

SPRAY-APPLIED PIPE LINER

Effective April 15, 2022

Description. This work shall consist of installing spray-applied pipe liners (SAPL) to rehabilitate pipe culverts or storm sewers.

Materials. Materials shall meet the requirements of the following:

(a) Geopolymer Mortar (Notes 1 and 2)

Note 1. The liner material shall be a prepackaged, micro-fiber reinforced, ultra-dense geopolymer mortar composed of a minimum 70 percent pozzolanic material of the following SiO_2 , MgO , Al_2O_3 , Fe_2O_3 and verified by third party certified X-ray Fluorescence (XRF) testing. The maximum size of aggregate shall be such that 100 percent of material (excluding fibers) passes the No. 8 (2.36 mm) sieve.

Prior to approval and use, the manufacturer shall submit a notarized certification of the independent laboratory, together with results of all tests, stating that this material meets the requirements as set forth herein. The certified test report shall state the lot tested, manufacturer's name, product name, and date of manufacture. The geopolymer mortar shall meet the following:

Compressive Strength	ASTMC39 or C109	1 Day 28 Day	2,500 psi 8,000 psi
Flexural Strength	ASTM C78	7 Day 28 Day	1,100 psi 1,300 psi
Tensile Strength	ASTM C496	28 Day	800 psi
Shrinkage RH	ASTM C1090	28 Day	0% at 65%
Modulus of Elasticity	ASTM C469	1 Day 28 Day	3,000,000 psi 5,800,000 psi
Bond Strength	ASTM C882 Type II	1 Day 28 Day	900 psi 2,500 psi
Freeze Thaw Durability	ASTM C666	300 Cycles	Zero Loss
Set Time	ASTM C807	Initial Final	< 75 min < 120 Min
Abrasion Resistance	ASTM C1138	5 Cyl.28 Day	< 3% Loss

Note 2. Additional materials including chemical grouts and hydraulic cements necessary to stop infiltration and create a surface for the geopolymer lining to be applied to may be necessary and shall be according to Article 1001.

Construction Requirements. The SAPL shall be spray-applied onto the existing pipe and shall conform to the interior of the original pipe, creating a continuous structural concrete pipe within a pipe.

The Contractor shall submit the following to the Engineer at least 15 days prior to the start of work, detailing the following:

- (a) References. A list containing at least three projects with diameters exceeding 36 in. completed within the last three years prior to this project's bid date in which the Contractor performing this work has installed SAPL. The list of projects shall contain names and phone numbers of representatives who can verify the Contractor's participation on those projects.
- (b) Experience. Name and experience record of the SAPL supervisor
- (c) SAPL materials. Manufacturer's published literature for the proposed SAPL.
- (d) Installation Procedure. Proposed methods of water diversion, cleaning and preparation of the existing culvert, setup locations for required equipment, testing and inspection methods, and final clean-up operations. Quality control procedures for conformance with applicable water testing and stormwater management requirements.

The Contractor shall submit a design report for each installation, sealed by an Illinois Licensed Structural Engineer, prior to the installation of the SAPL. Prior to completion of the design report, the Contractor shall clean and inspect the existing pipe as described in the work plan. The Contractor shall provide a recording of the inspection to the Engineer. Authorization from the Engineer shall be requested to clear any obstructions not able to be removed by conventional sewer cleaning equipment. The Contractor shall verify dimensions of the existing pipe.

The design report shall include:

- (a) The anticipated coverage and volume of repair mortar.
- (b) The location and characteristics of cavities around the existing structure, and the location and quantity of any additional materials required, such as aggregate or flowable backfill, to fill these cavities.
- (c) The location of any deformities such as jagged edges that may impact the liner installation or its function, and a plan to correct the deformities.
- (d) A log of the existing span and rise per every 5 ft. (2 m) of existing structure length. The thickness of the installed liner will be verified against these dimensions.
- (e) Design calculations and required wall thicknesses of the SAPL. The wall thickness shall be calculated using methodology in industry literature such as the document Testing and Modeling Analysis of Geopolymer Pipe-lining Technology for Sewer & Stormwater Rehabilitation (approved by Water Resources Council). The design loads shall be as per the AASHTO LRFD Bridge Design Specifications. The proposed SAPL is intended to have a 50-year design life. The existing pipe shall be

considered fully deteriorated. The SAPL design shall have a minimum factor of safety of two (2).

(f) The final, in-place, hydraulic opening shape, and dimensions of the SAPL.

See plans for additional design parameters such as existing culvert sizes.

The thickness proposed by the Contractor shall be the Required In-Place Liner Thickness calculated in the design report. Measured sample thickness will not include any portion not considered by the Engineer to be considered a structural component of the system.

No liner shall be installed until the design report has been approved by the Engineer. Liner shall not be installed if rain is in the forecast for the day of installation.

After completion of the design report, but prior to installation of the SAPL, the Contractor shall confirm that the existing pipe is adequately clean and in suitable condition for the installation of the proposed SAPL system.

Pipes shall be drained and flow shall be diverted.

Prior to lining, all drop inlets or taps shall be temporarily plugged to prevent water discharge onto newly placed mortar and to prevent mortar from entering the inlet or tap. Lines with active flow shall be temporarily plugged with a device that sufficiently prevents water from discharging onto the newly placed SAPL.

The interior surface of the existing structure shall be cleaned with a high-pressure water-blast sufficient to remove all laitance and loose material and flush debris from the structure. Upon final inspection, the existing structure shall be free of sand, dirt and all other laitance that may impede the placement or adhesion of the SAPL to the structure.

The Contractor shall have a manufacturer's representative on site during the mixing and start of application of the pipe lining mortar. On-site representation by the manufacturer is not required for the duration of the project. The representative will remain onsite as required by the Engineer.

Unless recommended by the supplier, the SAPL shall be installed by using a high speed, rotating applicator device as recommended by the manufacturer of the mortar. In areas with complex geometry, such as tight bends or pipe junctions, or in heavily damaged areas, the supplier may recommend that hand nozzles be utilized by trained technicians. Mortar mixers, compressors and pumps shall also be of a type recommended by the mortar manufacturer. The mortar shall be mixed and agitated according to the mortar manufacturer's instructions. If recommended by the mortar manufacturer, working time may be extended by mixing the material with cool water or ice-cooled water.

The mortar shall not be applied when ambient or existing structure surface temperatures are 100°F or above or when ambient temperatures are expected to fall below 45°F within 72 hours of placement. Both ambient and existing structure surface temperatures shall be at least 45°F at the time of placement.

A curing compound in accordance with ASTM C 309 shall be used if required. It shall be applied at the time and rate recommended by the mortar manufacturer.

The Contractor shall inspect the SAPL and provide the Engineer with a recording showing and describing the entire length of the completed SAPL. The completed liner shall be smooth and free from honeycomb and areas of segregation. Any damaged SAPL areas shall be repaired or modified at the Contractor's expense.

The Contractor shall measure the new span and rise per every 5 ft of structure length and shall provide these measurements along with the pre- installation measurements to the Engineer. Acceptance will be based on verification that the thickness of the installed SAPL is in accordance with the design report by comparison of the pre-installation and post-installation span and rise measurements along with a visual inspection to verify a leak- free, uniform appearance. A plan of corrective action shall be submitted for approval upon notification from the Engineer of any unacceptable areas of the SAPL.

Quality Control by Contractor. The Contractor shall perform quality control testing as follows.

CONTRACTOR JOBSITE SAMPLING AND TESTING		
Measured Property	Test Frequency	Illinois Modified AASHTO, Illinois Modified ASTM, or Illinois Test Procedure ^{1/}
Compressive Strength ^{2/}	1 per 25,000 pounds applied or minimum 1/day	R 60, R 100, and T 22

- 1/ Refer to the Department's "Manual of Test Procedures for Materials".
- 2/ Strength tests shall be according to Article 1020.09, except compressive strength shall be determined using 4- by 8-in. cylindrical specimens and flexural strength will not be required. Specimens shall be undisturbed for 24 to 28 hours prior to transportation. The tests of record for strength shall be at 7 and 28 days. Strength shall be defined as the average of three 4 x 8 in. cylinder breaks. The strength shall not be less than 2,500 psi at 7 days and 8,000 psi at 28 days. For each set of test specimens the following information shall be recorded Batch Number and Dry Material Bag Number.

Quality Assurance by Engineer. The Engineer will perform quality assurance tests on independent or split samples of compressive strength specimens at a frequency determined by the Engineer to verify control of production.

Documentation. The Contractor shall be responsible for documenting all observations, inspections, adjustments to the mix design, test results, retest results, and corrective actions in a bound hardback field book, bound hardback diary, or appropriate Department form, which shall become the property of the Department. The documentation shall include a method to compare the Engineer's test results with the Contractor's results. The Contractor shall be responsible for the maintenance of all permanent records whether obtained by the Contractor, the consultants, the subcontractors, or the producer of the mixture. The Contractor shall provide the Engineer full access to all documentation throughout the progress of the work. Applicable Department forms may be form BMPR MI504, form BMPR MI654, form BMPR MI655.

Acceptance. Final acceptance will be based on the Standard Specifications and the following:

- (a) The Contractor's compliance with all contract documents for quality control.
- (b) Validation of Contractor quality control test results by comparison with the Engineer's quality assurance test results using split samples. Any quality control or quality assurance test determined to be flawed may be declared invalid only when reviewed and approved by the Engineer. The Engineer will declare a test result invalid only if it is proven that improper sampling or testing occurred. The test result is to be recorded and the reason for declaring the test invalid will be provided by the Engineer.
- (c) Comparison of the Engineer's quality assurance test results with specification limits using samples independently obtained by the Engineer.

The Engineer may suspend mixture production, reject materials, or take other appropriate action if the Contractor does not control the quality of material applied. The decision will be determined according to (a), (b), or (c).

Method of Measurement. This work will be measured for payment in place in feet. When the SAPL enters a manhole, inlet, or catch basin, the measurement will end at the inside wall of the manhole, inlet, or catch basin.

Basis of Payment. This work will be paid for at the contract unit price per foot for SPRAY-APPLIED PIPE LINER, of the diameter specified.

Repair of existing pipes and filling of voids prior to the installation of the SAPL will be paid for according to Article 109.04 of the Standard Specifications.