

Classification and Certification Requirements for Polymeric Spray Applied Pipe Lining for Gravity and Pressure Pipes

By: Kawalpreet Kaur, CUIRE, UTA
Sanaz Ghalambor, Nukote Coating Systems
Mo Najafi, CUIRE, UTA

INTRODUCTION

Many underground infrastructures are aging and reaching or exceeding their original design life. That is why pipe replacement and rehabilitation has become a major focus over the last several years.

The trenchless technology renewal method of polymeric Spray-Applied-Pipe-Lining (SAPL) is one of the most cost-

effective and sustainable methods, with minimum ground disturbance and public inconvenience. Spray Applied Pipe Lining (SAPL), formerly known as Spray-In-Place-Pipe (SIPP) is a trenchless technology pipe renewal method that sprays layers of polymeric liner inside the deteriorated pipe to enhance the structural integrity and extend the design service life. The polymeric SAPL can be applied manually (Figure 1) or with a robotic application

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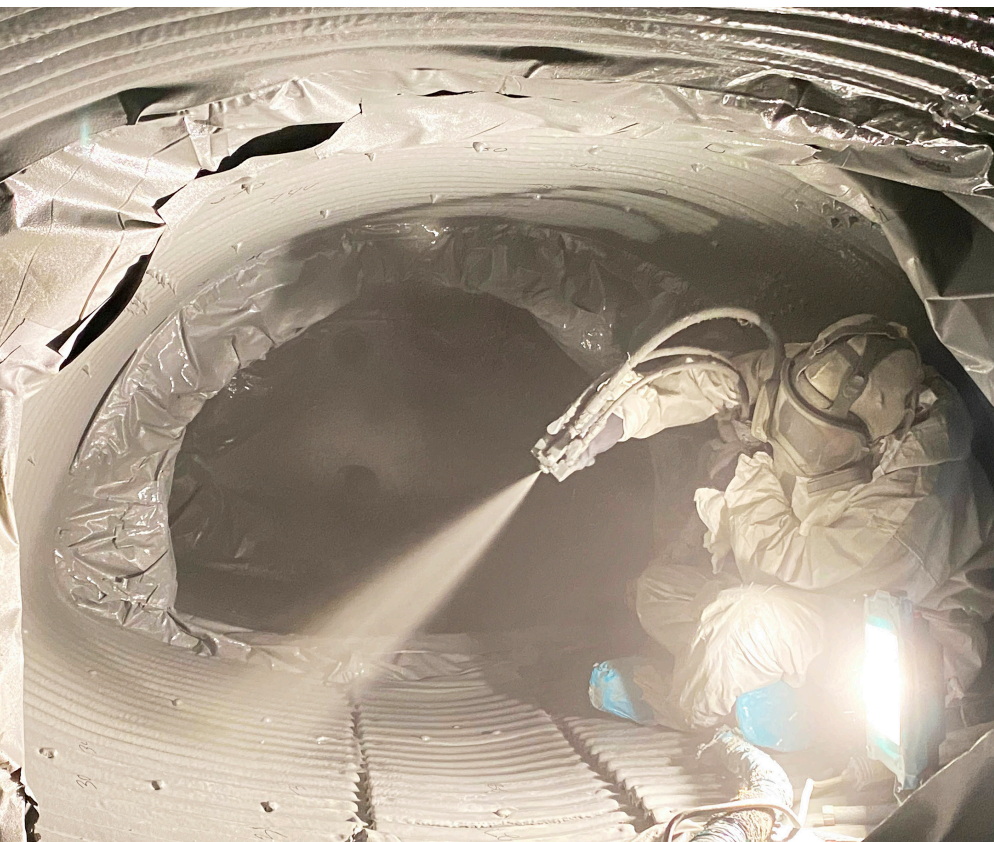


Figure 1: Manual SAPL Application



Figure 2: Robotic SAPL Application



Figure 3: Hole Spanning Test

(Figure 2), depending on the pipe diameter and space constraints.

The lack of comprehensive available standards, design guidelines, testing, and evaluation of polymeric SAPL is limiting its acceptance in the industry.

Due to the need for sufficient information on this technology, the Center for Underground Infrastructure Research and Education (CUIRE) at the University of Texas at Arlington, in collaboration with Nukote Coating Systems, are testing and evaluating the structural properties of the Polymeric SAPL for gravity and pressure pipes. This article will suggest some testing and methodologies for the classification and certification requirements for polymeric SAPL.

TESTING AND CERTIFICATION FOR POLYMERIC SAPL

As per AWWA Structural Classification of Lining Systems (2019), the SAPL lining system is divided into four classes. The tests needed for the evaluation of polymeric SAPL to be used in different

classes of pipe rehabilitation can be categorized into 3 groups: Material properties testing, Tests specific for Gravity pipes, Tests specific for Pressure pipes.

MATERIAL PROPERTIES TESTING

Material properties include both short- and long-term material testing. Material testing such as flexural, tensile, and punch shear tests are the common tests performed on polymeric material.

These tests show the material's resistance against stretching due to excessive or continuous loading, resistance to deformation, flexural impact resistance due to bending, ground movement, and temperature changes, shear impact due to sudden loading for shallow depth pipes.

In addition, the long-term creep properties of the material, both tensile and flexural, are important to determine the material behavior under long-term loading, which are required for semi-structural and structural design of liner systems.



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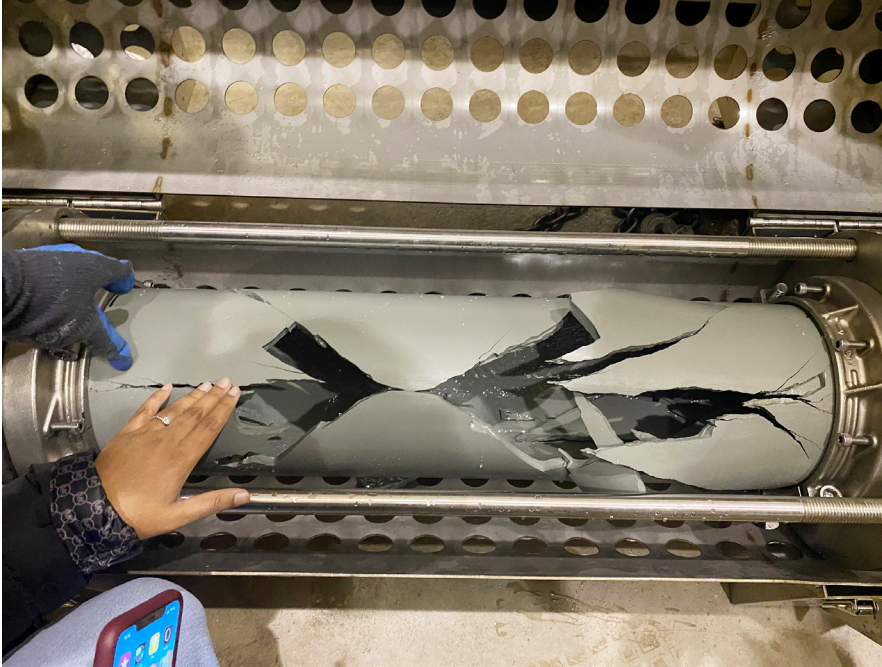


Figure 4: Hydrostatic Burst Test

GRAVITY PIPES TESTING

Full-scale laboratory test methods include:

Soil Box Testing: Simulates structural capacity of liner to renew the old and deteriorated gravity pipes and culverts in trench conditions using a 330-kip MTS actuator, data loggers, linear variable differential transformers (LVDTs), cable displacement sensors (CDS), uniaxial strain gauges, earth pressure cells, and image processing.

1. Parallel Plate Load (ASTM D2412): Determines liner pipe sample stiffness, which is a function of the liner material's dimensions and physical properties.
2. Ring Stiffness (ASTM D2412): Measure the liner pipe sample's deformation resistance to radial forces and resistance to ring deflection.
3. Creep Ratio (ISO 9967): Provide liner pipe sample deflection over an extrapolated two-year period.

PRESSURE PIPES TESTING

The recommended testing is categorized into two types: Short-term Testing and Long-term Testing. Short-term tests include:

1. Hole Spanning (AWWA): Determines hole spanning capacity of liner in pressure application. Hole-spanning pipe sample showed in Figure 3.
2. External Hydrostatic Buckling Test: Determines liner resistance to external hydrostatic pressure.
3. Hydrostatic Burst Test (ASTM D1599): Determines the burst pressure of liner pipe samples. Useful in calculating the short-term hoop strength of liner material. Burst failure pipe sample showed in Figure 4.
4. Hydraulic Flow Test: Evaluates the hydraulic flow characteristics of the liner material in comparison with the host pipe without liner, considering diameter reduction and surface smoothness under high flow.

Long-term tests include:

1. Fatigue Full-scale Test: Determines if liner can withstand cyclic loads that are 1.5 or 2 times higher than its pressure class for two million or more cycles and to predict design service life.
2. Hole Spanning Internal Hydrostatic Pressure (AWWA) Determine resistance of liner for long-term hole spanning.
3. Pipe Burst- Hydrostatic Design Basis (HDB) (ASTM D2837): Determine effects of temperature and pressure on the life span of liner material and long-term hoop tensile strength. †

ABOUT THE AUTHORS:



Kawalpreet Kaur, Ph.D., is a Postdoctoral researcher with a research focus on trenchless technology, pipeline rehabilitation, and asset management.

She is working on designing, testing, and evaluating spray applied pipe lining (SAPL) materials by performing various experimental tests for its applications in gravity and pressure pipes.



Sanaz Ghalambor is a CEM PhD candidate at UTA with Polymer Engineering background. She has spent two decades in pipeline

integrity, corrosion prevention, and rehabilitation. She's had several presentations at different conferences including UCT, NASTT, IWA and has supported many water and wastewater rehabilitation projects.



Dr. Najafi is a Professor and Direction of the Center for Underground Infrastructure Research and Education (CUIRE) at the University of Texas at

Arlington. He has more than 25 years of experience encompassing engineering, education, research, consulting, and management activities. He is the author of four trenchless technology books published by McGraw-Hill (the latest one published in 2022).