NARRAGANSETT BAY COMMISSION
REHABILITATION OF LARGE DIAMETER BRICK
SEWER WITH GEOSPRAy GEOPOLYMER
MORTAR

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NASTT’s 2019 No-Dig Show
Route 6 & 10 Connector – NBC Interceptor Rehabilitation

Project Details:

- Owner / Designer – Narragansett Bay Commission
- 2,430 feet of large diameter brick sewer up to 60”
- The Route 6 & 10 Connector built on top of the sewer interceptor
- Various defects within brick pipes creating high level of infiltration and structural defects
- Repaired with GeoSpray geopolymer from Milliken Infrastructure
- Contractor Installer – National Water Main Cleaning
Project Location – RT 6 & 10 Connector
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Lining Options Considered

- **Cured in Place Pipe (CIPP)**
  - 60” liner required MH removal, repaving and traffic redirection
  - Over hole wet out large construction footprint not desired
  - Construction not possible at transition in pipe diameter
  - Concerns over fins and folds causing obstructions

- **Slip Line**
  - Similar to CIPP, the desire was to avoid MH removal or insertion pits; Significant capacity reduction

- **Dig and Replace**
  - Pipe depth and location under the highway made it too $$$

- **Centrifugally Cast Concrete Pipe (CCCP)**
  - Portland cement material concerns on water intrusion and desired corrosion protection

- **Spin Cast Geopolymer Pipe (SCGP)**
  - Selected for stopping infiltration, small footprint, no excavation, no lane closure, corrosion protection, longevity, less bypass required
SCGP Liner Design (6 methods to pick from)

• Distributed Beam Load over a Partial Ring Model

\[ t = \sqrt[0.0744 \cdot Q_T \cdot r^2 \cdot N}{S_F \cdot c} \]

- **t** = Minimum Liner Thickness, inches
- **Q_t** = Total External Load as calculated from ASTM F 1216-09 for fully deteriorate pipe
- **r** = Radius of the interior crown of the pipe or ½ the largest interior horizontal dimension, inches
- **N** = Safety Factor = 2
- **S_F** = The 28 day Flexural Strength (or Modulus of Rupture) as determined by ASTM C78, psi.
- **c** = Ovality Reduction Factor as defined in ASTM F 1216-09

• 10-17 feet crown cover assume water at surface
• 30” x 45” & 38” x 57” Vertical Ellipse & 60” Round Brick Pipe
• 50 plus years
• AASHTO HS 25 and E80 Rail

• Result: \( t = 1\)” for smaller pipes and 1.5” for 60” Pipe
  (based on ASTM C78 Flexural Strength = 1500 psi)
What is a Geopolymer?

• Not a Plastic
  • Not HDPE/PVC/Epoxy

• Looks and feels like cement
  • Workability
  • Material Properties
  • Service Life

• Chemical structure like natural stone
  • Monolithic
  • Durable
  • Corrosion Resistant
Spin Casting Geopolymer Pipe (SCGP) Process
Geopolymer Chemistry Primer

Typical Hydrated OPC Structure

Typical Geopolymer Structure
Cold Joints

Experimental Parameters:

• On the first day a series of 2” by 4” cylinders were cast half full and cured with an approximately 45 degree angle.

• On subsequent days (1, 7, 14 and 28) the top half of the cylinders were cast and filled creating a 45° angled joint in the center of the cylinders.

• Compressive strength tests were conducted 28 days after the top half of the cylinders were cast.
Cold Joints – Testing Data

Results:

• Samples cast of GeoSpray Geopolymer (both halves) when tested under compression did not break at the joint.

• The chemical nature of GeoSpray allows for chemical bonding across the interface even with pours 28 days apart resulting in a monolithic structure.

• Samples cast of competitive cement mortars always broke along the angled joint essentially creating 2 separate layers.
Microbial Induced Corrosion (MIC) Mechanism

- Anaerobic Generation of $\text{H}_2\text{S}$ Below Water Line in Septic Effluent
- Aerobic $\text{H}_2\text{SO}_4$ Production and Corrosive Attack Above Water Line
- $\text{H}_2\text{S}$ Gas Emission
Geopolymer Advantage – Corrosion Protection

Weight Change Comparison

- GeoSpray AMS
- Portland

Day 0 Day 84
Day 0 Day 84

GeoSpray AMS

Portland
Independent Testing and Analysis

EPA Evaluation:

• U.S. Environmental Protection Agency developed an innovative technology demonstration program to evaluate technologies that have potential to reduce costs and increase the effectiveness of the operation, maintenance and renewal of aging water distribution and wastewater collection systems.

• The EPA observed and monitored this project as part of this program.
NWMCC  SCGP – Small Construction Footprint
NWMCC  SCGP – Small Construction Footprint
Construction Footprint / Pipe Access
INfiltration Issues
Crown Repair & Infiltration Control
Liner Thickness / Depth Gauges
Various Pipe Sizes of Rehab
Pipe Rehabilitation

Application of First Layer and Final Layer
Internal Bypass
SCGP Through 90 Degree Bend
Completed Structure
Challenges and Lessons Learned

• No National ASTM Design Standard Exists
  • Counting FEM there are 6 minimum design methods
  • 2” of SCGP ≠ 2” of CCCP ≠ 2” Portland Concrete

• Mobilization & Demobilization
  • Evaluate leaving equipment and barricades in place during day
  • Getting tractor trailer with GeoSpray in and unloaded in median

• Wet Weather Go / No Go Decision
  • Old CIPP rule - if chance of rain at 5 AM, scrub work
  • New – with geopolymer NBC let NWMCC decide to work or not

• Four Season Liner
  • Geopolymer is more resilient in hot cold and wet weather, so
    Geopolymer is a new tool for NBC on future projects
Thank You & Questions?

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