Xypex Chemical Corporation

- Founded 1969 in Vancouver, British Columbia
- Concrete Waterproofing & Protection by Crystallization™
- The original and world standard in crystalline technology
- Present in over 80 countries worldwide
- ISO 9001:2015 and CE certified

CENTRAL RESEARCH LABORATORY OF NIKKI SHOJI

Commissioned by JAERI

XYPEX CHEMICAL CORPORATION

Crystalline Growth

Independent tests conducted in Japan by the Central Research Laboratory of Nikki Shoji revealed crystalline growth at 50mm. This report is illustrated with electron microscope photographs of the crystallization.

A concrete test piece of cylindrical form was treated on one end surface with a slurry coating of Xypex Concentrate and water mist-spray cured for ten days. The opposite untreated end of the test piece was then immersed in shallow water for a period of fourteen days.

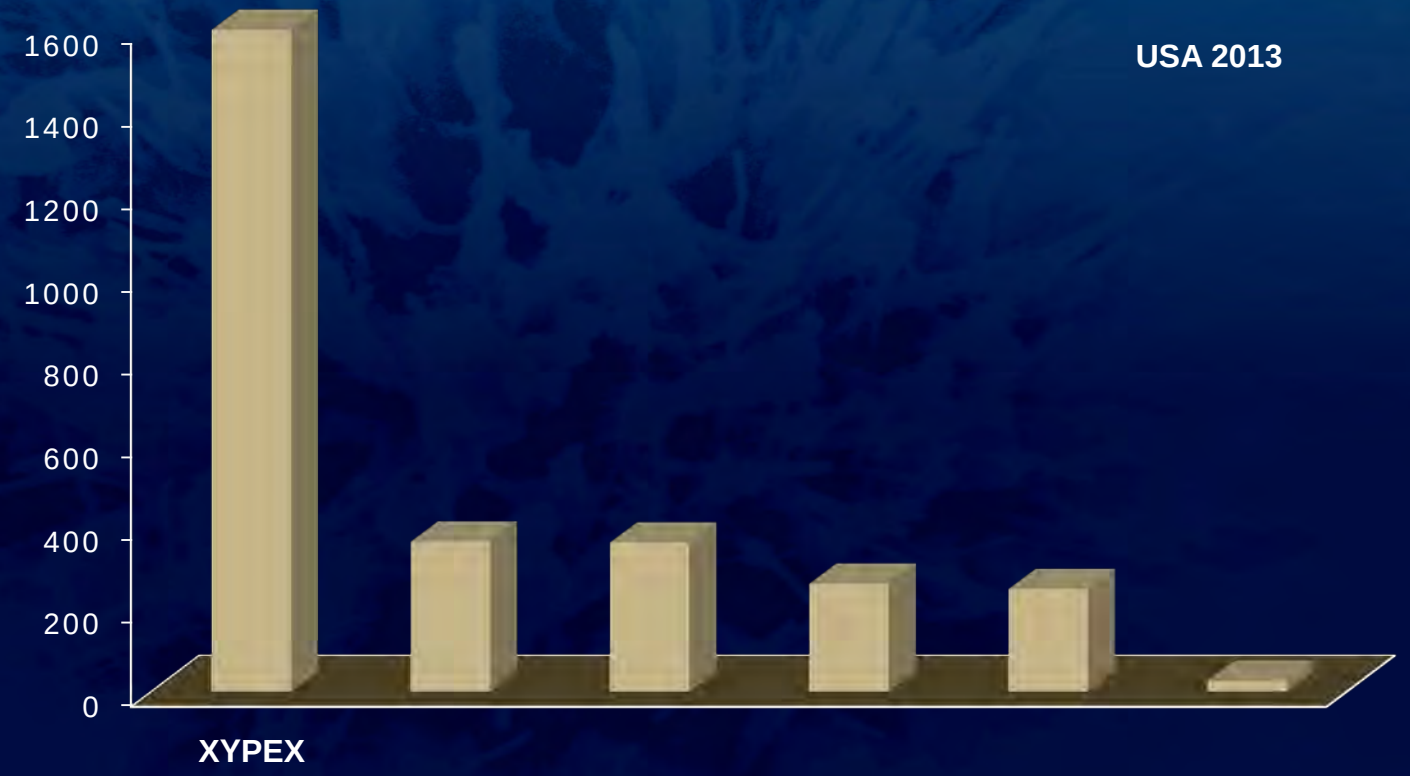
An untreated control sample was sheared through 50mm below the end surface. The photograph on the right is of the sheared face. Precipitated Ca(OH) Calcium Hydroxide together with cubic and rhombic particles are visible.

The sample treated with Xypex Concentrate was similarly sheared through at 50mm below the end surface. Photograph at the right is of the sheared face. Crystal formation by catalytic reaction emanating from the Xypex Concentrate commences. This is seen starting from the areas with Ca(OH) particles with growth towards the C-S-H gel.

This photograph of the sheared face shows the considerable growth of crystallization developed from the gel of C-S-H. Therefore, the crystals had penetrated a minimum of 50mm within the three week period after the surface treatment with Xypex Concentrate.

Leader

Number of specifications of Xypex Crystalline Technology



McGraw Hill Construction Network

XYPEX®

Xypex products and services are available in over 80 countries.

Concrete Challenges

Hydrostatic Pressure

- Dams
- Canals
- Tanks
- Reservoirs

Water Table

- Rivers
- Lakes
- Seas
- Mountains

Chemical Attack

- Water Treatment
- Waste Water Collection and Treatment
- Industry
- Agriculture
- Environmental

Environmental Attack

- Carbonation
- Chloride
- Sulfate
- Freezethaw

Waterproofing Failure

- Coatings
- Membranes
- Cementitious

Porous Concrete

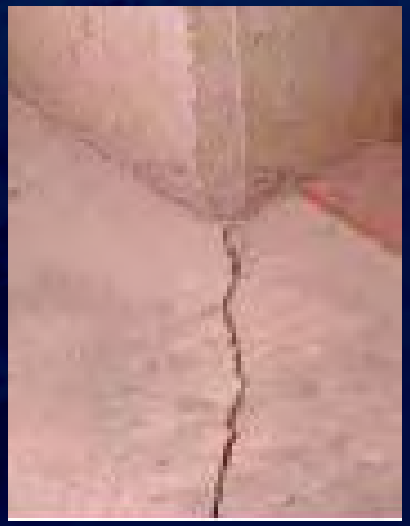
- Mix-design
- Type of structure
- Construction conditions
- Poor workmanship

- Cracks
- Cold joints
- Construction joints
- Poor consolidation

Cracks

The most common causes of cracking in walls and slabs are:

- Drying Shrinkage
- Thermal Cracking
- Strain Formed Cracks
- Settlement
- Plastic Shrinkage Cracking
- Rebar Corrosion



Key Problems and Costs

Four phases of concrete corrosion

Phase 1	Design, construction and concrete curing	$ 1
Phase 2	Corrosion initiation processes are underway, but increased damage has not yet begun	$ 5
Phase 3	Increase in damage has just begun	$ 25
Phase 4	Increase in corrosion is advanced with extensive damage clearly evident.	$125

Equivalent cost of $1 spent in Phase 1

Source: The Australian Concrete Repair Association

Current Solutions

Concrete Surface Protection

LINERS

	ADVANTAGES	LIMITATIONS
HDPE, PVC, PE 	•Impermeable •Excellent chemical resistance especially in areas where pH is lower than 3.0 •Visible protection system	•Errors in workmanship •Seam failure •False spark test •Liners can be affected by negative side pressure •One breach can affect the integrity of the entire system •Expensive

CEMENT BASED LINERS

Portland, high alumina, speciality 	•Reduce inflow •Structural integrity •Some corrosion protection •Withstand negative side pressure •No VOCs	•Physical permeability barrier •Application requires expertise •Specialized equipment •Residual overspray material difficult to remove

Liner Problems

Spark Test

Seams

Concrete Surface Protection

COATINGS

Epoxies, urethanes, polyurethanes, coal tar epoxies

ADVANTAGES

- Impermeable
- Good chemical resistance
- Visible protection system

LIMITATIONS

- Costly surface preparation required
- Installation errors leading to pin holes and thin spots
- No crack healing
- Concrete needs to be dry
- Limited abrasion resistance
- Single breach affects integrity of entire system
- Performance deteriorates over time
- Do not resist negative side vapour and liquid pressure

CEMENT BASED COATINGS

Polymer cement mortars

- Easy application
- Inexpensive
- Can be applied to moist concrete

- Significant and costly surface preparation required
- Limited resistance to hydrostatic pressure
- Can be pushed off by negative side hydrostatic pressure
- Limited abrasion resistance
- Poor crack bridging, no crack healing
- Limited chemical resistance
- “One scratch” affects integrity of entire system
- Performance deteriorates over time

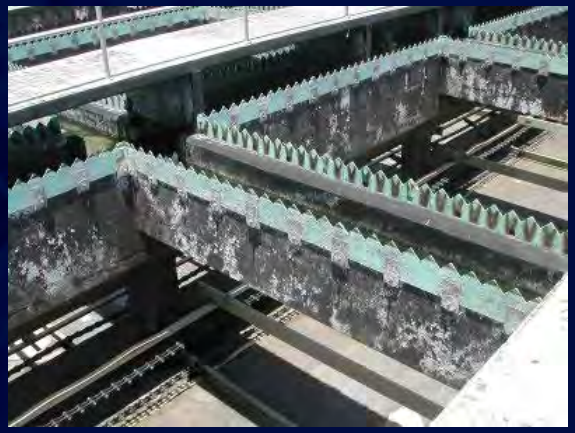
Coating Problems

Negative side water pressure

Pinholes

Blistering

Limited Lifespan



Admixtures

HYDROPHOBIC ADMIXTURES

	ADVANTAGES	LIMITATIONS
• Long-chain fatty acids (ammonium or calcium stearate) • Vegetable oils • Petroleum derivatives (mineral oils, paraffin wax, bitumen emulsions)	• Added at batch plant • Low labor costs • Low risk of error • Water repelling • Effective where no presence of hydrostatic pressure	•Low performance under hydrostatic pressure •Diminishing performance over time •Not recommended by ACI for concrete under hydrostatic pressure •No crack bridging or healing properties

ANTI-MICROBIAL AGENTS

Anti-microbial agents dosed into concrete at time of batching	•Interrupts the microbial induced corrosion process •Newer technology (1996) but appears to be effective •Can be added to concrete	•Moderately new system, no real long term field exposure •Expensive •Provides corrosion protection only, does not stop water infiltration or ex-filtration

Repair systems

	ADVANTAGES	LIMITATIONS
INJECTION SYSTEMS		
• Epoxy • Polyurethane	• Epoxies reinstate structural integrity • Polyurethanes allow movement • Polyurethanes can be applied on wet concrete • Effective for wider cracks	• High cost • Requires high level of application expertise • Requires specialty equipment • Poor aesthetics of typical injection job • Complicated re-working • Will not heal new cracks
ROUT & REPAIR		
Chipping out of crack then filling with cement-based mortar	• Inexpensive • Can be applied to wet or moist concrete & actively leaking cracks • Moderate level of expertise required • No special equipment needed	• Not a full depth repair • Will not cure future cracking • Not for cont. moving cracks

Injection Systems Limitations

Epoxy & Polyurethane

Our System

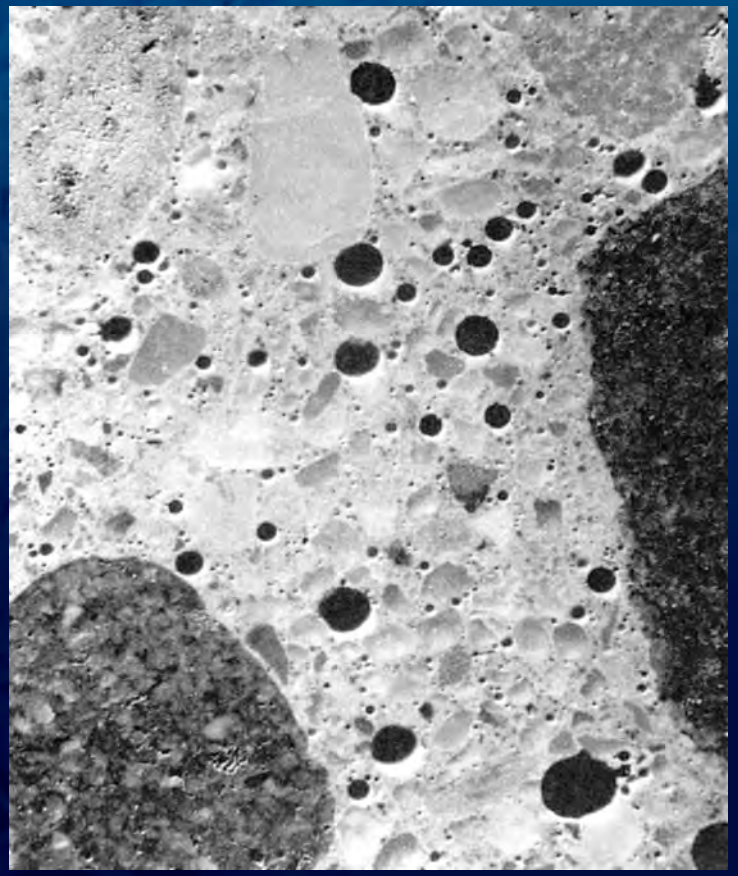
XYPEX®

Concrete Waterproofing by Crystallization

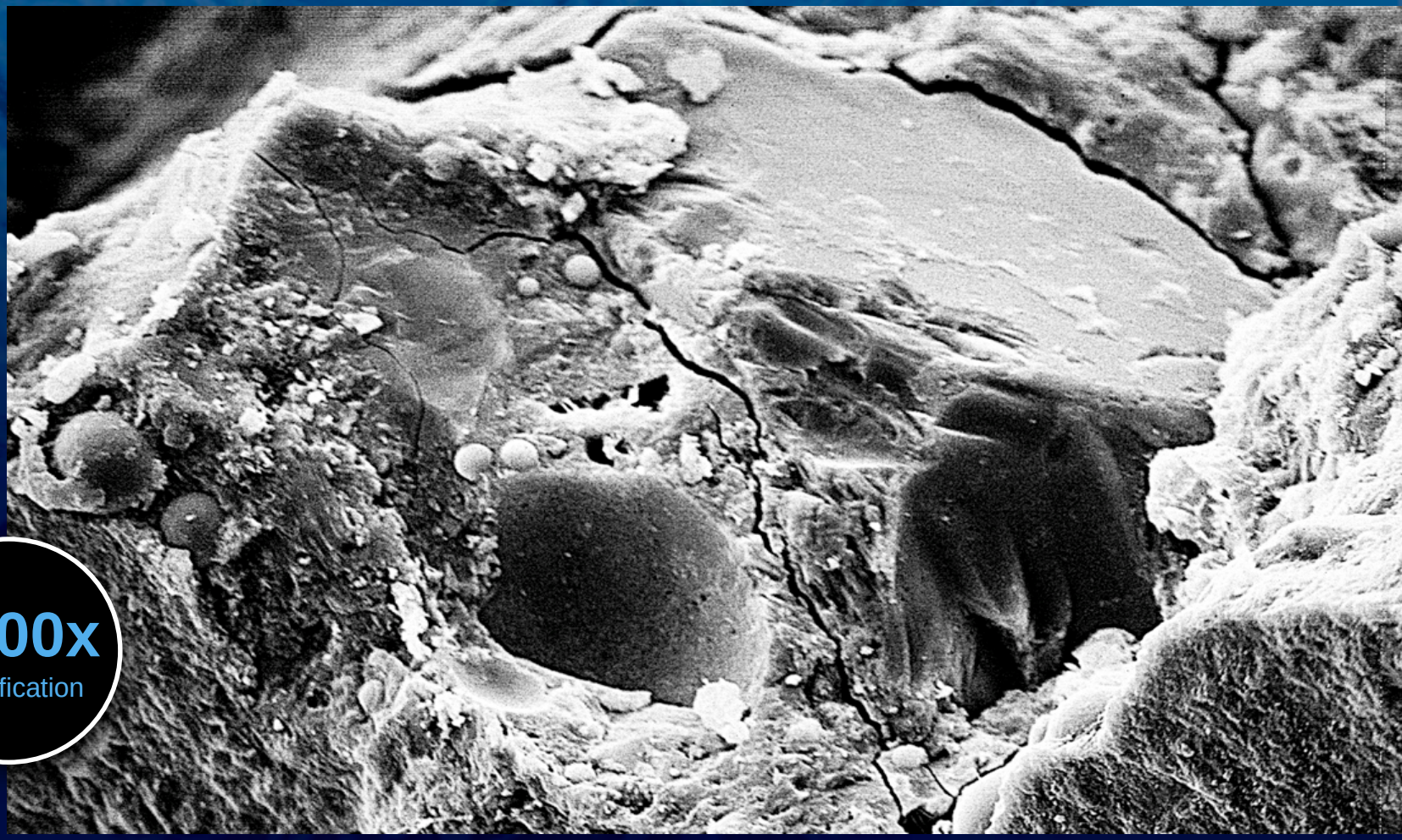

The Nature of Concrete
XYPEX®

Composition & Characteristics

- Composed of a mixture of rock, sand, cement and water.
- To be workable, more water than needed for cement hydration is used.
- Excess water bleeds out and leaves a network of capillaries and pores.
- As it dries, concrete shrinks and changes volume causing micro and macro cracks.

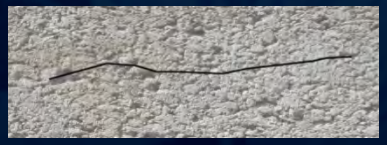
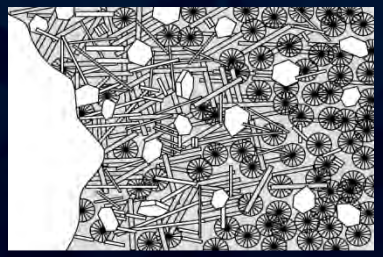
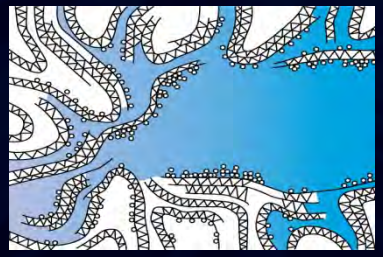


Micro Cracks



The nature of concrete can be determined by petrographic examination.

Permeability

Entrapped Void		***1mm to 10mm***
Crack		***0.1mm to 3mm***
Micro Crack		***<0.0001mm to 0.1mm***
Transition Zone		***0.01 mm to 0.05 mm***
Capillary Pore		***0.0001mm to 0.001 mm***

Permeable in several, different size scales.

Xypex Crystalline Technology

XYPEX®

What is Xypex?

Coating

Admixture

Dryshake

How It Works

Calcium Hydroxide and other by-products of cement hydration

+

Crystalline Waterproofing Chemicals

=

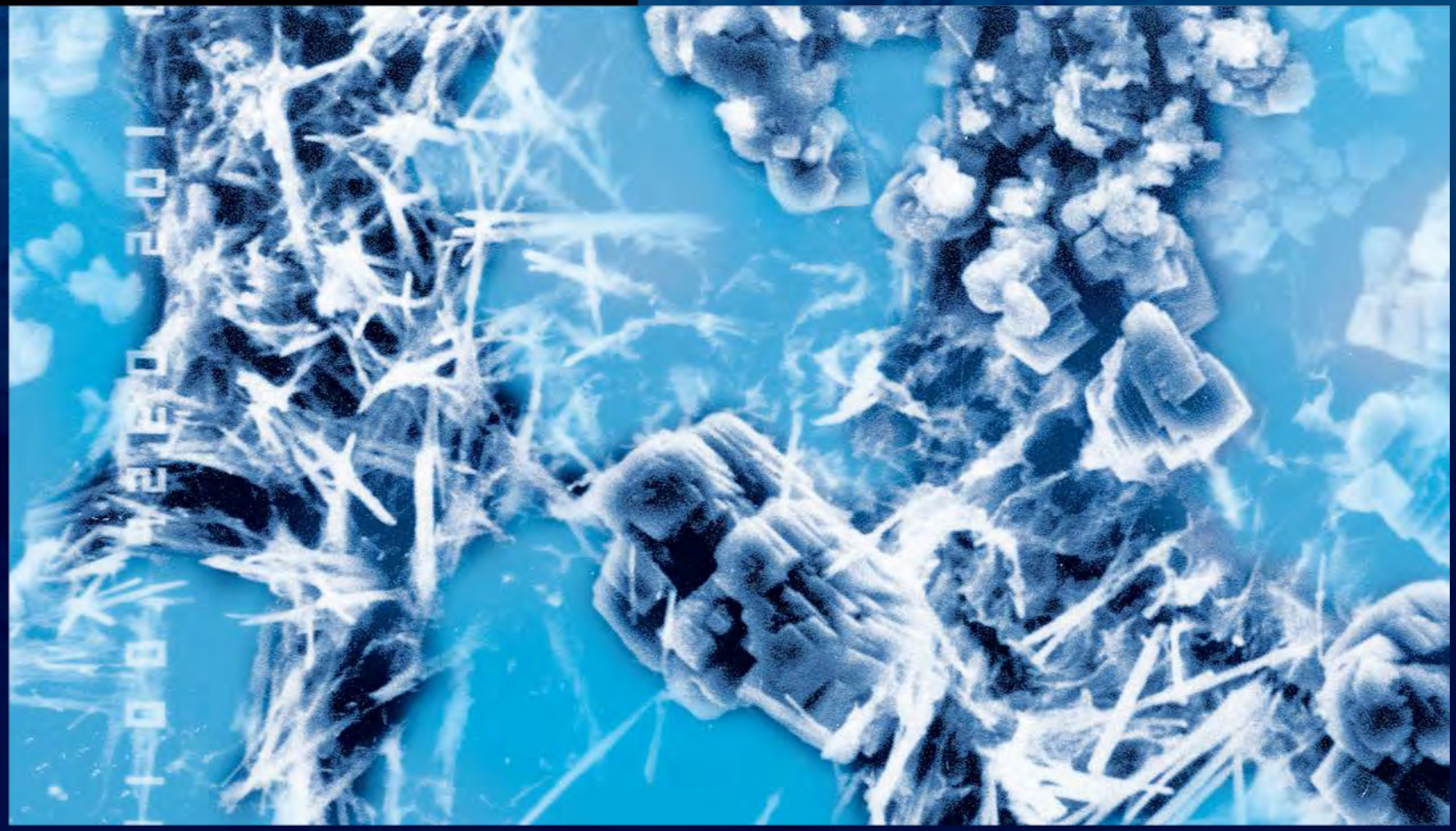
Non-soluble crystalline formation permanently fixed within the concrete's pore structure

Crystalline Formation

By-products of cement hydrations

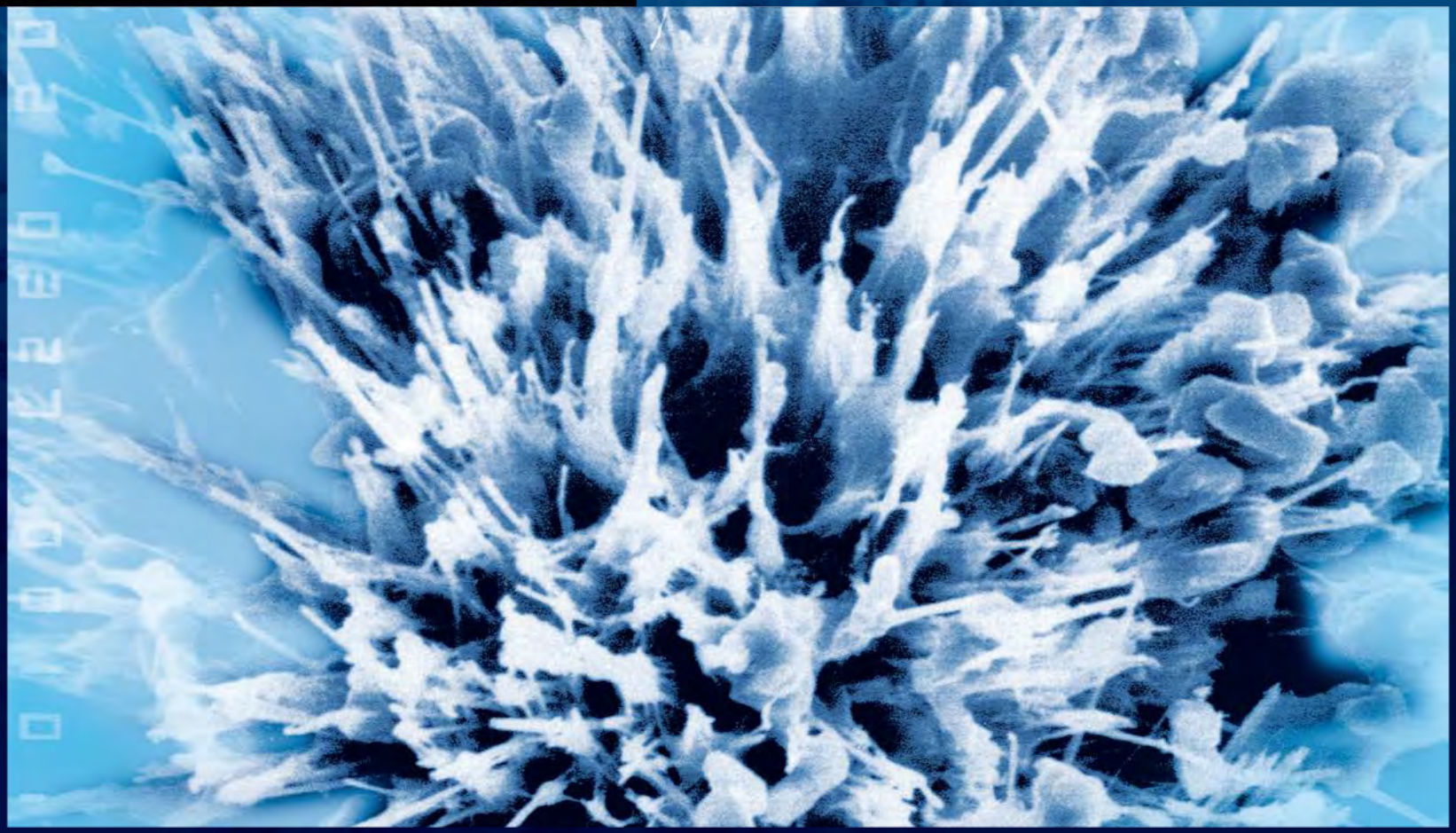
Crystalline Formation

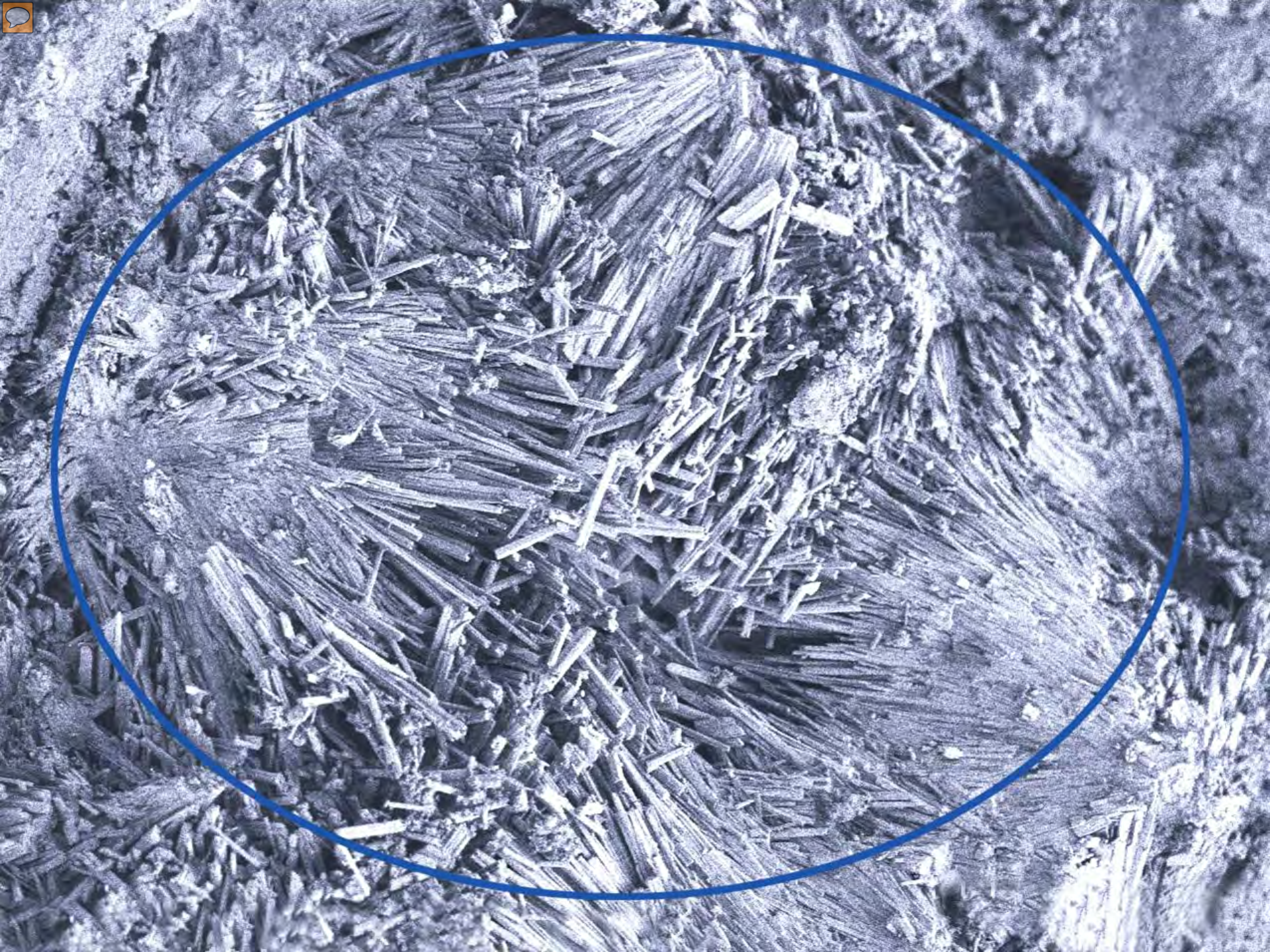
By-products + Xypex



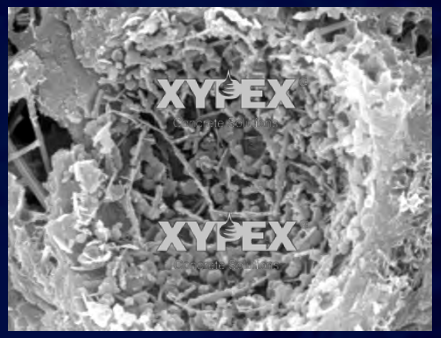
Crystalline Formation

Non-soluble crystalline structure





The investigation revealed an extensive manifestation of typical Xypex crystalline precipitations, varying in size and complexity according to the mineral and metallic salts from which they have developed.



What is Xypex?

- Becomes an integral, permanent part of the concrete matrix.
- Seals concrete from the penetration of water and other liquids from both the negative and positive side, even when subjected to hydrostatic pressure.
- Heals static cracks up to 0.4 mm, or 0.8 mm from both sides.
- Highly resistant to chemicals where the ph range is from 3.0 - 11.0 in constant contact and 2.0 - 12.0 in periodic contact.
- Cannot be punctured or damaged like a liner or surface coating.
- Enhances the durability of concrete.

Additional Advantages

- Not affected by humidity, ultraviolet light and oxygen levels
- Protects from freeze thaw
- Increased compressive strength
- Reduced shrinkage crack
- Is non-toxic
- Does not contain VOCs
- Does not produce any fumes
- Approved for use in potable water structures

Where is Xypex used?

- Hydrostatic Pressure
  - High Water Table
  - Tanks, Pools, Reservoirs, Dams
  - Tunnels
- Harsh Chemical Environments
  - Marine
  - Industry & Agriculture
  - Waste Water Collection & Treatment
  - Carbonation and Sulphate Attack
- Repair and Rehabilitation
  - Negative side after coating or membrane failure
  - Wet/Most concrete

Xypex and Concrete Properties

Xypex will have no negative effect on

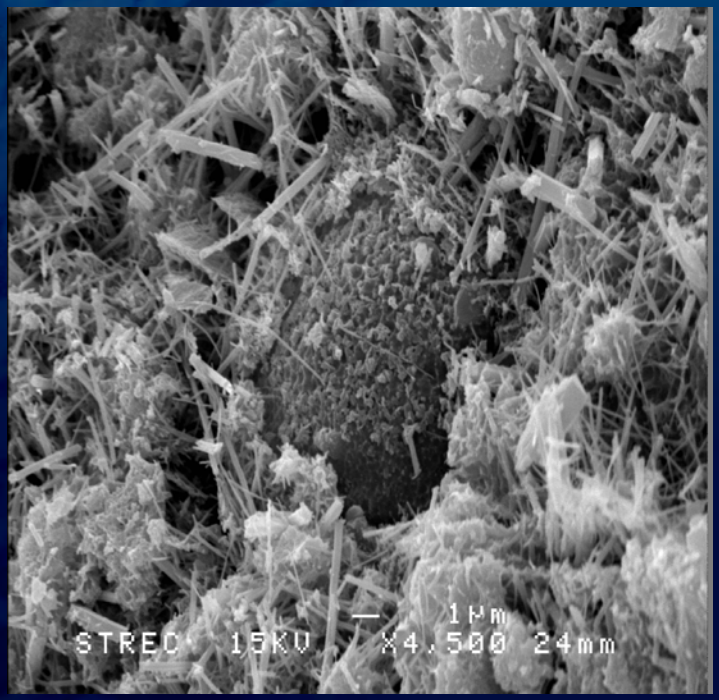
- Slump
- Set time*
- Air
- Shrinkage
- Compressive strength

*Xypex has three different Admixtures offering different set-times, including neutral-set

SCMs & Other Additives

Xypex can be used in conjunction with SCMs and additives

- Fly-ash
- Slag
- Silica fume
- Set retarders
- Water reducer
- Super plasticizers
- Air-entrainers



Trial batches always recommended

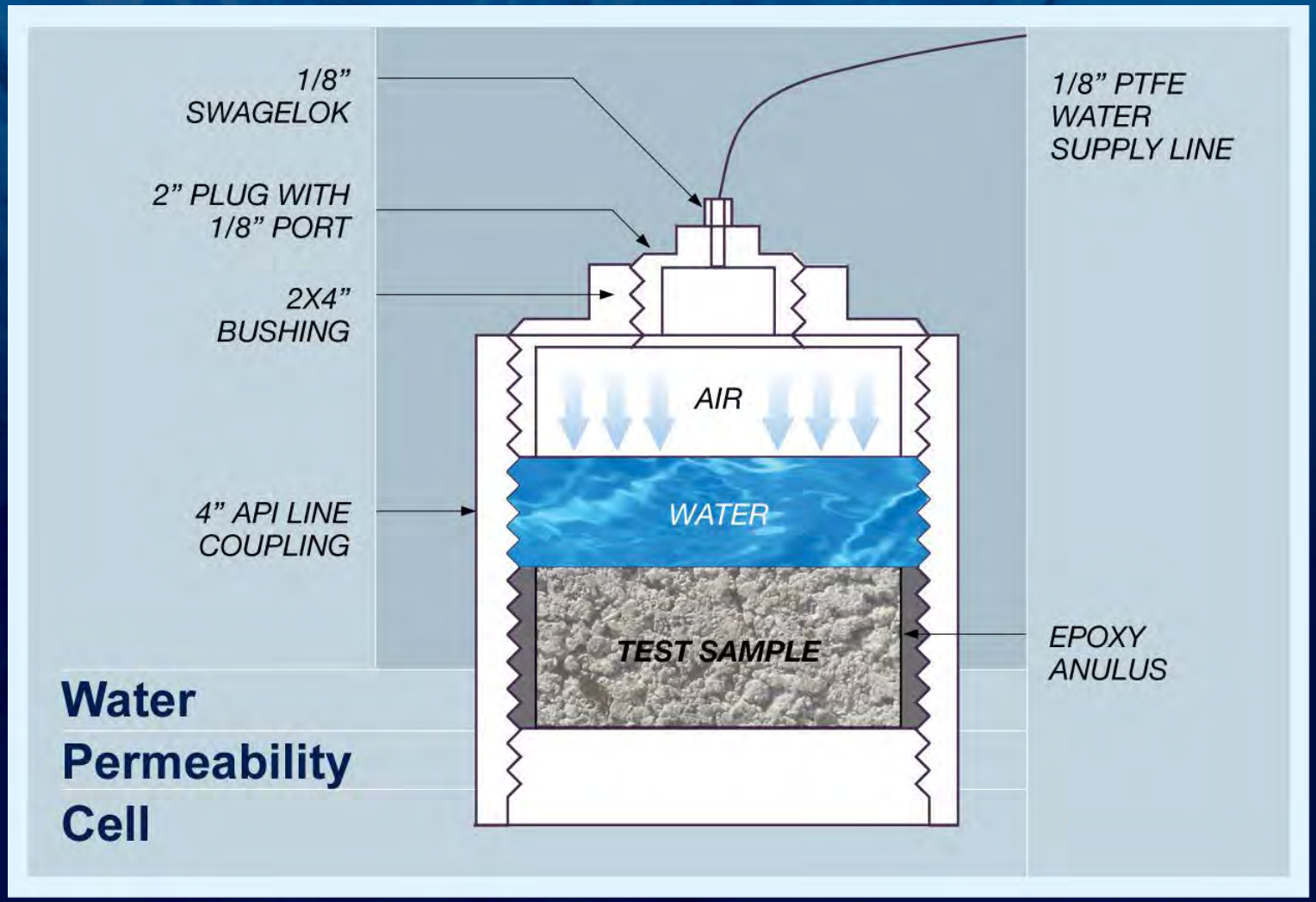

Proven Performance
XYPEX®

Independent Testing

Xypex has been independently tested worldwide for these characteristics

- Permeability
- Chemical Resistance
  - Acids
  - Sulfates
- Carbonation
- Compressive Strength
- Crack Sealing
- Scanning Electron Microscopy (SEM)

Permeability



Permeability

Taywood Engineering, CRDC C48-73, Singapore

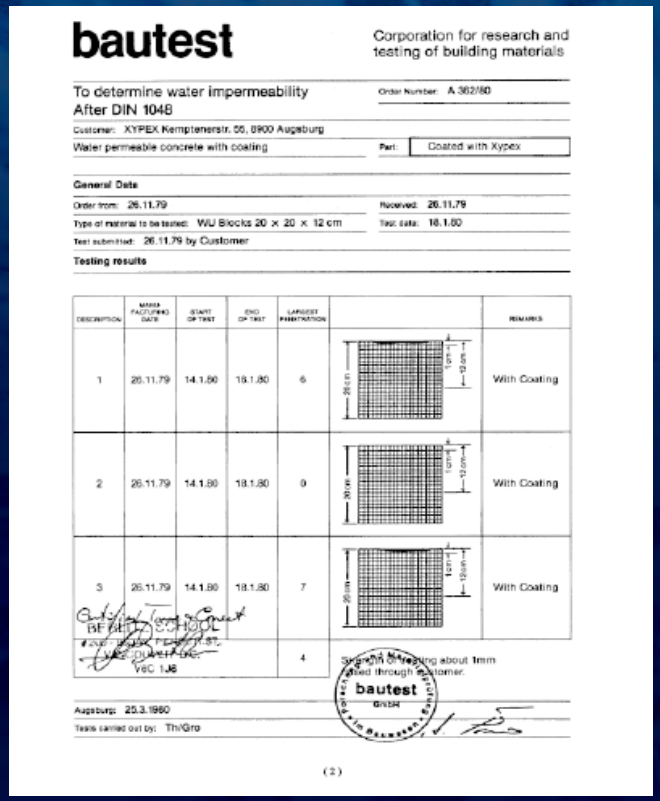
Sample Reference		Control Concrete						Xypex-treated Concrete					
Date of Cast		22/01/97						14/01/97					
Date of Coring		30/01/97			20/02/97			22/01/97			2/12/97		
Age of Curing (days)		8			29			8			29		
Specimen Size (mm)		150 x 50						150 x 50					
Specimen Reference		1	2	3	1	2	3	1	2	3	1	2	3
Volume of water moving through the sample (mL):													
At 1 bar on	1st day	0	0	0	0	0	0	0	0	0	0	0	0
At 2.4 bar on	2nd day	0	0	0	0	0	0	0	0	0	0	0	0
At 4.2 bar on	3rd day	0	0	0	0	0	0	0	0	0	0	0	0
At 7.0 bar on	4th day	0	0	0	0	0	0	0	0	0	0	0	0
	5th day	10	0	4	10	0	0	0	0	0	0	0	0
	6th day	30	20	25	74	13	0	0	0	0	0	0	0
	7th day	65	20	60	78	20	0	0	0	0	0	0	0
	8th day	70	30	60	45	10	0	0	0	0	0	0	0
	9th day	70	30	60	35	10	0	0	0	0	0	0	0
	10th day	70	30	60	46	10	0	0	0	0	0	0	0

XYPEX

Permeability

DIN 1048, Bautest, Germany,

Treated



bautest

Corporation for research and testing of building materials

To determine water impermeability
After DIN 1048

Order Number: A 362/80

Customer: XYPEX Kemptenerstr. 55, 8900 Augsburg

Water permeable concrete with coating — Part: Coated with Xypex

General Data

Order from: 26.11.79 — Received: 26.11.79

Type of material to be tested: WU Blocks 20 × 20 × 12 cm — Test date: 18.1.80

Test submitted: 26.11.79 by Customer

Testing results

DESCRIPTION	MANUFACTURING DATE	START OF TEST	END OF TEST	LARGEST PENETRATION	REMARKS
1	26.11.79	14.1.80	18.1.80	6	With Coating
2	26.11.79	14.1.80	18.1.80	9	With Coating
3	26.11.79	14.1.80	18.1.80	7	With Coating
				4	

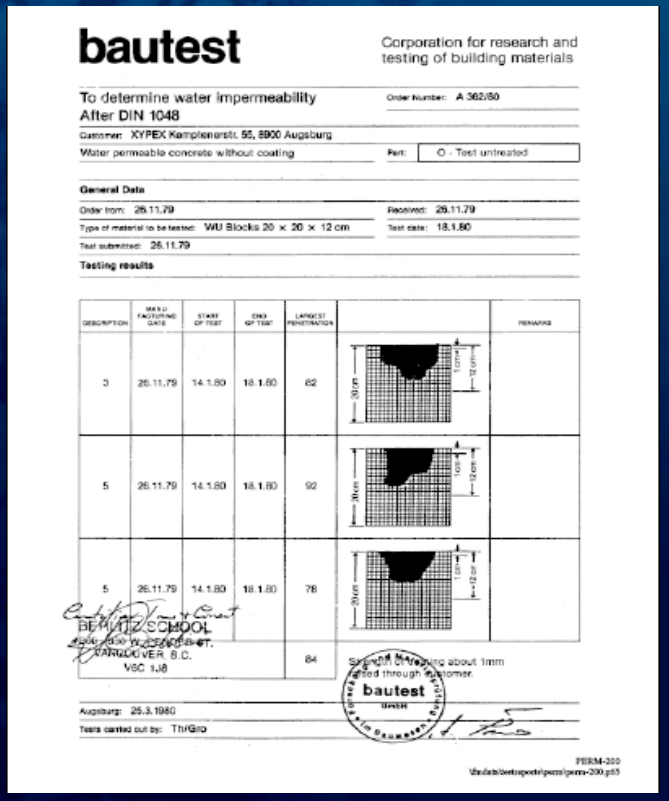
Augsburg: 25.3.1980

Tests carried out by: Th/Gro

bautest GmbH

(2)

Untreated



bautest

Corporation for research and testing of building materials

To determine water impermeability
After DIN 1048

Order Number: A 362/80

Customer: XYPEX Kemptenerstr. 55, 8900 Augsburg

Water permeable concrete without coating — Part: O - Test untreated

General Data

Order from: 26.11.79 — Received: 26.11.79

Type of material to be tested: WU Blocks 20 × 20 × 12 cm — Test date: 18.1.80

Test submitted: 26.11.79

Testing results

DESCRIPTION	MANUFACTURING DATE	START OF TEST	END OF TEST	LARGEST PENETRATION	REMARKS
3	26.11.79	14.1.80	18.1.80	82	
5	26.11.79	14.1.80	18.1.80	92	
5	26.11.79	14.1.80	18.1.80	78	
				84	

Augsburg: 25.3.1980

Tests carried out by: Th/Gro

bautest GmbH

PERM-200

Untreated control sample had average 84 mm of water penetration. Xypex treated control sample had average 6 mm of water penetration. Hydrostatic pressure equivalent to 224 ft of hydraulic head .

Chemical Resistance

Sulfuric Acid Exposure

Chemical Durability, Iwate University, Tokyo, Japan

The typical means of evaluating the ability of the Xypex treatment to provide chemical resistance include: measuring amount of mass loss, length change or relative dynamic modulus of elasticity.

Before Soaking

UNTREATED | XYPEX

5 Weeks

UNTREATED | XYPEX

10 Weeks

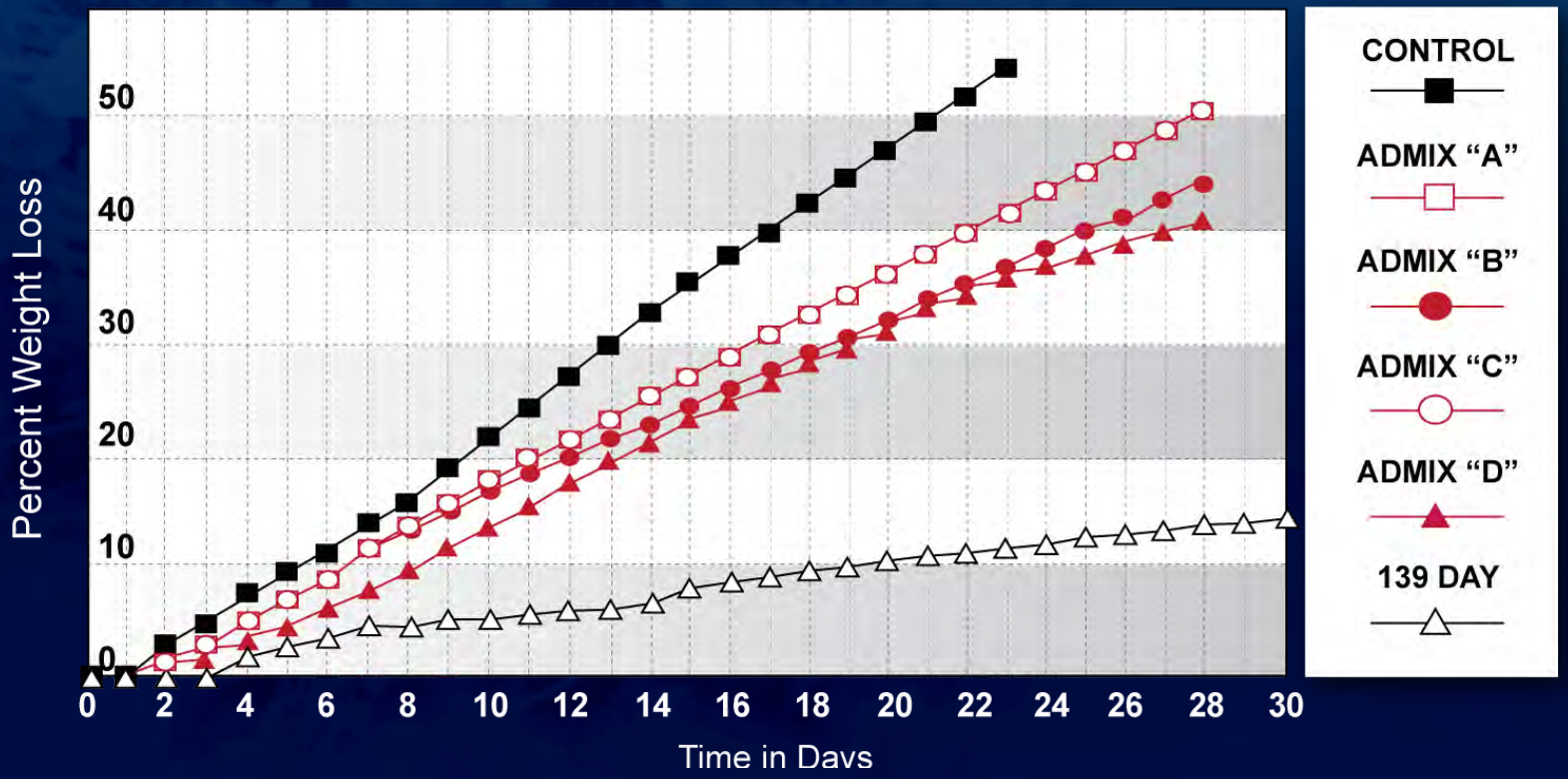
UNTREATED | XYPEX

Chemical Resistance

Sulfuric Acid Exposure

Aviles Engineering, Texas, USA

- 40 day cure acid comparison test in 7% $H_2(SO_4)$
- Control, 3%, 5% and 7% Admix (Regular Grade)
- Curing periods were varied to determine effects



Chemical Resistance

Ammonium Sulfate Exposure

Taywood Engineering, Sydney, Australia

- 1 molar - 132 g/l
- Six mixes: control, low slag cement, silica fume, high slag cement, silica fume cement, Xypex Admix

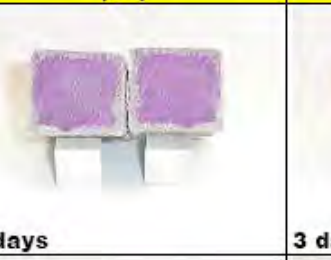
	MIX DESIGNATION					
Component	**GB80**	**GP**	**LH**	**SR**	**SF**	**ADMIX**
Total Percentage Weight Loss	14.60	12.00	28.40	7.20	8.80	**8.80**
Loss Percentage Length Change	0.01	–	0.12	0.00	-0.01	**-0.02**

Note 1: Total Percentage Weight Loss is given for 25 weeks exposure.
Note 2: Percentage Length Change is given as the change compared to the GP mix, at 25 weeks.

Carbonation

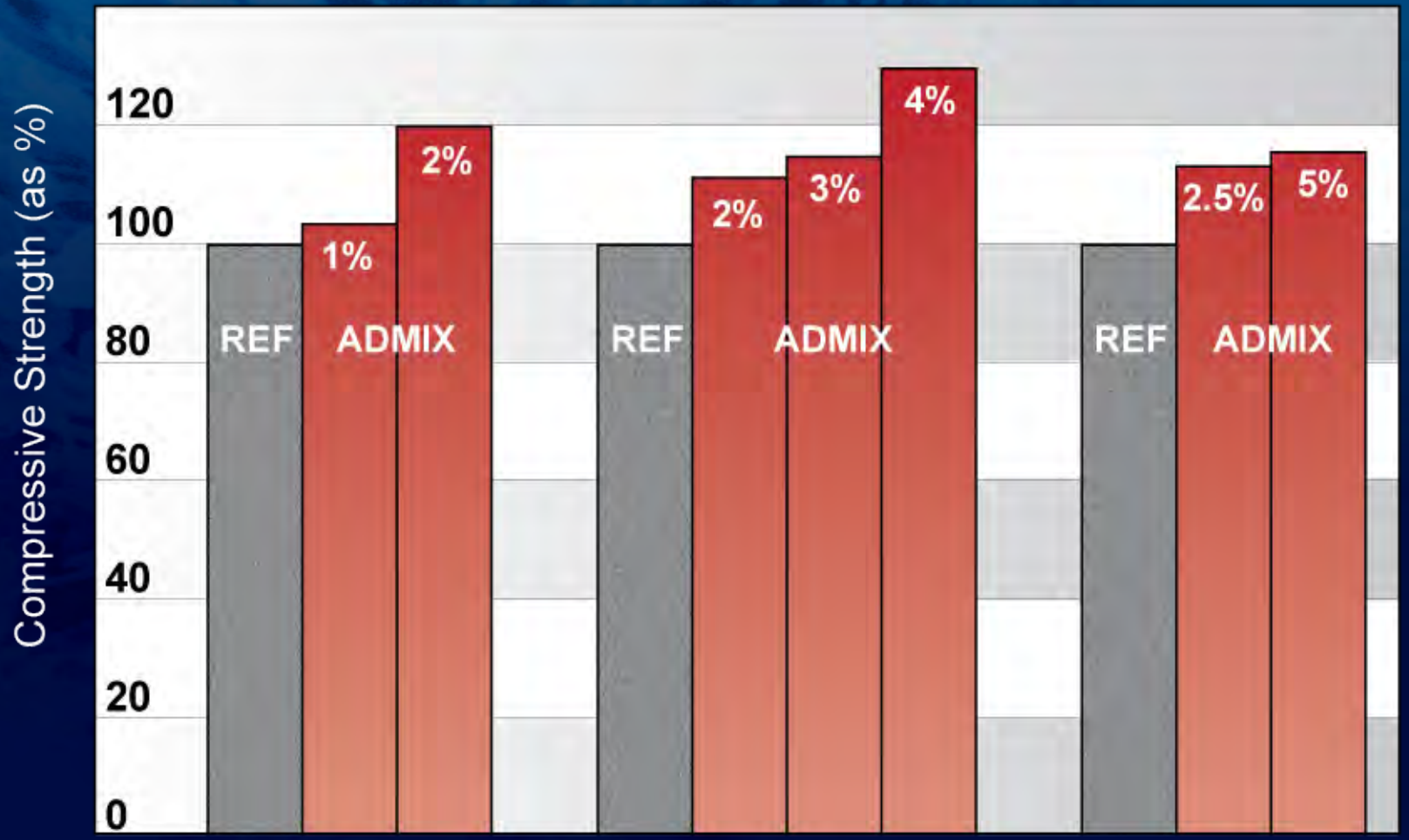
Resistance to carbonation

Slovenska Akademia Vied, Institute of Construction and Architecture (Bratislava 2002)

Plain Mortar (51)	Mortar with 1 Coat (52)	Mortar with 2 Coats (53)
 3 days	 3 days	 3 days
 7 days	 7 days	 7 days
 14 days	 14 days	 14 days

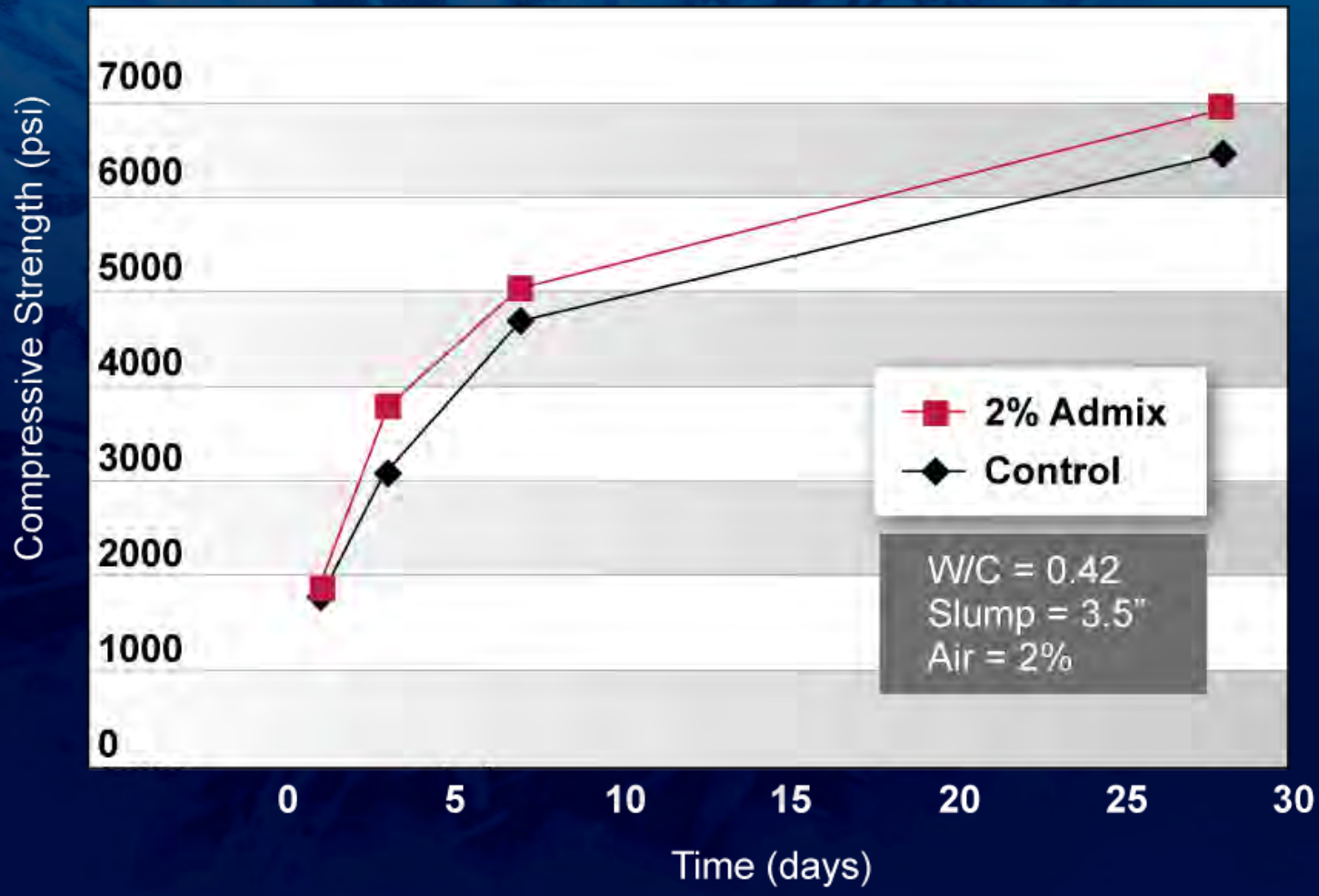
Compressive Strength

HBT AGRA, Vancouver, British Columbia, Canada



Compressive Strength

Kleinfelder Laboratories, San Francisco, California, USA



Crack Sealing Test

The Construction Bureau of Chubu District, Japanese Ministry of Construction (Sept 1996)

Photo 1: Evidence of cracking in concrete on underside of the deck slab

Crack Sealing Test

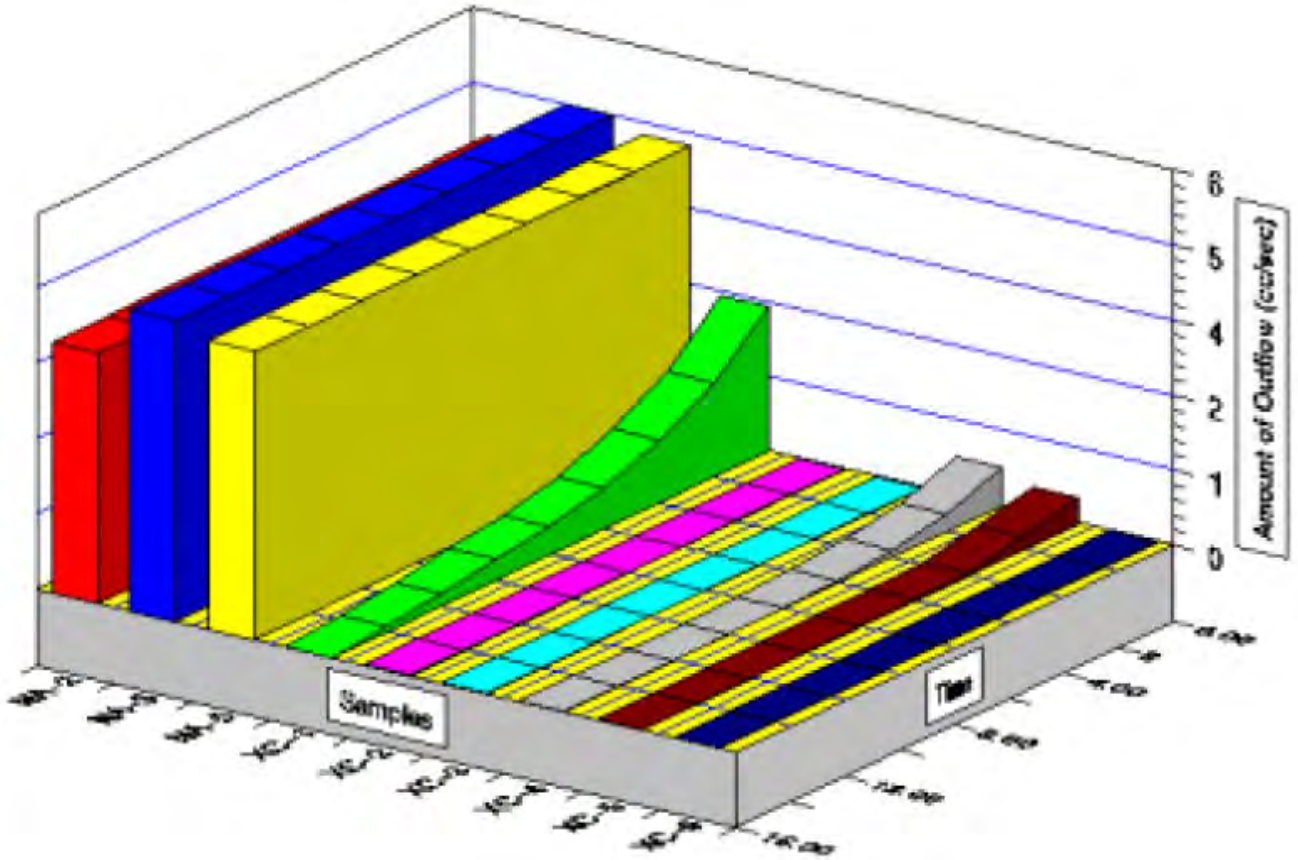
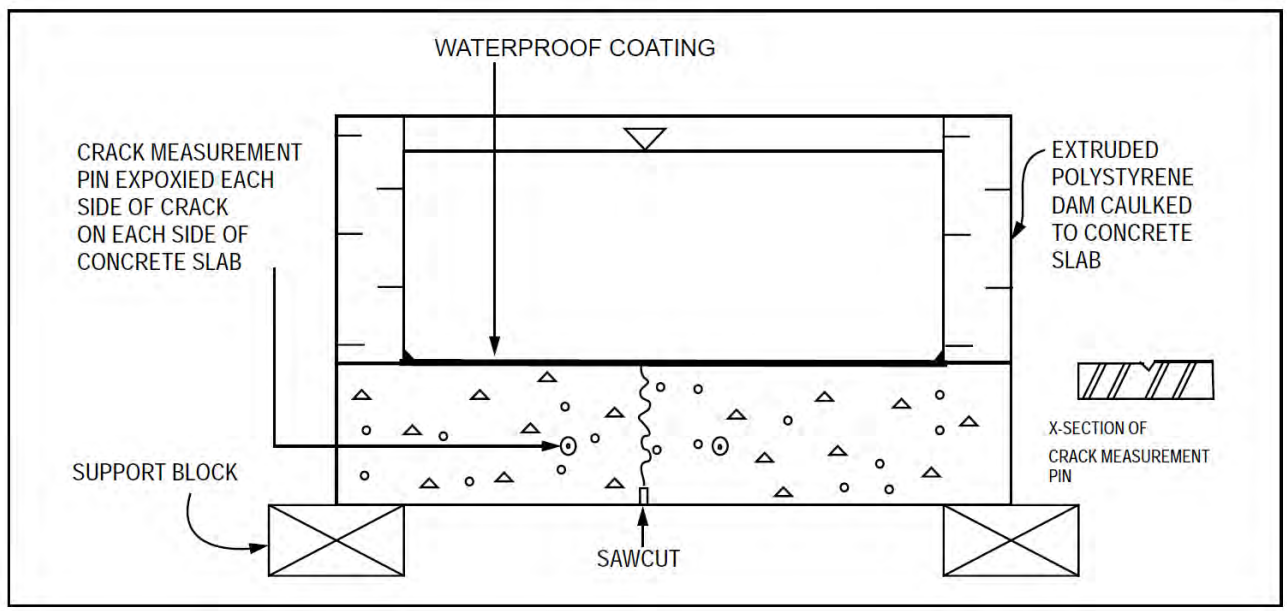


Figure 3: Change in Amount of Outflow with Time

Crack Sealing Test

Results of Cracked Slab Test



Sample Series	Materials	Crack Width (mm)	Initial Flow Rate (mm/min)	Time to Stop Leak (days)
Series 1	Xypex	0.2	0.25	35
Series 2	Xypex	1.0	3.50	70

Coating

Crystalline waterproofing chemicals can penetrate to a depth of 30 cm or 12” in a year.

Summary of Xypex

- **Waterproofs and protects concrete**
  against chemical attack.
- **Heals cracks up to 0.4mm**
  and reactivates any time with moisture when micro crack occurs.
- **Permanent, integral solution**
  as a new systems and as a rehabilitation system.
- **Advantages of barrier systems,**
  with none of the disadvantages.
- **Proven worldwide**
  through thousands of projects successfully completed and independent testing.

Summary of Xypex

- **Extends service life**
  amortizing investments over a longer period.
- **Reduces maintenance costs**
  allowing for significant savings.
- **Makes concrete more environmentally friendly**
  amortizing it's damage over a longer period.
- **Adds value to owners, engineers and contractors**
  all around the globe.

Xypex Testing

Xypex products have been extensively and successfully tested by leading, independent scientific laboratories throughout the world for durability permeability and chemical resistance, including JAERI.

AVLES ENGINEERING CORP.

BBA BRITISH BOARD OF AGREMENT TECHNICAL APPROVALS FOR CONSTRUCTION

PACIFIC TESTING LABORATORIES STATE OF WASHINGTON REGISTERED PROFESSIONAL ENGINEER

bautest

KLEINFELDER

MAHAFFEY ASSOCIATES

KAUNO TECHNOLOGIJOS UNIVERSITETAS

CSIRO

SETSCO

TSUS

UNSW THE UNIVERSITY OF NEW SOUTH WALES

XYPEX Main Products

XYPEX®

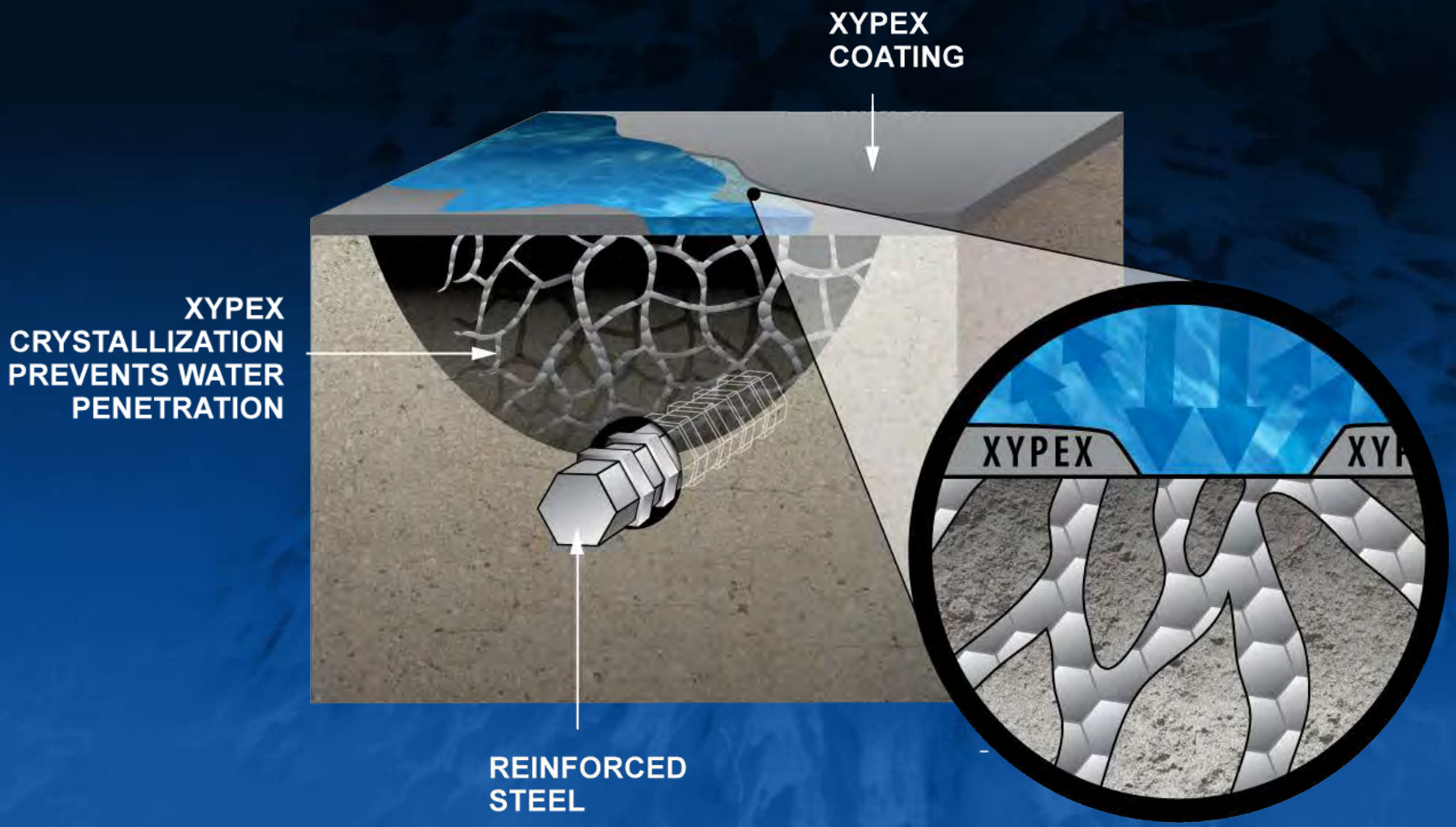
Coating

- Concentrate
- Modified

Spray Applied

Brush Applied

Coating


XYPEX
COATING
XYPEX
CRYSTALLIZATION
PREVENTS WATER
PENETRATION
REINFORCED
STEEL
XYPEX

Coating

- Does not require costly surface priming and leveling
- Does not require a dry surface
- Sealing, lapping or finishing is not needed
- Can be applied to both positive and negative side
- No protection required during back-filling
- Can be applied in confined spaces – no VOCs
- Crystalline waterproofing penetrates deeply into the concrete substrate and becomes an integral part of the concrete.
- Does not depend on surface adhesion like barrier systems
  and does not have seams that come apart.
- Permanent, one-time only treatment

Admixture

Dry batch
Central Mix

Pre-cast

- Admix C-500
- Admix C-1000
- Admix C-2000

Also available in NF (no fines) and non-soluble bags.

Admixture

Ready-mix Concrete

Precast Concrete

Shotcrete

Admixture

Admix Type	For Normal Waterproofing and Durability	For Extra Chemical Protection or Special Applications
C-500 C-1000 C-2000*	2%	3%
C-500 NF C-1000 NF C-2000 NF*	1%	1.5%

Based on % of cement or cement + pozzolan/slag depending on mix design

Admixture

May be used in conjunction with other admixtures

- Set retarders
- Water reducer
- Superplasticizers
- Air-entrainers

Trial Batching is always recommended

Admixture

- Added at time of batching.
- Minimizes installation costs
- Takes a trade off the job site
- Shortens construction schedule

Patching & Repair

Patch ‘n Plug

- Fast setting
- For crack repair and mortar joints with flowing water

Other Patching & Repair

- FCM 80 (Flexible Cementitious Membrane)
- Megamix I and II
- Xycrylic Admix
- Gamma Cure

Are there any questions?

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