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CENTER FOR UNDERGROUND INFRASTRUCTURE RESEARCH AND EDUCATION

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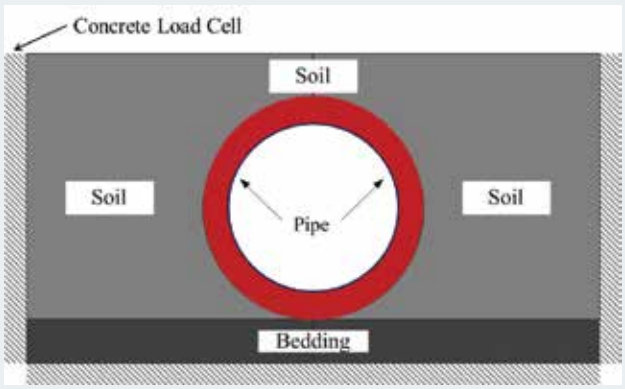
CUIRE TO DEVELOP A STRUCTURAL DESIGN METHODOLOGY FOR SPRAY APPLIED PIPE LINERS IN GRAVITY STORM WATER CONVEYANCE CONDUITS



Drainage infrastructure systems (culverts, storm sewers, outfall and related drainage elements) represent an integral portion of department of transportations' (DOTs) assets that routinely require inspection, maintenance, repair and renewal. These systems are buried and often out of public view unlike other assets such as pavement or bridges. Failure of these systems is costly due to unbudgeted expenses for infrastructure repair or replacement often resulting in an emergency project that is costlier than a planned and budgeted project. Impacts to the traveling public contain a cost due to lost time and in some cases fatalities have been experienced. Therefore, drainage infrastructure systems are in need of special attention in terms of proactive/preventive asset management strategy.

The variety in material types, shapes, backfill materials, types of roads located above and environmental conditions make every single culvert unique in terms of its behavior and durability. There have been many studies to identify the key parameters affecting culvert service life, but the success rate in providing standard service life estimates remains elusive. If culvert service life was completely understood it would have been much easier to manage this asset by timely renewal and repair efforts.

Asset management strategies for drainage infrastructure is being developed and implemented by DOTs in an effort to reduce emergency projects and impacts to the travelling public. While these efforts contain asset inventory and condition assessment, they also contain cost effective rehabilitative methods to extend asset service life. A relatively new method available to DOTs is the application of an in-situ spray applied pipe liner.

The American Association of State Highway Transportation Officials (AASHTO) National Transportation Product Evaluation Program (NTPEP) developed a Technical Committee for Spray Applied Pipe Liners (SAPL) in an effort to implement this new technology. The SAPL TC consists of DOTs, manufactures of resin based material, and manufactures of cementitious based materials. An early request from the DOT members was to ensure that the spray applied liner functioned as a structural liner. However, it was quickly realized that no standardized structural design methodology existed for this technology. Manufacturers utilize different design methodologies with some using the cured-in-place- pipe (CIPP) ASTM 1216 methodology and others using various classical analytical structural design equations developed for other purposes. A gap in knowledge was identified and preliminary discussions for research among the SAPL TC members was formed.

Discussions within the SAPL TC led to the development of a research need statement (RNS) to determine the structural design methodology for spray applied liners. After several iterations and funding considerations, the RNS became a pooled funded solicitation with Ohio DOT as the lead state.

The funding commitment was achieved and a contingent of six DOTs (North Carolina, Florida, Pennsylvania, New York, Minnesota and Ohio) are participating members. The RNS was posted through Ohio DOT's research program and the University of Texas

at Arlington (UTA) Center for Underground Infrastructure Research and Education (CUIRE) was selected. Final contracting details are currently being vetted and the research is expected to commence in late 2017. Data collected via the SAPL NTPEP program will be incorporated into the pooled funded research project in addition to field and laboratory testing via the research project.

PIPE/SOIL INTERACTION TESTING AT CUIRE

CUIRE has conducted soil box testing for large diameter flexible pipe under soil and traffic loadings. A 73-in. diameter steel pipe was recently tested under soil loads with different types of embedment. The equipment used for this testing were strain gauges, data loggers, extensometers, load cells for deflection testing. ABAQUS Finite Element Modeling software then was used to simulate the results for different loading and embedment conditions. In another test, deflection measurements were conducted for flexible pipes in trench testing and impacts of soil cover as well as traffic loads were measured.

The knowledge gained from above tests, as well as equipment used will be utilized to reduce amount of testing and conduct additional laboratory testing needed for evaluation of spray applied structural linings.

STORMWATER CONDUIT (CULVERT) REHABILITATION MATERIALS

Culvert-applied sprayed materials include cementitious (with added chemicals to prevent hydrogen sulfide induced corrosion) and polymeric (polyurethanes, epoxies, polyureas and their mixtures). Each of these materials and methods has its pros and cons; with a number of unknowns in terms of the structural support they can provide to a deteriorated culvert as each lined pipe and other drainage structures is a system with the following parameters that play a role on the overall durability and life cycle:

1. Residual strength of the culvert and drainage structures
2. Mechanical properties of the applied lining material
3. Adhesion between the lining and substrate (may not be necessary for a structural application)
4. Magnitude and type of loads exerted on the culvert
5. Durability of the culvert/pipe material against corrosion and other environmental effects.

The development of practical spray-applied structural culvert pipe linings could be of enormous benefit to the DOTs. 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, spray-applied linings promise greater cost-effectiveness and less community disruptions.

Spray-applied linings have a long-established track record longer than any other type of pipe rehabilitation for potable water and sanitary pipe applications. In-situ applications of spray applied cementitious linings date to the 1930s and polymer linings date to the 1970s. This track record provides procedures, standards, inspection methods, which can used for this project through a comprehensive literature search. There are also experiences with usage if these applied liners that can be used for purpose of this research through field inspections.

GOALS AND OBJECTIVES

The primary objective of this two-year research is to develop design equations for structural renewal of gravity storm water conveyance culverts using spray applied pipe liners for both cementitious and resin-based materials and for circular and non-circular (NC) shapes. These design equations developed with this project will use loading as detailed in the AASHTO LRFD Bridge Design Specifications and will be applicable for round, elliptical, egg, and box shapes. All parameters of the host culvert that may impact the design thickness such as vertical or horizontal deflections, unsymmetrical racking, section loss, cracks, material geometry (corrugations), or protrusions such as bolts and flanges will be considered. Additionally, practical limitations on the use of these design equations will be included.

For more information on this unique project, contact Dr. Mo Najafi at CUIRE, 817-272-9177 or email *najafi@uta.edu*.

CUIRE TO HOLD 16TH ANNUAL ENGINEERING, INSPECTOR SCHOOLS IN NEW ORLEANS

CUIRE will hold its 16th annual trenchless technology inspector training and certification schools Jan. 29-30, 2018, at the Ernest N. Morial Convention Center in New Orleans, Louisiana. Attendees may register for any of the following half-day sessions:

Jan. 29 - Morning

- Advanced Horizontal Directional Drilling (HDD) School (Part One)
- Geotechnical School (Part One)
- Flexible Pipe Design and Installation School (Part One, Design Requirements)

Jan. 29 - Afternoon

- Advanced Horizontal Directional Drilling (HDD) School (Part Two)
- Geotechnical School (Part Two
- Flexible Pipe Design and Installation School (Part Two, Installation Requirements)
- Microtunneling and Pilot Tube School

Jan. 30 – Morning

- Pipe School
- Mud School for Trenchless Technology
- Horizontal Auger Boring and Pipe Ramming School
- Pipe Lining and Renewal School

For more information, contact CUIRE at 817-272-9177 or email sahar.habibzadeh@mavs.uta.edu or visit cuire.org.