HIGH CHEMICAL RESISTANCE LINER (EPOXY RESIN FORMAPOX 301)

LINING SPECIFICATIONS

FOR UNDERGROUND PROCESS PIPING WITH

No-dig Technologies

100122

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1. GENERAL CONDITIONS

These specifications cover the technical requirements to line underground process piping from 2 to 48 inches (50 mm to 1200 mm) in diameter (man-hole to man hole lining or point repair) with FORMADRAIN®, or other type of underground conduits. For standard sewers refer to ***''TYPICAL SPECIFICATIONS FOR UNDERGROUND SEWER LINING WITH FORMADRAIN® TECHNOLOGY''***

1.1. Uses

Especially formulated for high chemical resistance; strong acids, caustic & hydrocarbons, also for high temperature applications 250^{O} F (120^{O} C).

1.2. Technological description

The developed technology consists of impregnating (wetting) a bidirectional woven fiberglass with **FORMAPOX 301** epoxy resin. The Liner is rolled on a pneumatic tube (thermomandrel) corresponding in length with the length to be repaired. The thermomandrel will then be slipped inside the conduit (steel, concrete, cast iron, stainless steel, clay, PVC, etc.) to be repaired using access, at manhole or cleanout.

After the insertion, the thermomandrel is inflated with steam at 10 to 20 psi (70 @ 140 Kpa) to create heat at 220^{0} F to 250^{0} F (105^{0}C to 120^{0}C) so the Liner is compressed against the conduit walls. The impregnation and the curing are completed with a 1.5 to 2 hour steam cure.

Once the liner is cured we air-cool the thermomandrel to ensure demolding from the composite Liner. The thermomandrel is then retrieved to be reused.

2. FORMADRAIN® INSTALLATION

The scope of work described by these specifications.

2.1. Conduits cleaning

The manholes and the conduits will be cleaned to remove roots, debris and other deposits to ensure a perfect moulding between the FORMADRAIN® liner and the host pipe.

2.2. Inspection

The section to be lined will be CCTV inspected before and after the FORMADRAIN® installation.

In main pipes lining, lateral connections will be identified (with CCTV) from a reference point and recorded to minimize the possibility for error when reinstating them.

2.3. Lateral connections reinstatement

All active lateral connections will be reinstated from the lateral by a Lateral cutting blade mounted on a Rooter or by a conventional cutter. Both are operated with a CCTV camera.

2.4. Scope of work

2.4.1. Cleaning and CCTV inspection.
2.4.2. Bypass pumping where required.
2.4.3. The composite (fiberglass and resins) will be prepared in a shop or in the field under a strict quality control.
2.4.4. The wetted composite material is transported to the jobsite (if prepared in a remote location) and slipped into the conduit to be lined.
2.4.5. Steam cure for a duration of 1.5 up to 2 hours.
2.4.6. Cooling and retrieval of the thermomandrel to be reused for other insertions.
2.4.7. Opening of the lateral connections.
2.4.8. CCTV inspection and video, after installation.

3. FORMADRAIN® MATERIALS

- Balanced bidirectionnally woven fiberglass.
- Two component epoxy resin (FORMAPOX 301) as binding matrix.
- Polyethylene film

3.1. General physical properties of the fibreglass (E-glass)

Tension load	3.4 x 10^3 Mpa	(493 000 psi)
Tension modulus	72 x 10^3 Mpa	(10 442 000 psi)
Thermal expansion coefficient	2,8 x 10^{-6} po/po/^oC	
Break elongation	4,8%	
Elastic recovery	100%	

3.2. General physical properties of the resin

Tension load	ASTM D638	60 Mpa	(8 700 psi)
Tension modulus	ASTM D638	3,3 x 10^3 Mpa	(478 600 psi)
Flexion load	ASTM D790	100 Mpa	(14 500 psi)
Flexion modulus	ASTM D790	2,1 x 10^3 Mpa	(304 500 psi)
Barcol Hardness	ASTM 2583-81	50	

3.3. FORMADRAIN® composite material [1]

Tensile load	ASTM D638 [2]	160 MPa	(23 200 psi)
Tensile modulus	ASTM D638	8.0 GPa	(1 160 000 psi)
Compression load	ASTM	ref. [3]	
Compression modulus	ASTM	ref	
Flexural load	ASTM D790	160 MPa	(23 200 psi)
Flexural Modulus (E_S)	ASTM D790	10.672 GPa	(1 547 840 psi)
Long-term Flex Mod (E_L)[4]	ASTM D2990	5.580 GPa	(809 300 psi)
Hardness (shore D)	> 80		

[1] The typical values can be modified to meet specific requirements of the customer. Use of different fiberglass or carbon and resins permits adjustment to reinforce a part or the entire assembly.
[2] To appreciate the full integrate of the composite material this standard should be replaced by ASTM D3039 applied in the aeronautical industry for all and every oriented composite.
[3] For a bi-directional composite it is generally accepted to use the tension constraint and modulus to evaluate the compression constraint and modulus. To confirm the material strength we will use ASTM D635 data.
[4] For a 50-year design life.

3.4. Chemical resistance

FORMAPOX 301 is resistant to strong acids such as sulphuric acids, nitric acids and also resistant to hydrocarbons and caustics. The fiberglass tissue is not affected at all by a great majority of chemicals, bacteria, fungus or insects (ref.: SPE Society of Plastics Engineers, Mr. George Lupin, chief scientist Grumman Aerospace Corporation).

FORMAPOX 301 CHEMICAL RESISTANCE

(HIGH CHEMICAL RESISTANCE LINER)

CHEMICAL SOLUTION	IMMERSION (Months)	Flexural Modulus (MPa)	Comments
Sulfuric Acid 50%	12	4 848	Very good
Phosphoric Acid 20%	12	4 733	Very good
Citric Acid 20%	12	6 837	Excellent
Sodium Hydroxyde 50%	12	4 386	Very good
Kerosene 100%	12	6 385	Excellent
Diesel 100%	12	5 543	Very good
Xylene 99%	12	4 516	Very good
Acetone 100%	12	5 979	Very good

FORMAPOX 301 was designed for industrial applications where strong acids, caustics, hydrocarbons (refineries), and several other type of chemical can be used. FORMAPOX 301 is a high chemical resistance epoxy resin, its tight cross-linked cured system assure a high performance chemical resistance at elevated temperatures.

3.5. Resin mix

The two components epoxy resin mix is controlled by a 4:1 weight ratio (1 part ‘’B’’ hardener for 4 parts ‘’A’’ of resin). The homogenate mix will be applied on multiple layers of the bi-directional fibreglass.

3.6. Fibreglass stratification

The bi-directional fiberglass layers are overlapped when wetting.

4. WALL THICKNESS DESIGN

For man-hole to man-hole lining, lateral lining or point (spot) repair, engineering calculations are made accordingly to ASTM F1216 Appendix X1. For a point (spot) repair it is important that the repair starts and ends in a good structural sound pipe; point (spot) repair must cover the broken portion of the pipe (cracks or else) plus a minimum of 1 foot (300 mm) at each ends in a good structural sound pipe.

The thickness of FORMADRAIN® Liner will be established considering data supplied for the conduit to be lined. FORMADRAIN® is made of a 90º oriented bidirectional woven fibreglass impregnated (wetted) with epoxy resin, FORMADRAIN®'s liner mechanical capacity is increased by adding layers (thickness).

It is important to note that FORMADRAIN® Liner is one of the few technologies that meets the criteria for a structural liner ***where*** and if it is required by adding fibreglass layers where it is required. It allows maximum engineering design and keeps costs at a minimum by not over sizing the whole liner length for a punctual requirement.

Among the studied constraints we can quote:

- Structural pipe condition
- Depth of the conduit to be lined
- Pipe diameter
- Dead load
- Live load
- Soil condition
- Conduit ovalization

5. HYDRAULIC CAPACITY OF THE LINED CONDUIT

Because of the interior hardness and smoothness of FORMADRAIN® Liner, we figure we maintain a minimum flow resistance factor of at least 0,009 in the Manning equation. Considering the minimal thickness of FORMADRAIN®, the flow capacity is practically not affected and can even be increased.