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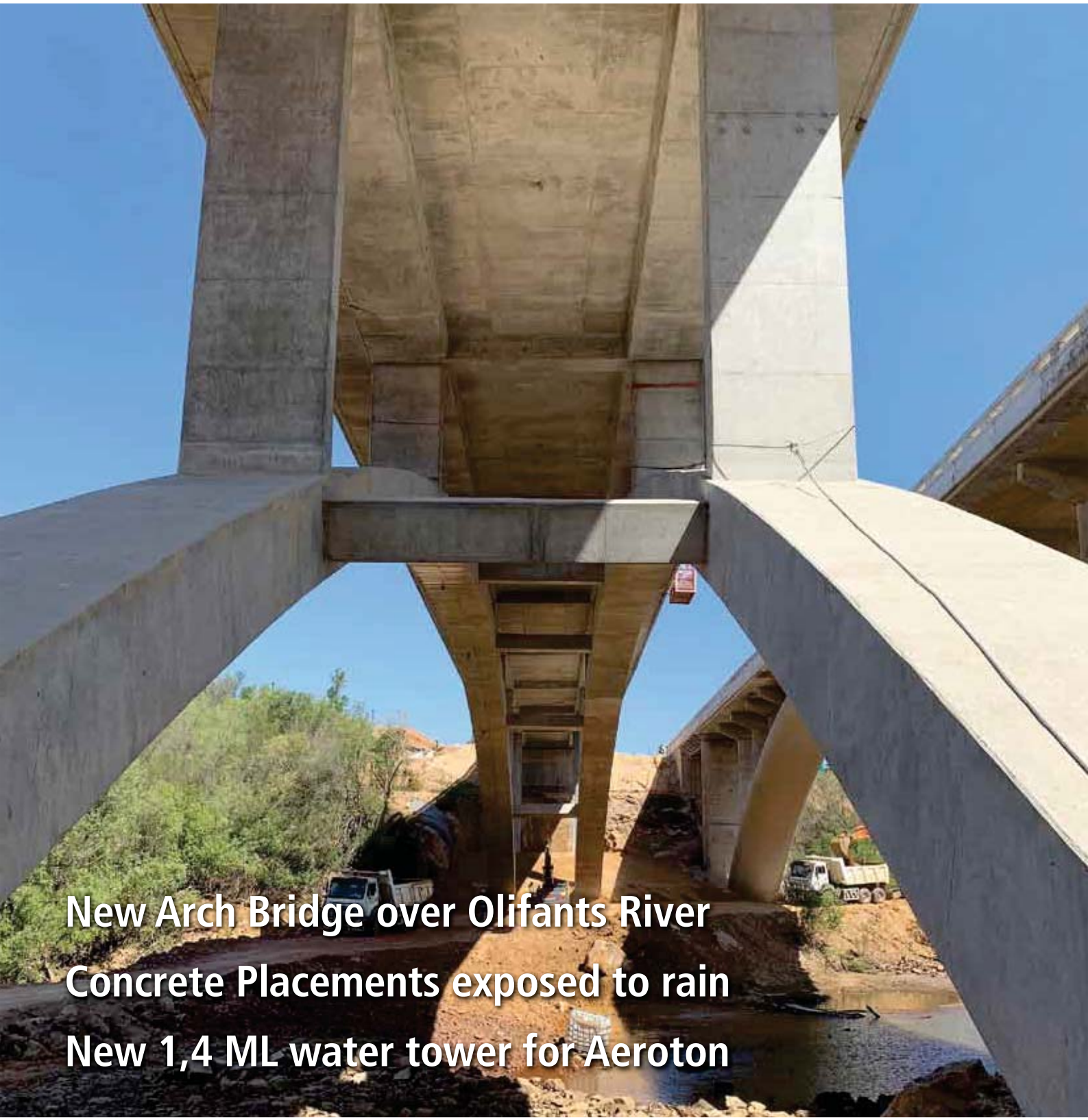
CONCRETE SOCIETY OF SOUTHERN AFRICA

CONCRETEBETON



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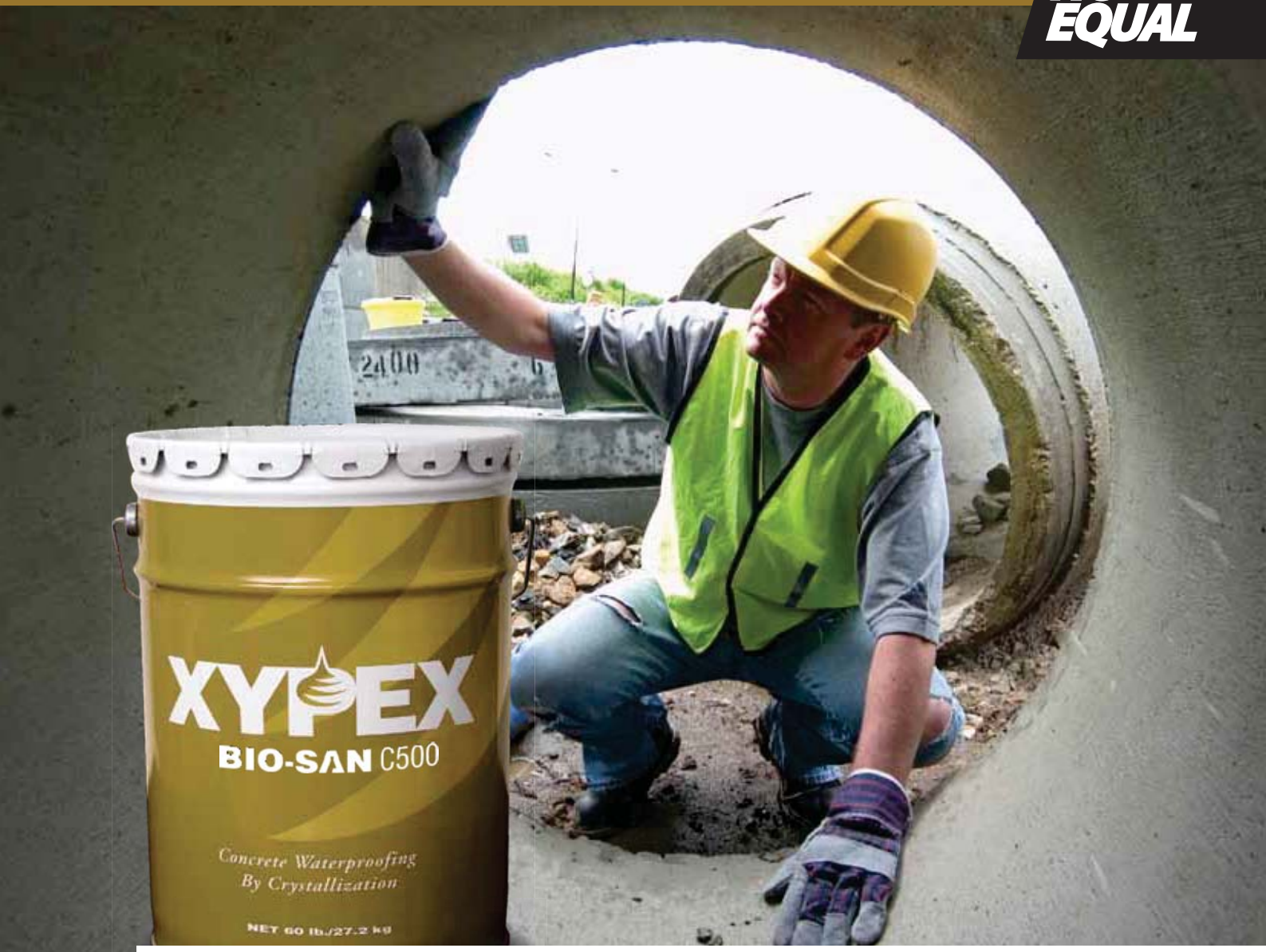

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Concrete (Untreated)

Xypex Crystallization (Initiated)

Xypex Crystallization (Mature)

Xypex Bio-San C500 is a uniquely designed admixture for integral, long-term protection of concrete is harsh sewage conditions with high levels of H_2S that cause microbial induced corrosion. Bio-San C500 combines potent antimicrobial protection along with the unique crystalline technology of the Xypex Admix C-Series. Bio-San C500 prevents microbial induced corrosion, stops infiltration/exfiltration of water, and provides acid and sulphate resistance, significantly extending the service life of concrete sewage collection systems and waste infrastructure.

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Two-prong approach to protect concrete in harshest environments

Acid-producing microorganisms are eating away some of the world's most important infrastructure at an alarming rate. Known as microbial induced corrosion (MIC), this bacterial process ultimately produces biogenic sulfuric acid that can steadily reduce the surface pH of concrete sewer system components to destructively low levels, leading to rapid decay and potential collapse.

Many wastewater collection and treatment systems around the world are in need of repair or replacement because they have lost structural integrity due to MIC (fig 1). The breakdown of wastewater infrastructure allows increased infiltration of runoff and groundwater adding additional load to already stretched treatment plants, and also the leakage of wastewater into the environment along deteriorated conveyance systems.

It has been reported that Western Europe water and wastewater utilities, which supply drinking water and sanitation services to 390 million people across 17 countries, are expected to invest nearly EUR 90 billion over the next 5 years to rehabilitate water and wastewater infrastructure. With so much replacement and repair work on the books, owners and specifiers are challenged to find ways to prevent deterioration from reoccurring and to protect against MIC using modern construction methods.

Preventative measures commonly used to protect concrete sewer system infrastructure such as precast reinforced concrete pipe, manholes, cast in-situ lift stations, head works and other structures from accelerated corrosion and failure, include:

- Corrosion-resistant barriers such as PVC and HDPE liners and epoxy and cementitious coatings
- PVC pipe as a replacement for small diameter concrete pipe
- Durable concrete mix designs to reduce permeability and enhance resistance to chemical attack.
- Waste stream treatments and chemical additives – to reduce hydrogen sulfide levels (e.g. oxygen/air injection, or chemicals such as hydrogen peroxide, chlorine, potassium permanganate, calcium nitrate, sodium hydroxide or magnesium hydroxide).
- Antimicrobial additives – can be added to concrete at the time of batching, or applied later.

While there are many approaches to providing MIC protection, there are limitations for each that need to be considered by owners and design professionals. For instance, liners and coatings do provide visible protection against acid and sulfate attack; however, these options can be expensive and time-consuming to install in existing structures. If not installed properly, they may also be subject to failure.

Plastic liners, for example, are particularly sensitive to the quality of the site-welded seams. Both liners and coatings can be forced off the surface by hydrostatic pressure. Coatings must be carefully applied to avoid pin-holing, which can be a challenge in dry-cast pipe mixes. PVC pipe has advantages but is limited to smaller diameter pipes. Waste stream additives can be expensive and cumbersome to install and maintain.

For existing structures, solutions for repair of MIC damage are more limited, and include:

- Repair mortars, followed by corrosion-resistant epoxy coatings
- Corrosion-resistant repair mortars
- Cured in-situ pipe relining – may include many different pipe repair and renewal techniques
- Repair mortars with antimicrobial additives
- Waste stream chemical treatment additives – following repair.

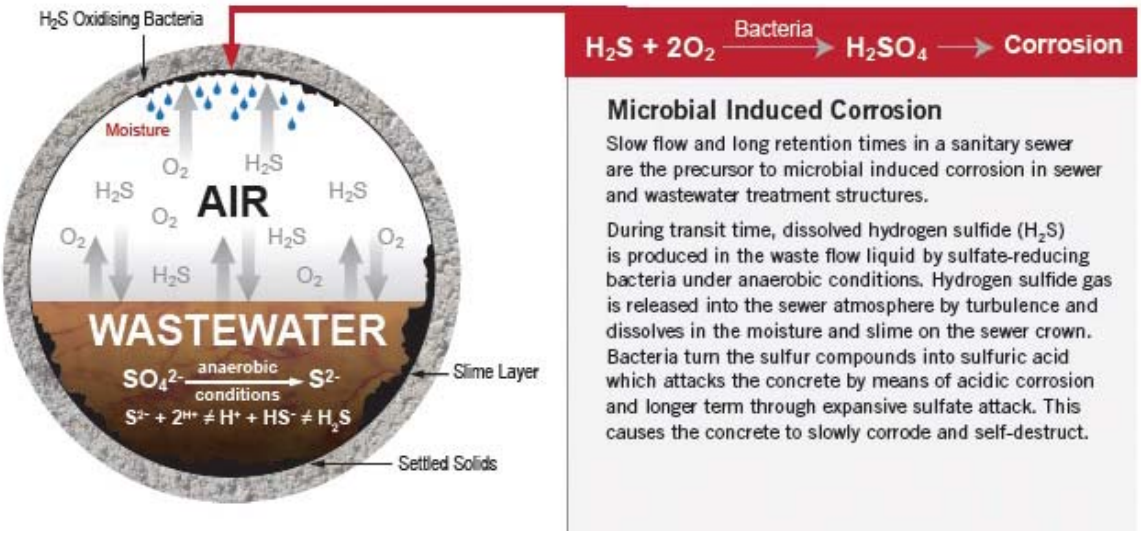

Fig.1: Microbial corrosion (MIC) is a complex biochemical process that ultimately results in the production of highly acidic conditions that can rapidly deteriorate concrete and metal.

One of the major limitations of these strategies are the very difficult working conditions that may be present in existing sewers. These remedies may need quality surface preparation and thorough drying prior to application of moisture sensitive materials such as epoxy and these can be difficult to achieve in a live sewer environment.

ENHANCING CONCRETE DURABILITY

There are various ways to increase the resistance of concrete to acids and other forms of chemical attack. Diffusion or penetration of aggressive substances into concrete through interconnected capillary pores, and cracks can lead to degradation and deterioration of the structure. Depending on the nature of the diffusive substances, they can attack concrete or its steel reinforcement. By blocking the pores and healing cracks, the mass-transfer rate into the concrete can be decreased thereby enhancing the concrete's durability and the longevity of the structure's service life.

Traditional means of improving the durability of concrete are through reduction of water/cement ratio (W/C) and by increasing the moist curing time. Another way to increase concrete durability and other factors, is through the partial replacement of Portland cement with supplementary cementitious materials (SCM's) such as fly ash, ground-granulated blast furnace slag (GGBS) and silica fume.

The addition of these materials has been shown to improve the durability and longevity of concrete structures. However, it is important to evaluate the source of SCM's because their quality and performance can vary greatly, particularly when it comes to fly ash. In addition, silica fume can be difficult to work with as it can make concrete 'sticky' and, in some cases, prone to cracking.

CRYSTALLINE WATERPROOFING

Another time-proven method of increasing durability of concrete structures is through the use of crystalline waterproofing technology. This technology can be used as an admixture or cementitious coating to reduce the permeability and increase the durability of concrete. By filling and plugging pores, capillaries and micro-cracks with a non-soluble, resistant crystalline formation.

Most of the mechanisms related to concrete deterioration depend on diffusion of offending substances through these paths and passages. Crystalline waterproofing technology reacts with the by-product of cement hydration to plug the pores, capillary tracts and micro-cracks with a crystalline formation (Figs 2 and 3). The infiltration and diffusion of liquids and gases is significantly reduced, which improves concrete's resistance to the effects of acid, sulfate and chloride attack.

ANTIMICROBIAL INNOVATION

Xypex Chemical Corporation of Vancouver, Canada, has provided a family of crystalline waterproofing and protection products since 1968 and distributes its products through a service network in more than 90 countries, including South Africa. Recently the company introduced a new dual-protection product called Xypex Bio-San C500 admixture that combines crystalline waterproofing with a mineral-based antimicrobial that kills the Thiobacillus group of bacteria species responsible for microbial induced corrosion.

This innovative product is manufactured in the form of a dry powder that is added to the concrete at the time of batching. It can be added manually or through a computer-controlled batching system. It can also be added directly to the ready-mix truck prior to adding the balance of the materials in a dry-batch plant operation.

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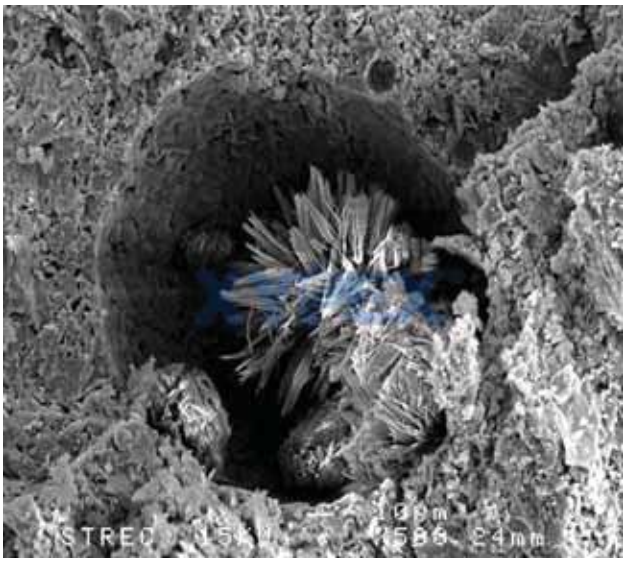

Fig.2: Here, Xypex crystalline waterproofing begins to fill in a pore in this concrete matrix.

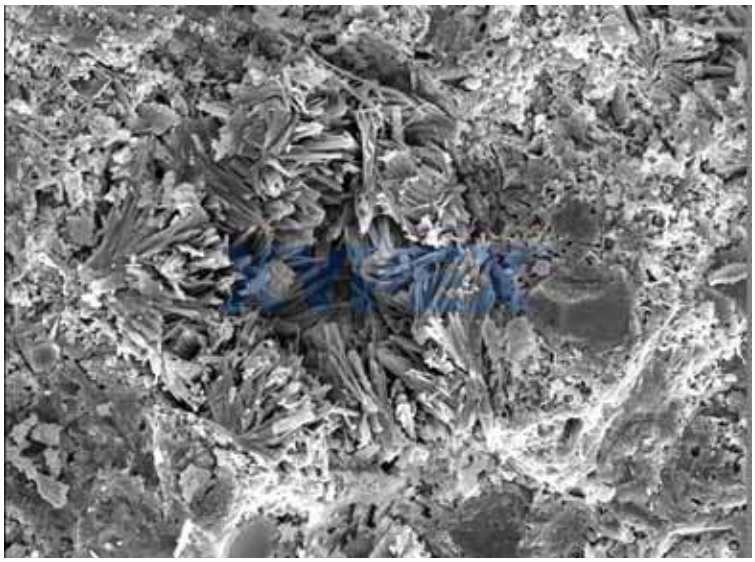

Fig. 3: In this photo, the crystalline formation completely fills the pore preventing the infiltration or exfiltration of moisture and potentially damaging diffusion substances

Xypex Bio-San C500 admix provides concrete precasters and ready-mix producers with a single, convenient product that can be added to any project or product requiring a high level of corrosion resistance, waterproofing and antimicrobial protection. The product's antimicrobial components are fixed in a mineral matrix that becomes an integral part of the concrete. They work indefinitely to destroy harmful bacteria at a cellular level through a "two stage kill' system that both opens holes in the bacteria's cell membrane and destroys the cell's ability to reproduce itself. It cannot be washed off or wear out.

DUAL PROTECTION FOR REPAIRS

In addition to Xypex Bio-San C500 admix, Xypex Megamix II with Bio-San is a new resurfacing mortar that is also formulated with Xypex crystalline waterproofing technology in combination with Bio-San's bioactive mineral solids. In this way, Megamix II with Bio-San provides chemical resistance to acid, sulfate, and chloride as well as waterproofing. It stops the MIC process from reoccurring and replaces lost section thickness all in one product. It is quickly applied by spraying or hand application, and also trowels easily and does not require elaborate procedures such as the surface drying needed for most other coatings.

Megamix II with Bio-San requires less surface preparation than would be required for an epoxy or other coating materials. Megamix II with Bio-San saves time and money and becomes an integral part of the repaired concrete that will extend the life of the repair surface and actively work to prevent microbial induced damage for the life of the structure.

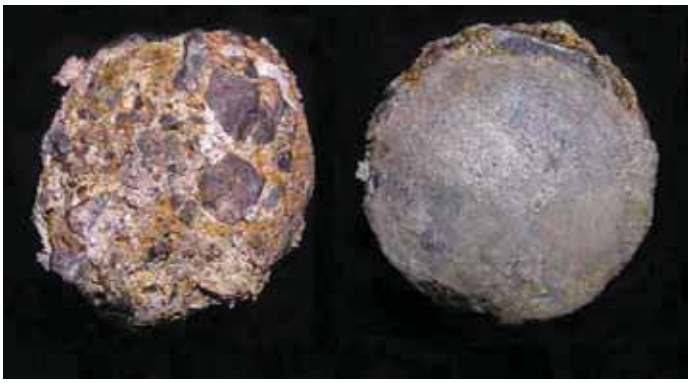

Fig. 4: Untreated concrete sample on left and sample treated with Xypex Bio-San.

LONG-TERM FIELD TESTING

In an independent study of the antimicrobial effect of Xypex Bio-San, the active ingredient was added at 1% by weight of Portland cement mortar and compared to untreated control samples. The sample cylinders were suspended in a wastewater facility that was chosen due to elevated levels of H_2S (about 50 ppm) over a period of 10 years. The exposure trials showed that treated samples had nine times less concrete mass loss compared to the untreated control samples (fig 4). Bacterial concentration on the treated samples was minimal, even after 10 years of exposure.

Using Xypex crystalline waterproofing with Bio-San – as an admix or coating – the antimicrobial protection becomes an inherent part of the structure. It not only heals cracks and stops leakage it inhibits the MIC process. It eliminates the need for any supplemental coatings inside or out and eliminates the need to coordinate a separate coating contractor and their need for time in the production process or special preparation. This protection is built into the structure and eliminates many concerns.

"We are excited to be able to offer Xypex with Bio-San antimicrobial protection in our market," notes Lewis Lynch, Managing Director of MSASA, a Cape Town-based waterproofing solutions provider and Xypex representative for South Africa. "Both Xypex Bio-San C500 admixture and Xypex Megamix II with Bio-San provide dual protection in one product. Any project where high levels of corrosion are expected or have been experienced will benefit. Xypex admixture with Bio-San can also be used to add value to many types of precast concrete products." ▲

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