectively counters alkali silica reaction (ASR)
- Prevents corrosion of reinforcement steel
- Not a vapor barrier; allows concrete to breathe
- Protects against sulfate attack
- Exceeds requirements of ASTM C494-S (Specific Performance Admixtures)
- Provides a fully waterproof and permanently dry concrete structure



# PENETRON ADMIX: The concrete solution.

PENETRON ADMIX is the world's most efficient and economic permeability-reducing admixture for hydrostatic conditions (PRAH), as defined by tests of the American Concrete Institute (ACI). As a true PRAH, PENETRON ADMIX provides comprehensive protection against concrete deterioration caused by chemical attack, freeze-thaw cycles, and corrosion, while withstanding high hydrostatic pressure.

Added during batching, PENETRON ADMIX can significantly increase concrete durability and service life.

## The PENETRON ADMIX benefits

1. Increases durability and life-span of concrete by 60 years or more
2. Eliminates the need for any surface-applied protection systems
3. Saves money—lifetime concrete protection
4. Maximizes time on the construction site
5. Doesn't require specific W/C or cement content to perform
6. Easy to mix into the concrete during batching
7. Non-staining tracer ensures quality and performance
8. Soluble bag packaging eliminates measuring and simplifies mixing
9. "Green" product that contributes points to LEED projects
10. No incompatibility issues with workability admixtures, such as superplasticizers, retarders, etc.

## Packaging:

PENETRON ADMIX is available in a variety of packaging containers:

- 18 kg (40 lbs.) bags
- 25 kg (55 lbs.) pails
- 3 kg (6.6 lbs.) soluble bags
- Bulk sizes



# How does PENETRON ADMIX work?

## The science behind Penetron technology

**PENETRON ADMIX consists of Portland cement and various active, proprietary chemical formulations.**

The active ingredients in PENETRON ADMIX produce a catalytic reaction when combined with moisture in fresh concrete and by-products of cement hydration. This chemical reaction generates a non-soluble crystalline formation throughout the pores and capillary tracts of the concrete that permanently seals micro-cracks, pores and capillaries against the penetration of water or liquids from any direction. This protects concrete from deterioration, even under harsh environmental conditions.



### A MICRO SOLUTION FOR A MACRO PROBLEM.

Because water and waterborne contaminants penetrate concrete mainly through capillary absorption and hydrostatic pressure, countering this problem demands a "molecular level" solution. Penetron crystalline waterproofing technology was developed and optimized over many years through careful micro-engineering. The results speak for our success.

#### **Durability in freezing weather:** Cathedral of Christ the Savior and pedestrian bridge, Moscow, Russia

A comprehensive renovation and upgrade of the foundations of the famous cathedral and the adjoining bridge – a popular Russian tourist destination – was carried out using PENETRON ADMIX to ensure freeze-thaw resistance.





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**Distinctive and durable design:**

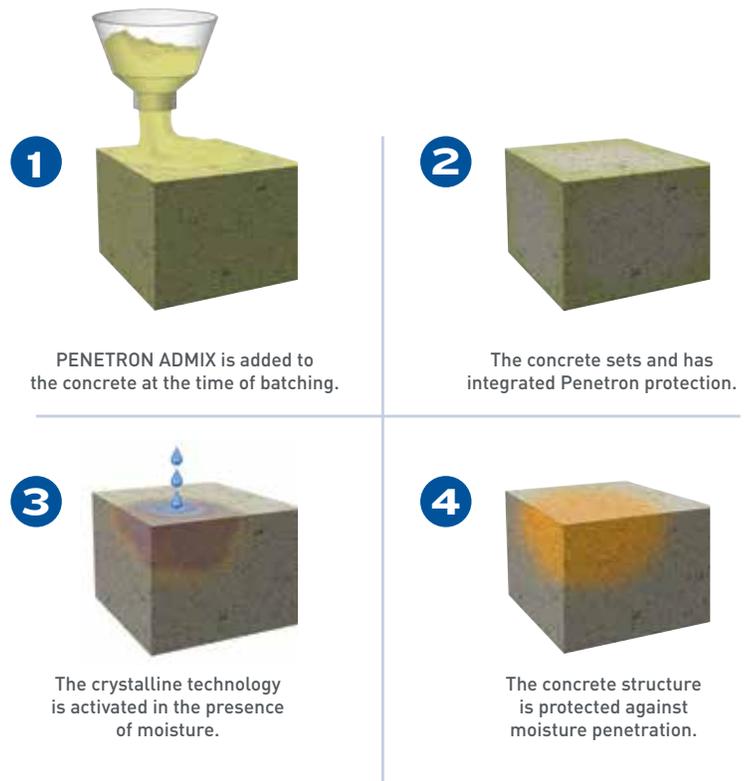
Strauss Daly Building,  
Durban, South Africa

A modern and dramatic design, the Strauss Daly Building features large, off-shutter concrete planes that create a visually striking profile on a prominent hill above the ocean. The concrete used in the dramatic outside structure and below-grade basement was treated with PENETRON ADMIX to protect against saltwater breezes from the Indian Ocean.

**This is how Penetron technology works:**

**Adding to a concrete mix**

- 1. PENETRON ADMIX is added to the concrete at the time of batching.** This disperses the Penetron chemicals homogenously throughout the mix.
- 2. The Penetron active ingredients react with water (and with calcium hydroxide, aluminum and other metal oxides and salts contained in the concrete) to form insoluble crystals,** which fill in cracks, pores and voids up to a width of 500 microns (0.5mm). PENETRON ADMIX is an integral part of the concrete matrix; crystalline growth takes place throughout the concrete structure.
- 3. Water molecules (and harmful chemicals) can no longer pass through the concrete.** However, air can still pass, allowing the concrete to breathe. This avoids the build-up of vapor pressure.
- 4. In the absence of further moisture, the Penetron components lie dormant. Should moisture reoccur at any time, the sealing process resumes automatically, providing a fully self-healing concrete.**



# Optimizing concrete for durability.

A versatile material. Concrete is the world's most common man-made material that has transformed modern cities around the world from a horizontal landscape into vertical societies.

Concrete is a hard and solid matrix, but also porous and subject to cracking. Waterborne chemicals can seep in through pores, micro-cracks and capillary tracts, resulting in a wide range of problems that damage the concrete or the underlying reinforcing steel.

## The main challenges



# PENETRON ADMIX: Breakthrough for enhanced durability.

## Test results show vast improvement in durability.

Extensive, two-year research by independent laboratories confirm the beneficial effects of PENETRON ADMIX on the durability of concrete. The tests included compressive strength, drying shrinkage, permeability, sulphate resistance, chloride diffusion resistance, freeze-thaw cycle resistance, self-healing ability, microscopic examination of crystalline formation and most importantly—a calculation of the improved service-life of concrete treated with PENETRON ADMIX.

Despite (ASTM C1556) test parameters that apply a chloride concentration 4.7× higher than true marine environments, the PENETRON ADMIX-treated concrete added up to 60 years or more to the service life of conventional concrete (before the onset of corrosion).

A second chloride migration test done with CEM III/A, an extremely durable concrete mix design, still yielded an additional 40 years of service life with PENETRON ADMIX.

These test results show that PENETRON ADMIX completely eliminates the need for silica fume, corrosion inhibitors and air-entrainment admixtures.

### OVERVIEW of the TEST RESULTS

Individual Test	Benefits of PENETRON ADMIX vs. untreated concrete	Additional Benefits
<b>Drying &amp; shrinkage</b> (1 year length changes mm/m)	<b>&lt;24%</b>	<b>Reduced shrinkage and cracking</b>
<b>Sulfate resistance changes</b> (ASTM C1012-12)	<b>No internal expansion</b>	<b>No cracking under sulfate attack</b>
<b>Chloride diffusion coefficient (m<sup>2</sup>/s)</b> (ASTM C1556-04)	<b>&lt;45%</b>	<b>Low chloride diffusion coefficient prolongs service life of the structure</b>
<b>Freeze-thaw cycle length changes (%)</b> (NCh 2185 Of 92)	<b>&lt;10.53%</b> of control sample	<b>Optimizes resistance when used with air entrainment admixtures</b>
<b>Reduction of permeability</b> (DIN 1048)	<b>91%</b>	<b>Activation of crystals reduces permeability</b>
<b>Self-healing capacity</b> (crack width)	<b>≤0.5 mm</b>	<b>Concrete self-heals new cracks</b>
<b>Compressive strength</b> (Mpa)	<b>13%</b>	<b>Increases compressive strength</b>
<b>Extension in service life</b> (years)	<b>Up to 60 years</b> (compared to control samples)	<b>Significantly increases corrosion resistance</b>

To achieve concrete durability, especially in critical environments, properties such as low permeability, low shrinkage and self-healing—protection against chemical attack must be realized.

EXCEEDS REQUIREMENTS OF ASTM C494-S (SPECIFIC PERFORMANCE ADMIXTURES)

# PENETRON ADMIX:

## The leading crystalline technology for durability.

### The only 3<sup>rd</sup> generation crystalline admixture.

When PENETRON ADMIX is added to the concrete, it reduces permeability by permanently sealing micro-cracks, pores and capillaries, effectively protecting the concrete against water penetration and the effects of deterioration, even under high hydrostatic pressure.

Now in its third generation, PENETRON ADMIX is continually optimized to ensure industry-leading performance. The strength, slump or setting time of the concrete are never affected.



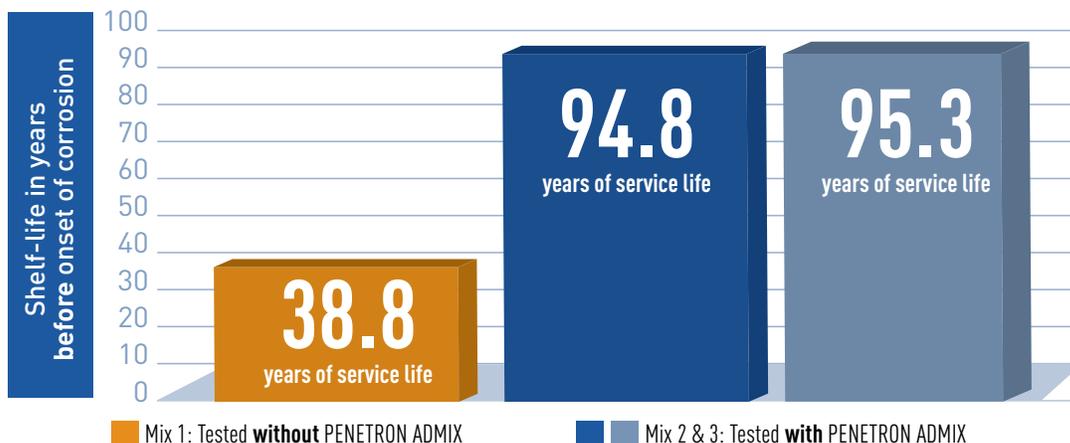
### Getting durable concrete.

The prime concern for concrete designers has traditionally been resistance to mechanical stress, i.e. strength. In recent years, durability has become an equally important factor. Tests and experience have shown that durability cannot be achieved only with optimal W/C ratio, high compressive strength mixes or added cement / air integration.

### Adding up to 60+ years to the concrete lifespan.

Concrete durability in critical environments is a result of low permeability, low shrinkage, self-healing capabilities and resistance to chemical attack. PENETRON ADMIX delivers the technology to provide these properties. Recent test results show that PENETRON ADMIX can add up to 60+ years to a variety of concrete, including CEM II/B-P, CEM II/B-S and CEM III/A, in critical environments before the onset of corrosion.

### Projected concrete service life (according to Fick's Law)



← **Extended Service Life:**

Recent breakthrough tests show that PENETRON ADMIX (as a Permeability Reducing Admixture for Hydrostatic Conditions) can extend the service life of concrete structures in severe environments by 60 years or more.



**Elegant and durable:** Arena Fonte Nova, Salvador, Brazil

A FIFA World Cup venue adjacent to the Atlantic Ocean, the Arena Fonte Nova stadium is a multi-purpose complex for sports and cultural events with a 55,000-seat capacity, a 2,000-car parking garage, food courts and 12 elevators. The basement slabs and lower reservoirs were sealed with PENETRON ADMIX, ensuring a durable structure.



**Durability:** Central Train Station, Samara, Russia

The new train station, built to replace the original 1876 building, features one of Europe's highest railway buildings (93m / 307 feet) and a hotel. PENETRON ADMIX was used to waterproof all the below-grade structures (including the underground pedestrian tunnel, foundations and basements).



# PENETRON ADMIX makes good concrete better.

## Increasing concrete performance

A key characteristic influencing concrete durability is permeability by water, carbon dioxide, chloride, sulfates and other potentially harmful substances. Increasing durability by reducing the ingress of harmful substances, as shown by the examples below, underline how PENETRON ADMIX enhances durability by improving many aspects of concrete performance.



### Permeability

While an optimal W/C ratio is crucial in achieving the desired overall concrete performance, permeability is crucial for concrete durability: decreased permeability means increased durability. PENETRON ADMIX reduces shrinkage cracking and seals micro-cracks. It provides self-healing of cracks (up to 0.5 mm) over the service life of the structure. Finally, our admixture provides a 70% or more permeability reduction as per ACI guidelines for PRAH (permeability-reducing admixtures for hydrostatic conditions).

### Corrosion of steel

Corrosion is an electrochemical process that occurs with a difference in electrical potential of steel and the surrounding cement matrix. Chloride-induced corrosion of steel is one of the most important aspects of concrete durability. Concrete dosed with PENETRON ADMIX ensures huge reductions in rapid chloride permeability test (RCPT) values (as per ASTM C-1202 and AASHTO T-277 tests) by reducing chloride ion permeability.

### Self-healing properties

PENETRON ADMIX is a hydrophilic product that reacts with moisture and concrete minerals to form crystals in cracks and voids. This gives concrete a permanent self-healing capability. Whenever new moisture enters, PENETRON ADMIX develops new crystal formations that seal newly formed micro-cracks.

### Freeze / thaw resistance

In cold climates, freeze-thaw cycles are a major factor in the deterioration of exposed concrete structures (bridges, roads, etc.). Water inside the concrete expands when it freezes, causing internal pressure; this leads to cracking, and the following thaw allows water to penetrate deeper into the newly formed cracks, then expanding again and causing further damage as the cycle repeats itself. Tests of PENETRON ADMIX-treated concrete show a 90% reduction in length changes due to freeze-thaw cycles.

### Strength of concrete

Depending on the design strength of the concrete, PENETRON ADMIX can increase compressive strength of concrete.

### Acid resistance

When under acid attack, some projects face potential dissolution of the concrete matrix and a subsequent loss of structural integrity. PENETRON ADMIX offers protection against chemical attack (pH 3-11) and is the preferred and widely-used solution for wastewater treatment plants.

**Watertight development:** Brickell CitiCentre, Miami, Florida USA

In a huge project (>9 acres / 3.7 hectares) in Miami's financial district, PENETRON ADMIX treated below-ground structures (and garage) at the saturated site. ↓



## Alkali silica reaction (ASR)

Susceptible to attack by alkalis ( $\text{Na}_2\text{O}$  and  $\text{K}_2\text{O}$ ) from cement or other sources, some aggregates produce an expansive reaction that causes cracking and disruption. Damage normally occurs with: **1)** a high moisture level in the concrete; **2)** cement with a high alkali content and other alkali sources; and **3)** aggregate containing alkali reactive constituents. **PENETRON ADMIX eliminates the moisture content of concrete; this prevents ASR from occurring.**

## Sulfate attack

Sulfate attack typically occurs where water containing dissolved sulfate penetrates the concrete. The ensuing reaction causes the composition and microstructure of the concrete to change. These changes include extensive cracking and loss of bond between the cement paste and aggregate, which, in turn, cause an internal expansive force. Extensive testing has shown that concrete treated with PENETRON ADMIX and subjected to a solution of sodium sulfate does not show any change in length by such expansion. Untreated concrete samples subjected to the same sodium sulfate solution showed significant change in length and disintegration of mass.

## Carbonation

When carbon dioxide reacts with calcium hydroxide in the concrete to form calcium carbonates,  $\text{CO}_2$  dilutes into carbonic acid; this attacks the concrete and reduces its alkalinity. PENETRON ADMIX seals capillaries and cracks to increase carbonation resistance and protect embedded steel.



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**Massive and waterproof:** Estádio Kléber Andrade, Cariacica (Espírito Santo), Brazil  
This soccer stadium was totally rebuilt for the FIFA World Cup 2014 to accommodate 45,000 spectators; the above-ground support structures, the basement slabs, and lower reservoirs were all sealed with PENETRON ADMIX, ensuring a durable structure.



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**Resists hydrostatic pressure:** Mediterranean Village, Katerini, Greece  
Located just outside Katerini in Northern Greece, the luxury five-star Mediterranean Village resort used PENETRON ADMIX to protect the below-grade structures to withstand the seaside environment. The permanently waterproofed structures cover an area of 54,000 square yards (45,000m<sup>2</sup>), some of it below sea level.

# Using PENETRON ADMIX with fresh concrete.

Through years of practical use and continuous testing, PENETRON ADMIX has shown no adverse effect on the properties of the concrete mix. Further aspects of concrete performance and PENETRON ADMIX include:

## Water Demand

PENETRON ADMIX has **no significant effect on the water demand** of concrete.

## Workability

Tests have shown **no significant effect on the workability** of concrete treated with PENETRON ADMIX.

## Set Time

PENETRON ADMIX typically **provides a normal set time.**

## Types of concrete using PENETRON ADMIX:

### Ready-Mix Concrete

PENETRON ADMIX can be mixed at the batching plant, adding substantial durability and waterproofing without extra labor costs.

### PENETRON ADMIX-enhanced Shotcrete (PAES)

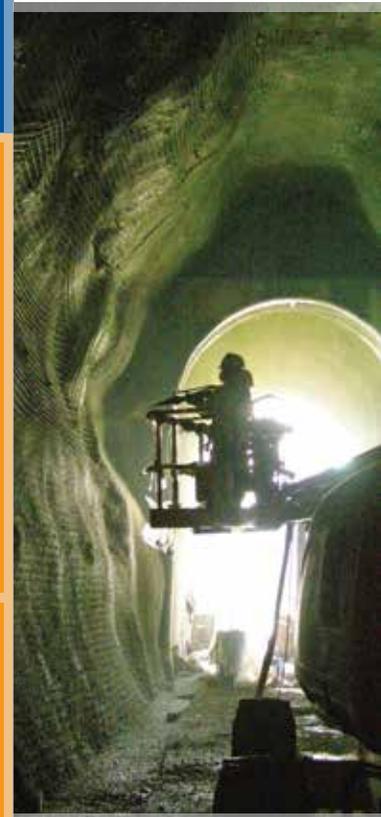
PENETRON ADMIX is dosed during batching for shotcrete applications. Preferable for tunnel projects, PAES can form a self-supporting water-proof arch roof. Shotcrete tunnel linings can be sprayed in a layer thickness of 150 mm (6") in a single spray application.

### Pre-Cast Concrete

As the primary waterproofing and durability-enhancing solution for pre-cast concrete (for concrete tanks, pipes, drains and underground tanks, etc.), PENETRON ADMIX saves time and costs in pre-cast manufacturing.

### Other Types of Concrete

PENETRON ADMIX can be used in all types of concrete where added protection is needed: tremie concrete, self-compacting concrete, mass concrete, high strength concrete, high volume fly ash concrete (HVFAC), etc.





**Solving scheduling issues:** Bangalore International Airport, India  
Due to a very tight construction schedule, the project authorities switched to PENETRON ADMIX after rejecting a PVC membrane proposal—saving over three months in the construction schedule.

## Achieving an optimal concrete mix design.

**PENETRON ADMIX must be added to the concrete at the time of batching. The exact mixing procedure is determined by the batching plant.**

### Typical concrete mixing guidelines:

#### Ready mix plant / Dry batch operation

Add PENETRON ADMIX to the drum of the ready-mix truck. Add 60-70% of the required water along with 136-227 kg (300-500 lbs.) of aggregate. Mix the materials for 2-3 minutes to ensure even distribution of PENETRON ADMIX. Add the balance of materials to the ready-mix truck using standard batching practices.

#### Ready mix plant / Central mix operation

Mix PENETRON ADMIX with water to form a very thin slurry (for example, 18 kg/40 lbs. of powder mixed with 22.7 l/6 gallons of water). Pour the required amount of material into the ready-mix truck. The aggregate, cement and water should be batched and mixed in the plant (using standard practices according to the quantity

of water already in the truck). Pour the concrete into the truck and mix for at least 5 minutes to ensure even distribution of the admixture.

#### Pre-cast batch plant

Add PENETRON ADMIX to the rock and sand and mix thoroughly for 2-3 minutes before adding the cement and water. The total concrete mass should be blended using standard practices.

#### Dosage rate: 0.8-1.0% by weight of cement

Penetron technical support specialists can help verify the appropriate dosage rate and provide information on the optimal concrete performance for your project.

#### Compatibility with workability admixtures

Standard workability admixtures, such as super-plasticizers, accelerators, etc., are compatible with PENETRON ADMIX. Trial mixes under project conditions are recommended to ensure the desired performance.

#### Compatibility with cement replacement materials (CRMs)

PENETRON ADMIX-treated concrete may contain Portland cement substitutes, such as pozzolans, fly ash, GGBS, silica fume, etc. As PENETRON ADMIX contains all reactive ingredients for the crystalline reaction (except water), abundant crystalline formation is assured, even in mixes with high percentages of cement replacement materials (CRMs).

# Our commitment keeps your project on track.



## **Adaptable design:** Sports Hub, Kallang, Singapore

With a design that shifts to accommodate football/ rugby, cricket and athletics, the new National Stadium is the highlight of a multi-faceted sports complex. All below-grade concrete, as well as the parking garage, aquatic center and waterfront mall, used PENETRON ADMIX for optimal durability and water resistance.

**Optimize and optimize again.** The superlative performance of PENETRON ADMIX in your concrete mixture is a result of constant testing and evaluation—both on-site and in the lab. Getting the optimal mix for your project starts with the planning process and discussing performance goals. PENETRON ADMIX is compatible with all types of workability admixtures and has no negative effect on concrete strength and other concrete performance requirements.



## **Wilderness Wastewater Treatment Plant:**

Wilderness, Virginia, USA

The comprehensive upgrade to the Wilderness wastewater treatment plant on the shores of the Chesapeake Bay included new tanks, filters and headworks to meet strict environmental regulations. PENETRON ADMIX was added to protect the concrete from the hazardous chemicals found in all wastewater plants.

**From the plant to the project.** Penetron products meet all main manufacturing and environmental compliance certifications, including but not limited to ISO 9001, ISO 14001, NSF 61, DWI, Singapore Green Label, CE mark, GB-18445.

**Cost effective construction choice.** PENETRON ADMIX offers project savings from the beginning: simplified dosing and quick integration, thanks to an innovative soluble bag package. This reduces job-site overheads and ensures that construction deadlines are met. Recognized as the leading concrete waterproofing solution, PENETRON ADMIX provides maximum concrete durability. It eliminates the need for traditional waterproofing systems, such as membranes and coatings.

**Looking at the service life of the structure.** A PENETRON ADMIX-treated structure eliminates further maintenance and repair costs, saves money, and will out-live untreated structures by 60 years or more.

# Continued improvement through collaboration and innovation.

Recognized as the leading concrete waterproofing solution, PENETRON ADMIX provides maximum concrete durability. It eliminates the need for traditional waterproofing systems, such as membranes and coatings.

## Making the best — even better.

The reliability and performance of PENETRON ADMIX has made it the industry-leading admixture to reduce concrete permeability. Penetron works closely with clients to continually optimize our products; this continuous feedback has led to recent innovations, such as the ADMIX Tracer and our soluble bags.



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### Proof that Penetron is in the mix:

An industry first, the PENETRON ADMIX Tracer is a reliable indicator that shows up as a clearly visible tracer in the bleed water after fresh concrete is poured.

## Unique in the industry.

PENETRON ADMIX Tracer provides construction and design teams with a reliable identification control tool —and proof that “Penetron is in the mix.” This proof can be verified after the concrete has hardened by pulverizing a piece of the concrete, mixing it with water and holding the sample against a fluorescent light. During construction, the tracer may also evidence itself through a light green tint in the bleed water. The tracer is non-toxic.



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### Cooperative admixture effort: Metro Guangzhou, Guangzhou, China

Penetron worked closely with the Guangzhou Metro Corporation (GMC); PENETRON ADMIX underwent strict testing for impermeability, resistance to chloride ion penetration and crack-sealing ability by the South China University of Technology. Over 70 tons of PENETRON ADMIX were specified for the concrete structures of the Xicun Station of Metro Line No. 5.

## The Penetron advantage.

The convenience and ease of use of the unique PENETRON ADMIX soluble bags help save time and costs and ensure the correct mixing for any project. The bags dissolve quickly and completely during mixing. This is just one example of Penetron’s ongoing efforts to optimize and innovate.



photo © Robbi Heitrick

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### Non-toxic solution: Clough Commons, Georgia Tech, Atlanta, GA, USA

An innovative “green” construction with over 220,000 square feet (20,000m<sup>2</sup>) of space, the Clough Commons has 41 classrooms, two auditoriums, study rooms, a roof garden, a solar energy array and water cistern (1.4 million gallons / 5.3 million liters capacity). As an NSF 61-approved non-toxic solution, PENETRON ADMIX was used for the underground cistern to ensure the structure walls remain absolutely waterproof.

# Total Concrete Protection



With locations in all key markets and production facilities in Europe, Asia, North America and South America, Penetron offers products and technical support to every country in the world through a comprehensive network of distributors.

**PENETRON ADMIX** has been proven effective in tens of millions of cubic meters/yards of concrete for countless major projects worldwide. The performance and reliability of our admixture has made Penetron the industry leader.



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