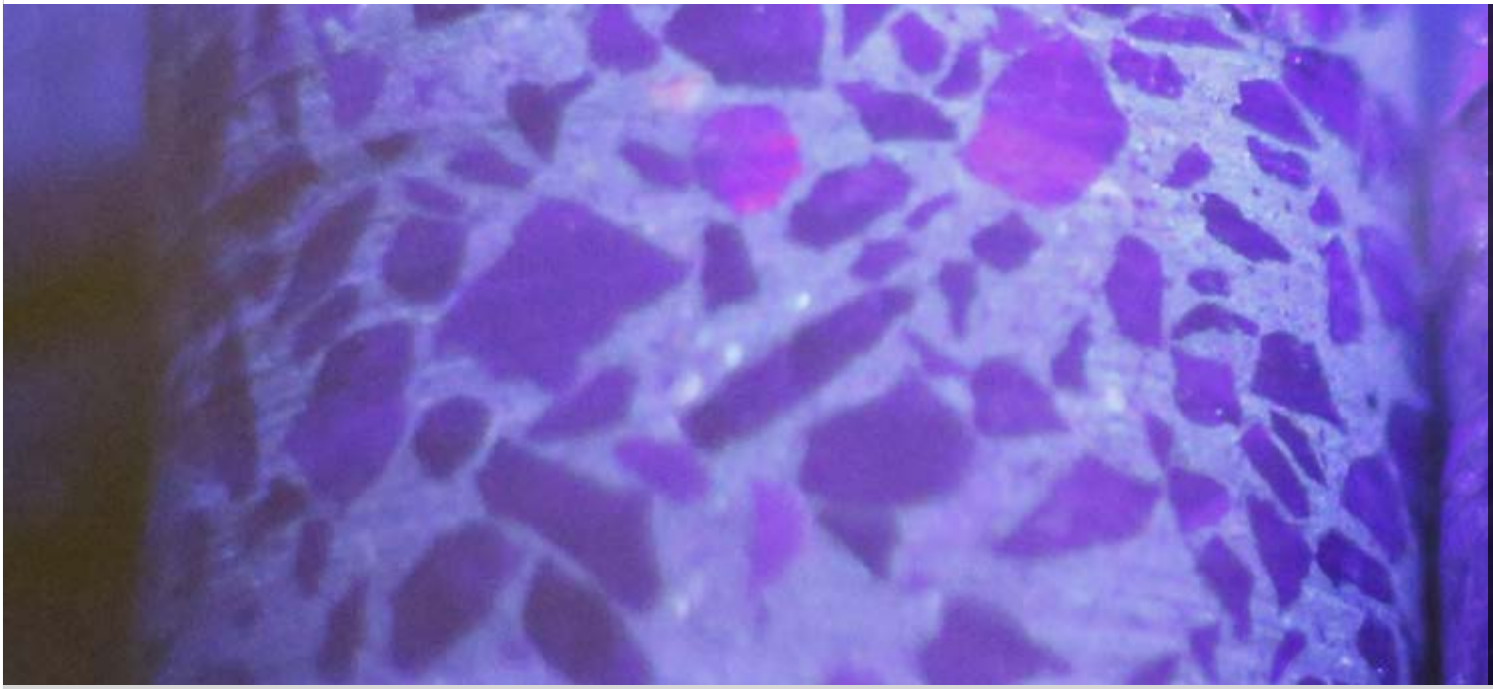
Bicrete®

Technical Guide D1.13

Bicrete® is a Biogenic Sulphuric Acid Corrosion Resistant Concrete manufactured with an antimicrobial additive (B!C® Agent).



Applications

Spun and wet-cast concrete pipe

Spun and precast concrete manholes (bases, risers and lids)

Precast concrete chambers

Product Attributes

Anti-bacterial additive dispersed throughout concrete matrix

Uses standard manufacturing processes

Quality

ISO 9001:2008 Quality Management Standard

"S" Mark to AS/NZS 4058

Approvals/Standards

Construction Technology Review and Certification Report issued by the Japan Institute of Wastewater Engineering Technology

Suitable for precast concrete pipes manufactured to AS/NZS 4058

Precast concrete products designed to NZS 3101 and manufactured to NZS 3109

We are the supply partner of choice for New Zealand's civil construction industry, specialising in water and infrastructure based solutions.

HYNDS PIPE SYSTEMS

Bicrete® is an antibacterial concrete manufactured with an antimicrobial additive (B!C® Agent) which has been developed to have an antibacterial effect on sulphur oxidising bacteria.

The B!C® Agent is added in a very small quantity during manufacture of the Bicrete® concrete. The B!C® Agent is dispersed throughout the concrete matrix and is thus spread through entire wall of the precast pipe or component.

This ensures that the antibacterial protection continues throughout the service life of the product even as any slower corrosion occurs.

Bicrete® is manufactured using standard production processes commonly used in the manufacture of concrete pipe *(spun and precast)* and general precast concrete. Bicrete® suppresses the proliferation of the bacteria, thus limiting the production of sulphuric acid where the H_2S concentration is 10 ppm or less.

The generation of hydrogen sulphide *(H_2S)* in concrete sewer pipes carrying aged sewage leads to the interior surface of the pipe above the effluent level being attacked by sulphuric acid generated by bacterial action. The bacteria responsible, Thiobacilli, is a whole family of bacteria with various strains thriving at different pH levels. This process, known as Biogenic Sulphuric Acid *(BSA)* corrosion is one of the most aggressive forms of corrosion.

In a sewer pipe environment, hydrogen sulphide *(H_2S)* gas is mainly produced by sulphur reducing bacteria present in the slime layer of submerged sewer, which convert sulphur compounds in the sewerage into hydrogen sulphide *(H_2S)* gas which has the rotten egg smell. The H_2S is released into the air from the water by turbulence or diffusion, dissolves into the condensate film that forms on the roof and walls of the pipe above the sewage.

Where sufficient oxygen, nutrients and moisture are present, colonisation of the condensate film by successive strains of neutrophilic bacteria leads to oxidation of the H_2S into sulphuric acid *(H_2SO_4)*.

The acid reacts with the roof and walls of the pipe, with a lowering of the pH facilitating the colonisation by new strains adapted to the lower pH conditions, leading to gradual decrease in pH.

When the pH of the concrete has dropped to approximately 4, colonisation by aggressive acidophilic bacteria generates enough sulphuric acid to reduce the surface pH to 1-2 which is considered highly aggressive to any concrete. At this point the H_2SO_4 reacts with the calcium hydroxide *($CaOH_2$)* in the concrete to form gypsum. The formation of gypsum leads to an increase in volume, and further reaction between the gypsum and the tri-calcium aluminate *(C_3A)* forms etteringite which causes an even larger volume expansion, leading to a deterioration of the concrete matrix.

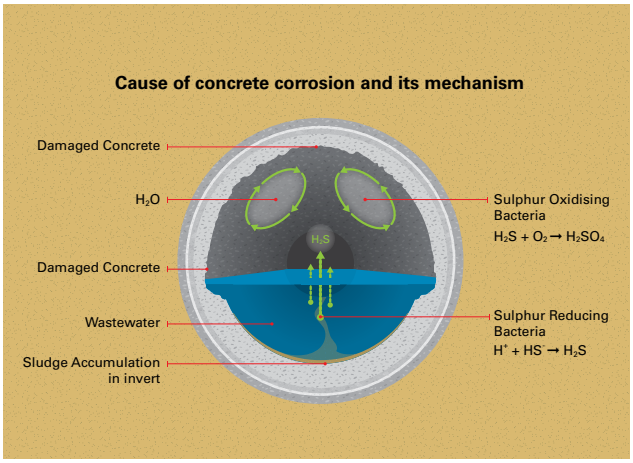


FIG. 1 Cause of concrete corrosion and its mechanism

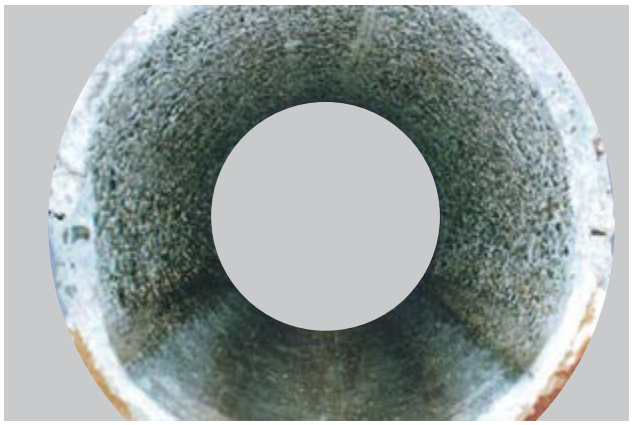


FIG. 2 Example of sewer pipe corrosion

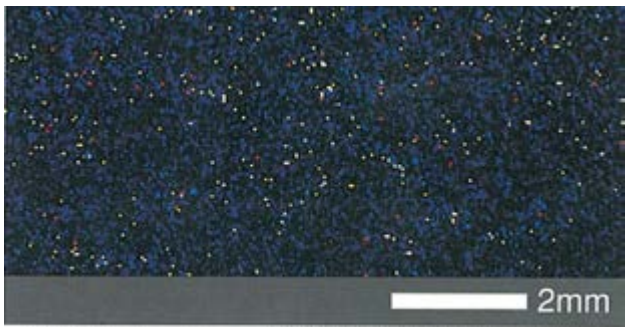


FIG. 3 Electron Micrograph showing dispersion of B!C® Agent in Bicrete®

Bicrete® Development

- Bicrete® is an antibacterial concrete manufactured with an antimicrobial additive (B!C® Agent) which has been developed to have an antibacterial effect on the sulphur oxidising bacteria.
- Bicrete® was developed from research carried out in the mid 1990's by researchers at the Okayama University Agricultural Department and Hazama Corporation in Japan, with the master paper by Dr Yasuo Nogami published in 1997. Subsequent testing by Japan Sewage Works Agency, Hazama Corporation and Nippon Hume was published in 1998, and Construction Technology Review and Certification granted in early 1999 by the Japan Institute of Wastewater Engineering Technology.
- The first application in Japan was in the manufacture of 800 mm diameter spun jacking pipe in January 1994.
- An increasing number of the concrete sewer pipe manufactured in Japan uses Bicrete® as a means of controlling Biogenic Sulphuric Acid corrosion.
- The B!C® Agent is a powder blend of blast furnace slag powder with nickel and tungsten compounds, which is added to the cement for the manufacturing of the Bicrete®. The combination of the nickel and tungsten compounds has an inhibitory effect on a various strains of Thiobacilli bacteria which thrive over a wide range of pH. B!C® Agent has little or no effect on other microorganisms in sewage, and has been tested on E. Coli, Staphylococcus aureus and Pseudomonas aeruginosa.

Bicrete® Manufacture

During the manufacture of the concrete a small dose of the B!C® agent is added to the dry materials in the mixture, to ensure uniform dispersion, before the water is added.

The B!C® Agent is dispersed throughout the concrete matrix and thus the entire wall of the spun or precast pipe, or precast component is manufactured with Bicrete®. This ensures that the antibacterial protection continues throughout the service life of the product even as any slower corrosion occurs.

Bicrete® is manufactured using standard production processes commonly used in the manufacture of concrete pipe *(spun and precast)* and general precast concrete. Test pipes manufactured using Standard Pipe Concrete and Bicrete® were subjected to compressive, cylinder load and water absorption tests. Figures 7-9 shown below confirm that the addition of the B!C® agent in the Bicrete® had no material effect on the strength and water tightness of the pipe and concrete respectively.


建設技術審査証明書

技術名称：ビックリート（防菌コンクリート）

FIG. 4 Construction Technology Review and Certification issued by Japan Institute of Wastewater Engineering Technology. Issued March 10th 1999. Renewed March 6th 2009.

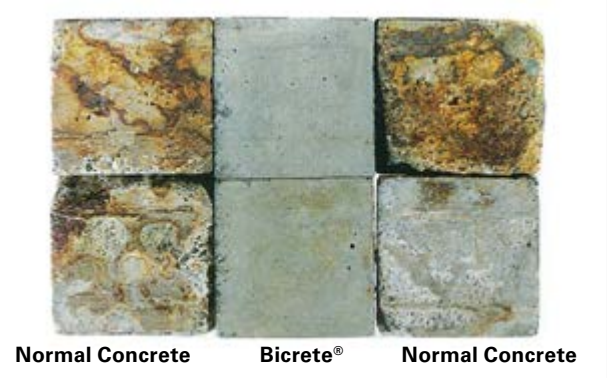


FIG. 5 Corrosion of test pieces over two year exposure study

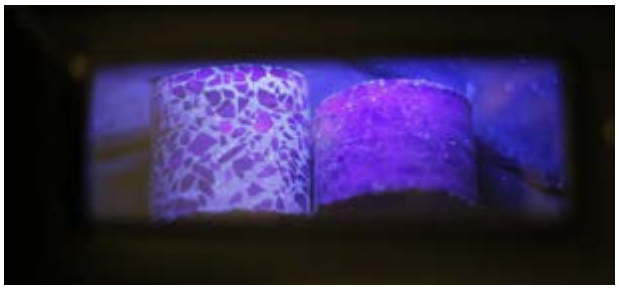


FIG. 6 Bicrete® (left) vs standard concrete (right) under UV light showing dispersion of B!C® Agent

Service Life

The expected service life of the concrete, based on the number of years it takes for the corrosion to extend through the concrete cover to the level of the reinforcing, is detailed in Table 1 for various H_2S concentrations and concrete cover to the reinforcing. Bicrete® effectively suppresses the proliferation of the bacteria where the H_2S concentration is 10 ppm or less, thus limiting the production of sulphuric acid and consequent concrete corrosion.

Where H_2S concentrations are anticipated to be >10 and <50 ppm consideration should be given to providing additional protective cover, as the Bicrete® deterioration *(corrosion speed)* is expected to be ¼ the rate of normal concrete.

FIG. 7 UV Dispersion viewer

TABLE 1 Expected Service Life

Product Type	**Cover to reinforcing** (mm)	**Max avg H_2S concentration** (ppm)	**Expected Service Life** (years)
Spun Pipes / Manholes	20	10	50
Spun Pipes / Manholes	35	10	70-100
Precast Concrete products (50 MPa concrete)	50	10	70-100

Reference: *Construction Technology Review and Certification (Sewage Technology) Report issued by the Japan Institute of Wastewater Engineering Technology – March 2009*

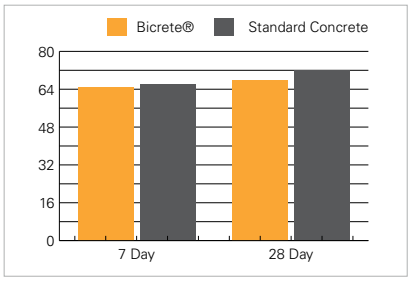


FIG. 8 7 and 28 Day Concrete Strengths

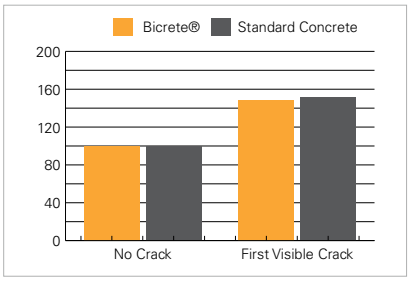


FIG. 9 Load Tests

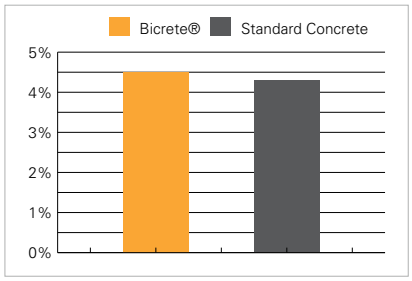


FIG. 10 Water Absorption Tests

See also:

- *D1.1 Hynds Hyspec Spun Rubber Joint Pipes*
- *D1.3 Hythrust Jacking Pipe System*
- *D1.4 Hynds Skid Ring Joint*
- *D1.5 Hyspec Flush Joint Pipes*
- *D1.10 Hynds Skid Ring Joint Jacking Pipe System*
- *D1.11 Hynds Hydura Concrete Pipe*