Geopolymer Liner Minimizes Culvert Rehab Impact Vista, California

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City of Vista

Located in Southern California
40 miles north of San Diego
Original Spanish Mission, 1798
Incorporated 1963
Population: 102,000

CITY OF VISTA
CALIFORNIA

Project Background

- City of Vista, California
- Master-Planned 80 Arce Business Park, First Developed in 1987
- Currently Home to:
  - Big Box Stores: Target, Home Depot
  - Watkins Wellness
  - 2 Breweries
  - Manufacturing
  - Various Local Business Offices

Vista Business Park

Business Park Drive

Business Park Drive Underpass

Project Details:

- 256 linear feet of tunnel plate pipe
- 182 x 186 inches
- Directly under main city thoroughfare
- Required design for HS20 loads as well as seismic concerns
- The structure serves as a culvert, pedestrian walk way and access road for city work vehicles

3D Project View

Culvert Inflow

Culvert Outflow

Project Concerns

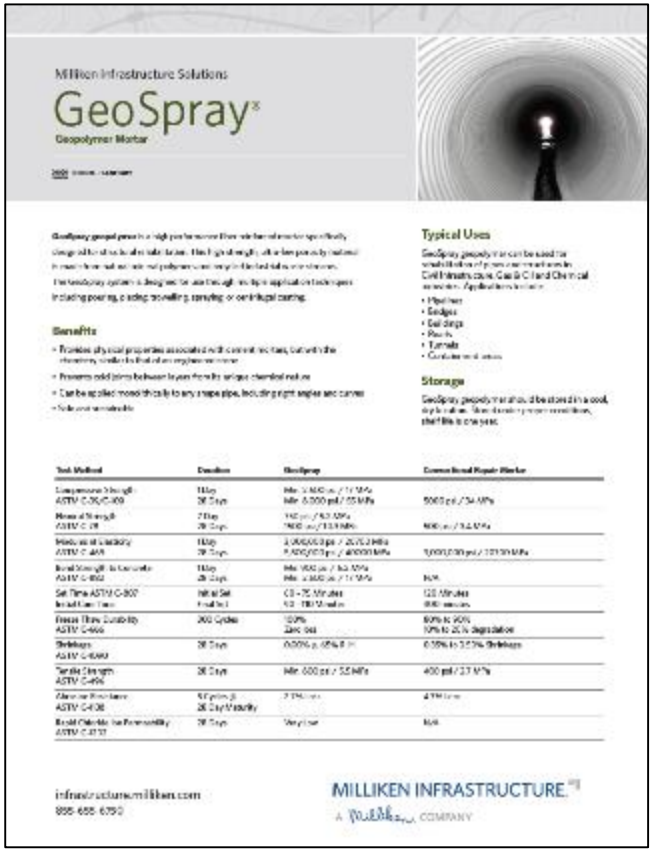
- City began tracking corrosion in 2002 with annual inspections
- In 2014, the asset owner decided a repair was needed.
- Construction area was limited
- Sensitive Environmental Areas – including Coastal Sage Scrub and wetland habitats.

Engineering Concerns

- Design was required to support earthen embankment and the vehicular live loads of Business Park Dr.
- Additional southern California seismic loading concerns
- Material needed to be non-flammable and heat resistant
- Also serves as an access road for sewer and fire vehicles so only slight profiles changes were allowed.

Product Selection:

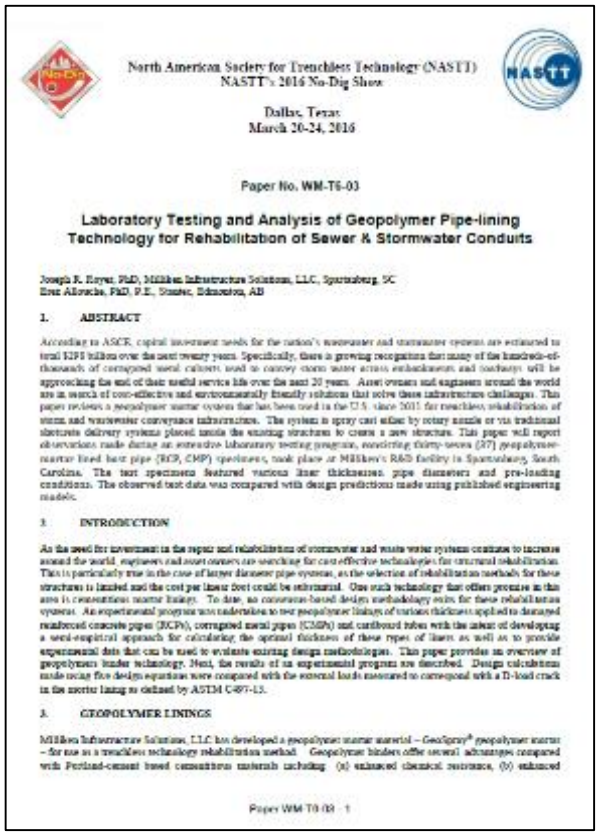
- The city reviewed various repair options and settled on a geopolymer mortar as the optimal repair method.
- They then contracted with Inland Pipe Rehab to design and construct the final solution.



Engineering Design

- The design, based on methodology developed by in conjunction with Louisiana Tech's Trenchless Technology Center called for a thickness of 3.2" of geopolymer with a 28 day compressive strength of 8000 psi and a 28 day (ASTM C78) flexural strength of 1500 psi.

- Additionally, due to the seismic concerns a layer of welded wire mesh was added above the corrugations as an additional layer of safety.



North American Society for Trenchless Technology (NASTT)
NASTT's 2016 No-Dig Show

Dallas, Texas
March 20-24, 2016

Paper No. WM-T6-03

Laboratory Testing and Analysis of Geopolymer Pipe-lining Technology for Rehabilitation of Sewer & Stormwater Conduits

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1. ABSTRACT

According to ASCE, capital investment needs for the nation's wastewater and stormwater systems are estimated to total $295 billion over the next twenty years. Specifically, there is growing recognition that many of the hundreds-of-thousands of corrugated metal culverts used to convey storm water across embankments and roadways will be approaching the end of their useful service life over the next 20 years. Asset owners and engineers around the world are in search of cost-effective and environmentally friendly solutions that solve these infrastructure challenges. This paper reviews a geopolymer mortar system that has been used in the U.S. since 2011 for trenchless rehabilitation of storm and wastewater conveyance infrastructure. The system is spray cast either by rotary nozzle or via traditional shotcrete delivery systems placed inside the existing structure to create a new structure. This paper will report observations made during an extensive laboratory testing program, monitoring thirty-seven (37) geopolymer-mortar lined host pipe (RCP, CMP) specimens, took place at Milliken's R&D facility in Spartanburg, South Carolina. The test specimens featured various liner thicknesses, pipe diameters and pre-loading conditions. The observed test data was compared with design predictions made using published engineering models.

2. INTRODUCTION

As the need for investment in the repair and rehabilitation of stormwater and waste water systems continues to increase around the world, engineers and asset owners are searching for cost-effective technologies for structural rehabilitation. This is particularly true in the case of larger diameter pipe systems, as the selection of rehabilitation methods for these structures is limited and the cost per linear foot could be substantial. One such technology that offers promise in this area is cementitious mortar liners. To date, no consensus-based design methodology exists for these rehabilitation systems. An experimental program was undertaken to test geopolymer linings of various thicknesses applied to damaged reinforced concrete pipes (RCPs), corrugated metal pipes (CMPs) and cardboard tubes with the intent of developing a semi-empirical approach for calculating the optimal thickness of these types of liners as well as to provide experimental data that can be used to evaluate existing design methodologies. This paper provides an overview of geopolymer binder technology. Next, the results of an experimental program are described. Design calculations made using five design equations were compared with the external loads measured to correspond with a 0.1-load crack in the mortar lining as defined by ASTM C-497-13.

3. GEOPOLYMER LININGS

Milliken Infrastructure Solutions, LLC has developed a geopolymer mortar material – GeoSpray® geopolymer mortar – for use in a trenchless technology rehabilitation method. Geopolymer binders offer several advantages compared with Portland-cement based cementitious materials including: (a) enhanced chemical resistance, (b) enhanced

Construction

- A crew of 5 with a project manager completed the project in under 2 months.
- When the original asphalt road was removed the tunnel plate was unstable and a new 5” thick geopolymer slab with #2 rebar was poured in the invert of the culvert to as a service road and to stabilize the lateral forces in the culvert.
- The project has been inspected annually for 2 years with no observed concerns.

Construction Progress

Initial views of the 14 ft high tunnel plate structure with asphalt invert

Construction Progress

First steps required removing the asphalt invert which was also used as a maintenance road

Construction Progress

Typical infiltration points through out the structure

Construction Progress

Because the structure is both a walking path and an access road the invert of the structure was filled with gravel and “paved” with geopolymer

Construction Progress

Invert paving in action

Construction Progress

All waste water was required to be collected and removed due to the sensitive environmental area

Construction Progress

Once the invert was complete the sides were lined through a hand spray process

Construction Progress

The material was applied on the sides and then across the crown of the structure

Construction Progress

Once the initial application was complete a welded wire cage was added to provide support for seismic loads

Construction Progress

The application was done in steps moving up to the crown

Construction Progress

The last few feet of application process

Construction Progress

The finished structure, which included expansion joints, was inspected and accepted.

The final Test

The final inspection had to ensure that a city Vac truck could still pass

Inspection

The rehabilitation is performing well after 2 years of inspections, with heavy rains in the area

Thank You

- A complete article is available in the September 2016 edition of Trenchless Technology Magazine.

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