Linabond
EURASIA LIMITED
CONCRETE PROTECTION AND STRUCTURAL REHABILITATION

Concrete protection and structural rehabilitation

Linabond®Structural Polymer Systems™

Linabond Eurasia Limited

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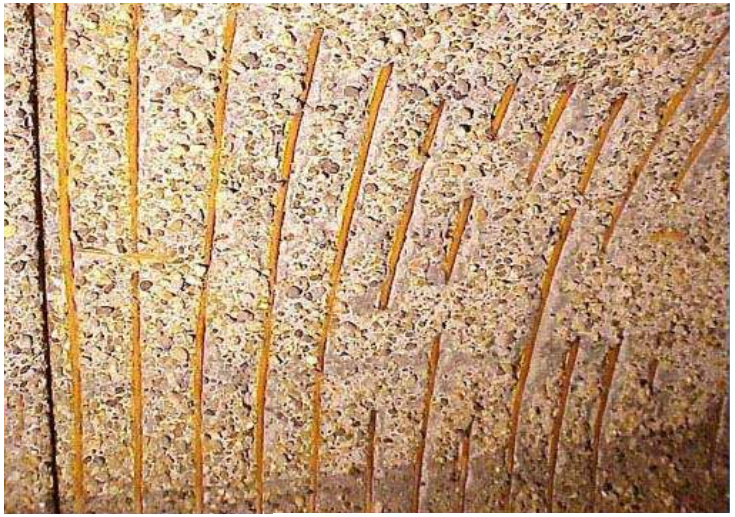
Concrete structures used in wastewater systems
Corrosion problems

Hydrogen sulfide and corrosion

- Bacteria living in wastewater produce hydrogen sulfide.
- Bacteria colonizing the concrete surface (Thiobacillus), in the presence of hydrogen and water transform hydrogen sulfide into sulfuric acid.
- Under the influence of sulfuric acid the concrete transforms into plaster and looses its structural strength.

Main tasks of concrete structures protection and repair

- Protection of structures against aggressive environmental factors.
- Rehabilitation of damaged structures, strength enhancement.
- Strength enhancement
- Securing gas- and waterproofing.
- Adding required parameters to the concrete structures (exterior view, individual features of the surface)



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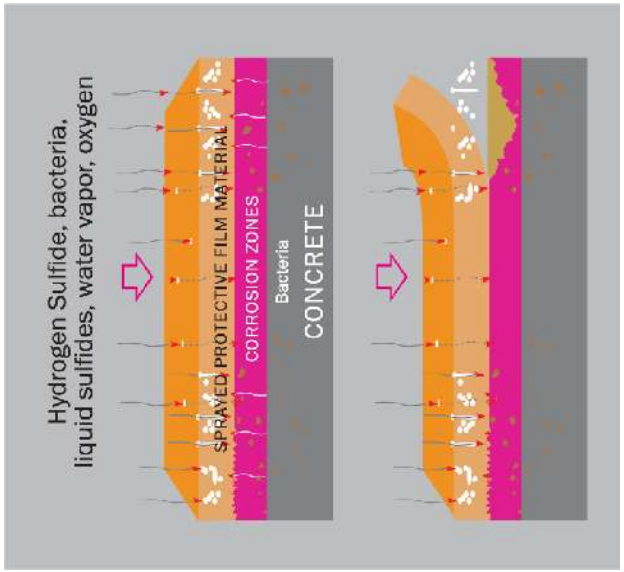
Technologies of concrete protection against corrosion

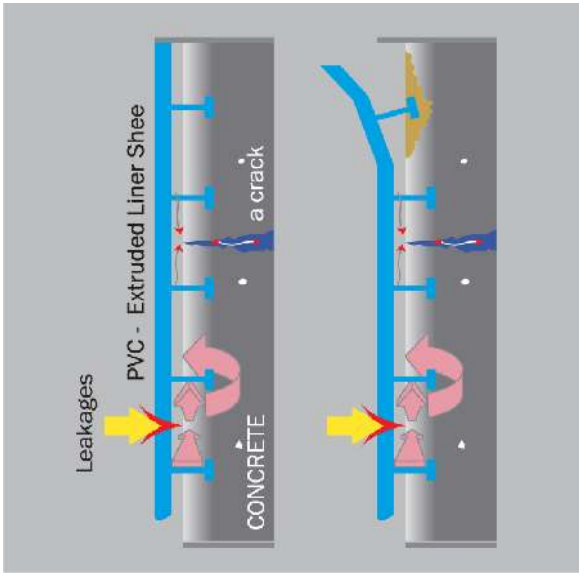
Application of protective **film-forming polymer coatings** of various thickness to the concrete surfaces (special types of the concrete with addings, primers and coatings: epoxy, polyether and polyurethane)



Drawbacks:

- Coatings are relatively thin and porous, they are permeable for gases and vapors (in particular, for hydrogen sulfide, hydrogen and water vapors).
- Bacteria colonizing the concrete under the coating have a free access to it through pores.
- As a result, the bacteria develop under the coating (corrosion) and the coating breaks away from the surface.
- Destruction of the structure keeps on.

Polymer sheet lining materials fastened to the concrete surface by anchors or other special constructive elements



Drawbacks:

- Due to the space between the lining sheets and the protected surface, water and hydrogen sulfide will always be present under the liner.
- As a result, the under-liner space will be subject to corrosion.
- The binding of liner to the surface gets loose, and as a result the liner separates fro the substrate.
- Destruction of the structure keeps on.

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Destruction of concrete under protective liners

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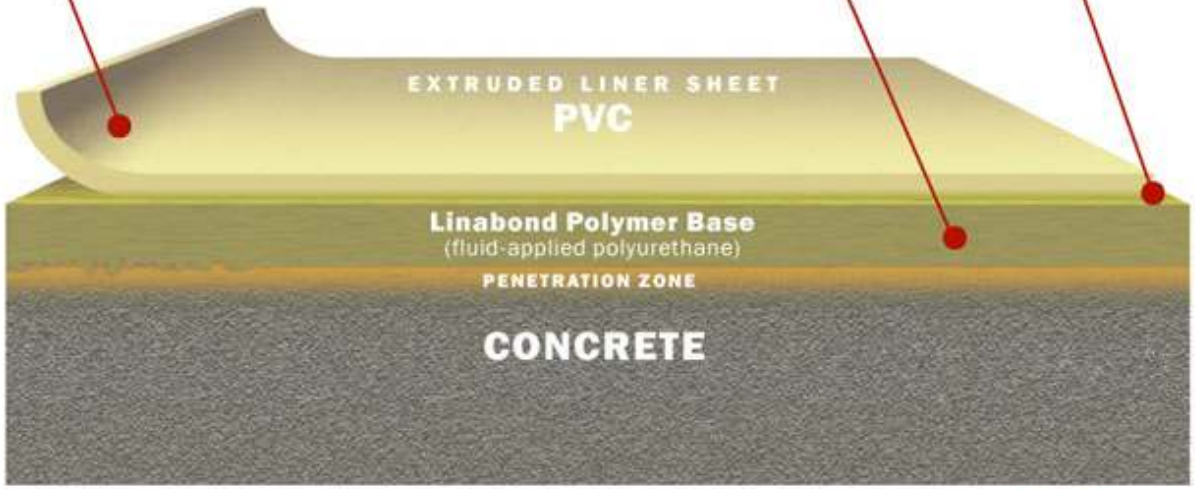
Basic principles of Linabond® Co-Lining™ technology

The PVC provides a pinhole-free extruded membrane which has proven itself over the last 50 years in the protection of wastewater structures. It has a good range of chemical resistance for wastewater environments and has excellent resistance to permeation by most fluids and gasses.

Linabond Polymers provide both an extremely effective anchoring method, and very substantial backup protection for the PVC. The Polymer is resistant to a different chemical range than the PVC. The System penetrates the concrete prior to polymerization, forming a saturated "zone" of high strength polymer composite material – part concrete and part polymer. Since the material is applied over 100% of the surface, lateral migration of fluids and gasses is eliminated, assuring complete protection and containment.

The Crosslink Activator creates a molecular bond between the PVC and the Linabond Polymer, providing an extremely effective fastening mechanism.



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Linabond® Co-Lining™ technology

Composite polymer based systems Linabond® Co-Lining Systems ™ mean:

- Protection against corrosion.
- Impermeability (gas-tight and water-proof)
- Rehabilitation of damaged structure; increase of structural strength.
- Prevention of leaks and infiltration.
- Applicable both for new (protection) and damaged (repair) structures.
- For concrete, brick and metal pipelines of large (more than 1 m) diameter, for tanks, water supply and sewage systems of all geometric shapes as well as for other constructions.

Advantages:

- Polymer liner linked to a polymer sheet makes a true composite.
- Composite lining is continuously bonded to the concrete surface forming a single monolith with the substrate.
- Extruded polymer sheet is not porous which prevents gas and liquid migration.
- The liner secures the strength of its bonding system not less efficiently than it protects the surface.

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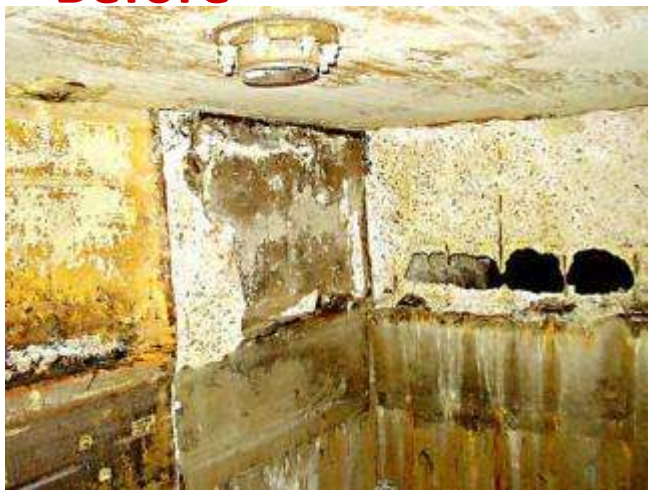
Linabond® Co-Lining Systems™

Linabond SP Mastic Systems™

are protective PVC Co-Lining Systems for new construction or rehabilitation of wastewater structures. The SP Mastic Systems can be installed on prepared new surfaces, aged surfaces or properly rebuilt surfaces where an air or hand placed repair mortar is used. The Linabond SP Mastic base polymer materials are trowel or spray applied to a prepared surface with typical thickness specifications ranging from 2,5 mm.

Before



After

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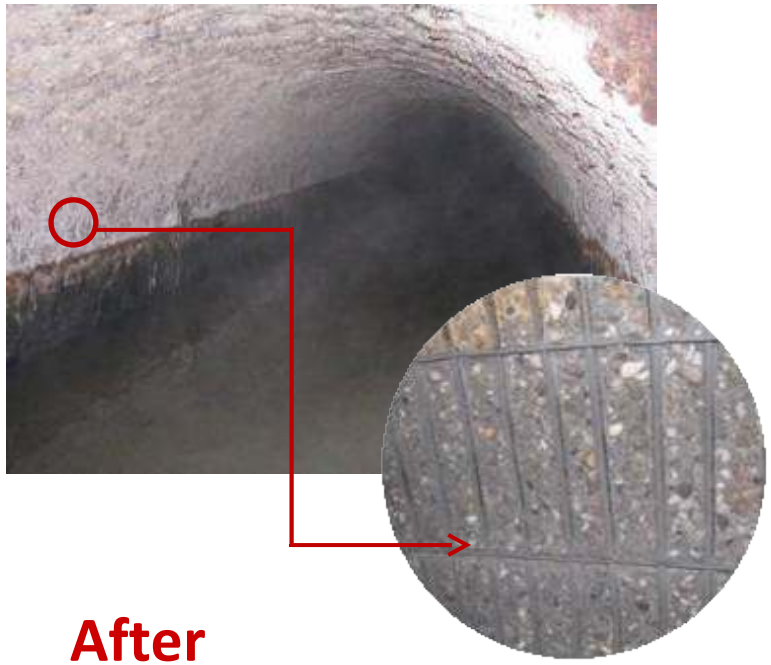
Linabond® Co-Lining Systems™

Linabond SP Pipeline Spray System™

is for pipeline rehabilitation and other areas needing fast structural repair, corrosion protection and gas/liquid containment. A major benefit of this system is the cure time; pipelines can be repaired and back in full service in hours. Typical repair thickness ranges from 6 mm to 15 cm or more. Special Spray equipment is necessary for this System.

Before



After

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Linabond® Co-Lining Systems™

Linabond Simulform System™

Interlocking rigid PVC gas barrier/form sheets are installed with a small annular space between them and the prepared surface of the original structure. The rigid PVC acts as the form for the thermosetting polymer. A pour-applied exothermic mix-at-point Linabond Structural Polymer is injected into the space, simultaneously penetrating the sub-strate and cross-linking with the PVC liner to form a Co-Liner. The in-jected polymer thickness ranges from an average of 1 to 20 cm and more.

Before

After

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Chemical resistance test data

LINABOND SP MASTIC

Percent Weight Change					
Chemical bath	*days immersed*				
	28	56	84	112	Requirements
Sulfuric Acid 20%	0,18%	-0,34%	0,32%	0,21%	(+/-) 1,5%
Sodium Hypochlorite 1%	-0,05%	-0,09%	-0,09%	-0,06%	(+/-) 1,5%
Sodium Hydroxide 5%	-0,07%	0,17%	0,20%	0,09%	(+/-) 1,5%
Ferric Chloride 1%	-0,14%	-0,01%	-0,08%	0,01%	(+/-) 1,5%
Soap 0,1%	-0,11%	-0,25%	-0,19%	-0,15%	(+/-) 1,5%
BOD > 700 ppm	-0,04%	-0,02%	-0,03%	-0,04%	(+/-) 1,5%
Nitric Acid 1%	-0,17%	-0,21%	-0,16%	-0,10%	(+/-) 1,5%
AmmoniumHydroxide 5%	0,02%	-0,19%	-0,08%	0,31%	(+/-) 1,5%
Detergent 0,1%	-0,09%	-0,12%	-0,10%	-0,17%	(+/-) 1,5%

LINABOND SEMI-RIGID PVC LINER

Percent Weight Change					
Chemical bath	days immersed				
	28	56	84	112	Requirements
Sulfuric Acid 20%	0,22%	0,20%	0,52%	0,10%	(+/-) 1,5%
Sodium Hypochlorite 1%	0,02%	-0,07%	-0,08%	0,03%	(+/-) 1,5%
Sodium Hydroxide 5%	0,05%	0,04%	0,19%	0,08%	(+/-) 1,5%
Ferric Chloride 1%	-0,01%	-0,01%	0,09%	-0,01%	(+/-) 1,5%
Soap 0,1%	-0,03%	-0,02%	0,09%	-0,02%	(+/-) 1,5%
BOD > 700 ppm	-0,03%	-0,02%	0,10%	-0,02%	(+/-) 1,5%
Nitric Acid 1%	-0,02%	-0,01%	0,10%	-0,01%	(+/-) 1,5%
AmmoniumHydroxide 5%	-0,02%	0,04%	0,12%	0,02%	(+/-) 1,5%
Detergent 0,1%	-0,03%	-0,02%	0,10%	-0,02%	(+/-) 1,5%

The tables show the results of chemical resistance tests conducted on LINABOND basic polymers according to Standard Specifications for Public Constructions (Greenbook, Section 210-2; Requirements to Protective Plastic Liners). As you can see, the tested materials withstand a very wide variety of harsh corrosive agents and far exceed the requirements for constant immersion in wastewater based on an expected 50 years design life.

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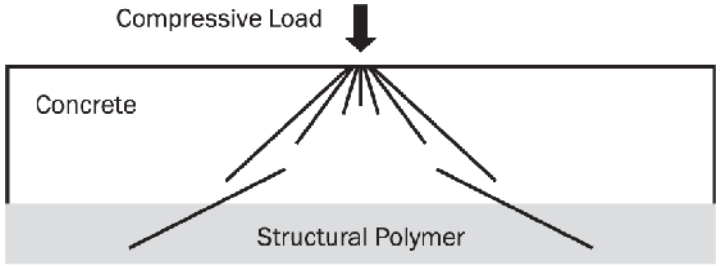
The results of liner testing

D-load test (ASTM D-497)

Sample	Load before cracks, t	Ultimate loading, t
Control Sample: Concrete pipe of 0,9 m diameter	10,0	11,8
Concrete pipe of 0,9 m diameter with 360º Co-lining	15,9	27,2 (complete failure 31,8)
Control sample Corroded concrete pipe of 0,6 m diameter	8,2	9,8
Control sample Corroded concrete pipe of 0,6 m diameter with 270º Co-lining	13,6	17,7
Pipe of the 0,6 m, made only of structural polymer	10,9	14,7

Flexural beam test (ASTM C-78B



Sample	Failure loading:
Control sample: concrete beam 15,2 cm thick	> 2,5 t
concrete beam 12,5 cm thick with a 2,5 cm thick structural polymer layer	> 9,5 t
concrete beam 12,5 cm thick c with a 2,5 cm thick structural polymer layer and two №5 reinforcement steel bars	> 10,9 t

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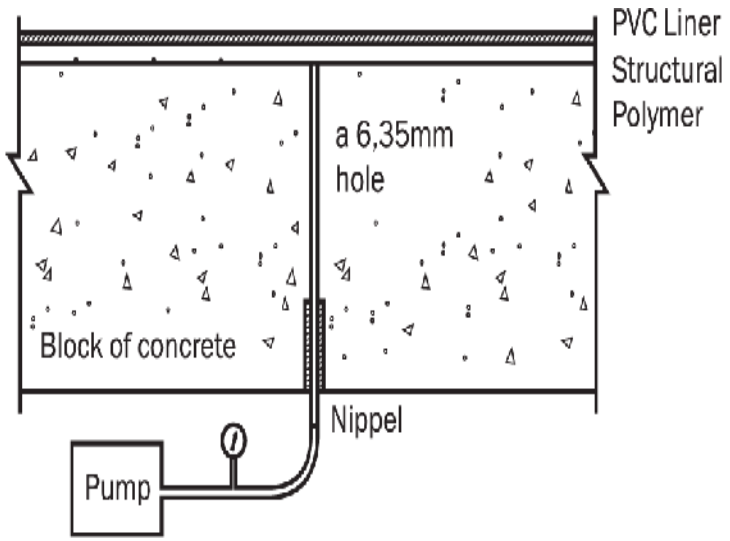
The ability to withstand hydrostatic pressure



Many structures are functioning below the ground water table, therefore this parameter is of considerable importance.
The test scheme is shown in the picture. The test result proves that under the water pressure of 96,5 bars the liner does not separate from the concrete surface, the leaks appear through cracks in the concrete substrate.

Adhesion to the substrate and to the reinforcement bars

As old concrete structure are used, the load transfer is essential. And the load transfer is not possible without strong bond or penetration of one material into the other to form a monolithic structure.

The main illustration of this test is the sight of the extracted elements. One can clearly see that the strength of liner adhesion to the concrete is higher than the structural strength of the concrete itself.

This test is obligatory and should be performed during everyday quality inspection of the lining installed.

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Linabond® application experience

More then 25 years of use.

More then 1 mln sq.m. applications in all regions of the world.

- City of San Diego, South Metro Interceptor Rehabilitation. Degree «Project of the year. Trenchless technologies»
- Singapore (Malaysia) - Changi Water Reclamation Plant
- Oakland (USA) - Wood Street Interceptor “Engineering Achievement of the Year Award” for the San Francisco Bay Section of CWEA and iSTT reward
- Columbus (USA), tunnel collector, BWARI project (13 km, 4,6-3,6 m in diameter)
- Boston (USA), treatment facilities
- Seattle (USA) King County Lake City Tunnel

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