

UNDERGROUND SEWER LINING (EPOXY RESIN DURAPOX 501)

LINING SPECIFICATIONS

UNDERGROUND SEWER LINING WITH



No-dig Technologies



DWV/Sewer

010126

FORMADRAIN® Inc.

10121 Parkway
Montreal, QC, H1J 1P7
Toll free: 1-888-337-6764

1. GENERAL CONDITIONS

These specifications cover the technical requirements to line a sewer main (man-hole to man hole lining or point repair), service lateral, stack or other type of underground or above ground conduits with FORMADRAIN® Liner.

1.1. Technological description

The developed technology consists of impregnating (wetting) a bidirectional woven fiberglass tissue with VOC free (No Styrene) **DURAPOX 501 green-colored** epoxy resin. A specificity of Durapox 501 resin is its extended open time of 60 days. The impregnated fabric 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 (concrete, clay, brick, PVC, etc.) to be repaired using access, at manhole or cleanout.

After the insertion, the thermomandrel is inflated with steam at 5 to 23 psi (40 @ 161 Kpa) to create heat at 228° F to 265° F (109°C to 130°C) so the fabric is compressed against the conduit walls. The impregnation and the curing are completed within an hour and half to two hours with the heat effect. In reference to "**FORMADRAIN INSTALLATION PROCEDURE MANUAL**" latest edition.

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

1.2. Product applicability

Pipe repair range: 2" (50 mm) up to 48" (1200 mm) in diameter.

Maximum bends: 45° for standard fiberglass, 90° for fiberglass tube¹.

Laterals, drains, stacks, Spot (point or short) repairs, man hole to manhole, offset joints and any 1 diameter pipe transition (without any wrinkle), etc...

Resin cannot be used in actively infiltrating pipes or in presence of large dips.

¹ Used with an elbow or a single-use mandrel and elbow Fiberglass.

1.3. FORMADRAIN Certifications

Durapox 501 liner is NSF (National Sanitation Foundation) 14 certified.

2. FORMADRAIN® INSTALLATION

The scope of work is described in 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 sewer lining, laterals will be identified (with CCTV) from a reference point and recorded to minimize the possibility for error when reinstating them.

If the inspection reveals major defects (unalienable) the owner (city or consultant) will be notified before remedial actions are undertaken.

2.3. Laterals reinstatement

All active laterals will be reinstated with a robot cutter 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. Material selection and FORMADRAIN® installation.
- 2.4.4. The composite (fiberglass, resins and poly) will be prepared in a shop or in the field under a strict quality control.
- 2.4.5. The wetted composite material is transported to the jobsite (if prepared in a remote location) and slipped into the conduit to be lined.
- 2.4.6. Curing with steam for a predetermined time based on diameter and length (between 1 and 2 hours). A **steam cure** is required to assure a high quality Liner, according to FORMADRAIN® Installation Procedure Manual (latest Edition).
- 2.4.7. Cooling and retrieval of the thermomandrel to be reused for other insertions.
- 2.4.8. Opening of the lateral connections.
- 2.4.9. CCTV inspection and video, after installation.

3. FORMADRAIN® MATERIALS

Only high quality and high mechanical properties materials are used in FORMADRAIN Durapox 501 Liner to guarantee longevity. These high mechanical properties allow a Liner wall Thickness as low as 0.08" (2.1 mm) in pipes 6" or less which will increase or at least maintain the flow capacity. FORMADRAIN main materials are:

- Balanced bi-directional woven fiberglass.
- **NO VOC** epoxy resin as binding matrix.
- Outside protective Poly layer

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

Tensile load	3.4 x 10 ³ Mpa	(493 000 psi)
Tensile modulus	72 x 10 ³ Mpa	(10 442 000 psi)
Thermal expansion coefficient	2,8 x 10 ⁻⁶ po/po/°C	
Break elongation	4,8%	
Elastic recovery ²	100%	

3.2. General physical properties of the resin

Tensile load	ASTM D638	60 Mpa	(8 700 psi)
Tensile modulus	ASTM D638	3,3 x 10 ³ Mpa	(478 600 psi)
Flexural load	ASTM D790	100 Mpa	(14 500 psi)
Flexural modulus	ASTM D790	2,1 x 10 ³ Mpa	(304 500 psi)
Elongation		4.5% to 12%	
Barcol «hardness	ASTM 2583-81	50	
Thermal expansion	ASTM D696	5.2 x 10 ⁻⁶ po/po/°C	

3.3. FORMADRAIN® composite material ³

Tensile load	ASTM D638 ⁴	160 MPa	(23 200 psi)
Tensile modulus	ASTM D638	8.0 GPa	(1 160 000 psi)
Compression load	ASTM	ref. ⁵	
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) ⁶	ASTM D2990	5.580 GPa	(809 300 psi)
Hardness (shore D)	> 80		

² Because the virgin fiberglass elastic recovery is considered to be 100% resilient, it is assumed that the value of the long term flexural elasticity modulus will be close to the short term flexural elasticity modulus, a value of 50% is actually used for design.

³ 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.

⁴ 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.

⁵ 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.

⁶ For a 50-year design life.

3.4. Chemical resistance

Liner complies with ASTM F 1216 (latest edition) minimum chemical requirements in appendix X2 (Chemical Resistance Tests). Also, FORMADRAIN® DURAPOX 501 Liner is resistant to sewer gas like carbon monoxide, dioxide, hydrogen sulphide etc. The fiberglass tissue is not affected at all by a great majority of chemicals, bacteria's, fungus or insects (ref.: SPE Society of Plastics Engineers, Mr. George Lupin, chief scientist Grumman Aerospace Corporation).

3.5. Resin mix

The two components epoxy resin mix is controlled by weight. The homogenous mix will be applied on the different layers of the bi-directional fiberglass fabric. Samples can be laboratory tested if required.

3.6. Fiberglass stratification

The bi-directional tissue 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. In the situation of 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 at each ends in a good structural sound pipe.

The thickness of FORMADRAIN® Liner will be established considering the data supplied for the conduit to be lined. FORMADRAIN® is made of a 90° oriented bi-directional woven fiberglass tissue impregnated (wetted) with epoxy resin, FORMADRAIN®'s liner mechanical capacity is increased by adding layers (thickness). Effectively, tension and flexion constraints and modulus are directly related to the nature of the fiberglass (type of glass, number of fibres, surface treatment, etc.) and the epoxy resin (tension, flexion, adherence, viscosity, etc.) and the glass/resin ratio obtained after wetting. The material affects a high performance liner with minimal wall thickness.

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

Among the studied variables:

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

5. HYDRAULIC CAPACITY OF THE LINED CONDUIT

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