ACADEMIC AWARD: ZAHRA KOHANKAR KOUCHESFEHANI AND AMIN DARABNOUSH TEHRANI

Principle Investigator: Dr Mohammad Najafi, PE

by Zahra Kohankar Kouchesfehani, Amin Darabnoush Tehrani and Dr Mohammad Najafi, The University of Texas at Arlington, US

Zahra Kohankar Kouchesfehani and Amin Darabnoush Tehrani were the recipients of the ISTT Academic Award for 2019. Their submission, 'Structural design methodology for spray applied pipe liners in gravity storm water conveyance conduits as a trenchless renewal application', presented methodologies of the use of SAPLs for structural applications in renewal of culverts and drainage structures.

A vital step in a trenchless renewal technique design is the selection of the most appropriate, cost-effective and reliable method. The selection of a solution is only made possible following the recognition of the problem, or problems, within the existing pipeline system.

A spray-applied pipe lining (SAPL) is a renewable methodology that inhibits further deterioration, which can structurally support severely damaged culverts and drainage structures. The primary SAPL substance falls into two broad categories of cementitious: geopolymers, and polymeric materials.

SAPLs can be a key strategy in extending service life and managing the future burden anticipated from the ageing network of culverts and is an environmentally friendly, cost-effective option that has fast installation without hydraulic capacity loss of the culvert.

The American Association of State Highway Transportation Officials' (AASHTO) National Transportation Product Evaluation Program (NTPEP) developed a SAPL technical committee to implement this new technology.

The committee promptly recognised that no standardised structural design methodology existed for this technology, which ignited the need for this three-year research project. The funding commitment was achieved by the: Delaware, Florida, Minnesota, North Carolina, New York State and Pennsylvania Departments of Transportation (DOT) and was led by the Ohio DOT.

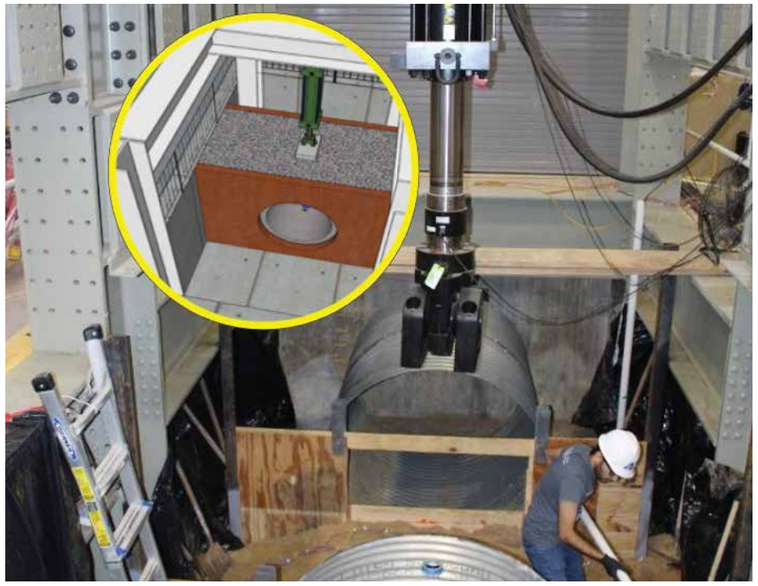
The development of practical spray-applied structural culvert pipe linings could be of enormous benefit to each DOT, as such linings could be a key strategy in extending service life and managing the future burden expected from the aging network of culverts and storm sewers. Compared to other culvert rehabilitation systems, SAPLs promise greater cost effectiveness and less community disruptions.

PROJECT OVERVIEW

The primary objective was to develop design methodologies and equations for structural renewal of gravity storm water conveyance culverts using both resin-based and cementitious SAPL applications for circular pipe and pipe arch shapes with span larger than 36 inches (915 mm). The design equations used loading as detailed in the AASHTO's Load and Resistance Factor Design Bridge Design Specifications while considering all parameters of the host culvert that may impact the design thickness, including any practical limitations on the use of such equations.

The research methodology included:

- a database of all the previous projects and experiences with SAPLs
- a literature search to minimise amount of laboratory testing and field inspections
- review of CIPP design equations and their applicability to SAPL
- laboratory and soil box testing to develop and validate structural design equations with circular and arch shapes and various thicknesses
- field data collections and inspections of actual SAPL installations for participating departments of transportation
- consideration of the impact of using additional reinforcements (glass fibre or carbon fibre) with SAPLs
- consideration of the impacts of filling corrugations on structural design of SAPLs
- a survey of US departments of transportation and Canadian agencies
- a lifecycle cost analysis
- computational modelling
- performance construction specifications.



CUIRE soil box test setup for SAPL research project with 330-kip capacity for static and dynamic loads.

Polymeric SAPL being applied to an asset. Image courtesy of Sprayroq.

RESEARCH FINDINGS

The research concluded that SAPLs have the potential to renew deteriorated culvert pipes as structural applications and recognised the need for an investigation of many structural and construction issues.

The objective of current research is to highlight these considerations for proper renewal of exiting culverts and develop proper design methodologies and equations for the structural application of SAPLs.

Dr Mohammad Najafi, PE, Principal Investigator

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

Zahra Kohankar Kouchesfehani, CUIRE Researcher and UTA Lecturer

Ms Kouchesfehani is a CUIRE researcher under the supervision of Dr Najafi and a lecturer at UTA, with an expertise in trenchless technology, pipe rehabilitation, inspection and condition assessment. She is the recipient of multiple recognition awards nationally in North America and has published research papers in international/national journals and conferences.

Amin Darabnoush Tehrani, EIT, CUIRE Researcher

Mr Tehrani's expertise lies in pipe structural analysis, numerical simulation, pipe installation and rehabilitation using trenchless technology. His skill is enhanced by his ongoing PhD in Civil Engineering at UTA as well as multiple recognition awards. Mr Tehrani has published several peer reviewed articles and has mainly been involved in multiple national- and state-level research projects.