PROTECT WITH CONFIDENCE

Manhole Lining & Rehabilitation

Michigan WEA Collections Seminar
East Lansing, MI
Jeff Croll
Raven Lining Systems
Factors Demanding Solutions in Wastewater Infrastructure

- Corrosion
- Inflow & Infiltration
- Construction & Age
Effective Assessment of Manholes

- Location
  - Accessibility issues
- Construction
  - Materials
  - Dimensions
  - Other repair or liner materials
- Condition
  - Inflow and/or Infiltration
  - Corrosion
  - Flow obstructions
  - Positioning of lines
  - Cracking or structural integrity issues
- Potential Future Conditions
Manhole Components
Materials and Technologies for Component Repair

- Covers & Frame Replacement
- Chimney Seals
- Wall and Cone Joint Sealants
- Steps
- Pipe Seals
- Bench and Inverts
Chimney Seal Alternatives

- **Mechanical Seals**
  - Rubber seals with stainless steel bands

- **Polymer Seals**
  - CIPP
  - Urethane resin
  - Epoxy resin
Grouting to Eliminate Leaks and Stabilize Soils

- Acrylamide
- Acrylic
- Urethane
- Polyurethane
- Cementitious
Mortar Replacement, Reprofiling and Filling Voids

- High strength cement
  - Portland cement
  - Calcium aluminate
- Polymer concrete
  - Acrylic and epoxy additives
- Epoxy mortar
Bench and Invert Repair and Rebuild

- Rapid setting
- High early strength
- Cementitious mortar
  - Calcium Aluminate
  - Portland
  - Modified Polymer
- Invert sleeves
  - PVC
  - Fiberglass
Pipe Seals

- Rapid setting, high strength cement
- Chemical grouts
- Adhesives for interfacing with plastic pipe and liner materials
- Mechanical seals
Steps – Do they Stay or Go?

- Safety
- Plastic, steel and composite materials
- Sealant materials
  - Rapid setting, high strength cement
  - Epoxy grouts
Compatibility Considerations for Repair Materials

- Portland Cement
- Repair Mortars
- Polymer Materials
- PVC, HDPE and other plastics
Evaluation, Selection and Use of Polymer Coatings in Sewer Manholes

- Corrosion Protection
- I&I Elimination
- Operation & Maintenance
- Inspection
211-2 Chemical Resistance Test (Pickle Jar Test). This test is used to determine the physical properties of material specimens used in sewers after exposure to chemical solutions. All test specimens shall be conditioned in a mechanical convection oven for 7 days and to a constant weight a 43°C ± 3°C (110°F ± 5°F) and subsequently cooled for 3 hours in a desiccator. This conditioning shall be done before and after submersion of the test specimens in the solutions specified in Table 211-2(A) for a period of 112 days at 25°C ± 3°C (77°F ± 5°F).

<table>
<thead>
<tr>
<th>Chemical Solution</th>
<th>Concentration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sulphuric acid (H₂SO₄)</td>
<td>20%</td>
</tr>
<tr>
<td>Sodium hydroxide (NaOH)</td>
<td>5%</td>
</tr>
<tr>
<td>Ammonium hydroxide (NH₄OH)</td>
<td>5%</td>
</tr>
<tr>
<td>Nitric acid (HNO₃)</td>
<td>1%</td>
</tr>
<tr>
<td>Ferric chloride (FeCl₃)</td>
<td>1%</td>
</tr>
<tr>
<td>Sodium Hypochloride</td>
<td>1%</td>
</tr>
<tr>
<td>Soap</td>
<td>0.1%</td>
</tr>
<tr>
<td>Detergent (Linear alkyl benzyl sulfonate or LAS)</td>
<td>0.1%</td>
</tr>
<tr>
<td>Bacteriological</td>
<td>BOD not less than 700 ppm</td>
</tr>
</tbody>
</table>

1. Volumetric percentages: Actual concentration of reagent must be corrected to 100%.
2. Weight change specimens per ASTM D543 shall be 25.4mm x 76.2mm x 3.175mm thick (1in x 3in x 0.125in) unless otherwise approved by the Engineer.

At 28-day intervals, specimens shall be removed from each chemical solution and tested. If any specimen fails to meet the 112-day requirements specified for the material being tested before completion of the 112-day exposure, the material will be rejected.

The Chemical Resistance Test is a qualification test only. Requalification is required only when the compound formulation changes.
Adhesion

- Test Methods and Standards
  - ASTM D7234
- Laboratory Testing
- Field Testing and Evaluation
Ability to Resist Hydrostatic Pressure

- Test Methods and Standards
  - Tensile Strength – ASTM D638
  - Flexural Properties – ASTM D790
- Design Criteria
  - Compressive buckling resistance due to external pressure (hydrostatic pressure)
  - NOT ASTM F1216
- Industry Precedence
  - Tensile >3,000 psi
  - Flexural Modulus >500,000 psi
Structural Repair Performance Criteria

- Methods and Standards
  - Condition Assessment
  - Physical Property Change after Chemical Exposure

- Design Criteria
  - Material Thickness
  - Reinforcement

- Industry Precedence
  - Composite Systems
  - Polymer Systems
Installation Good Practices

- Material Selection
- Contractor Qualification
- Surface Preparation
- Repair and Reprofiling
- Coating Installation
- Testing and Inspection
QA / QC Processes & Procedures

- Submittal Evaluation
- Contractor Qualification
- Project Documentation
QA / QC Processes & Procedures

- Metering & Mixing
- Film Thickness
- Film Integrity
- Adhesion
Performance & Maintenance

- Project documentation
- Repair ability of coating
- Ease of inspection
- Timely warranty inspection
Project Inspection

- Inspector shall inspect the quality of work that is being performed throughout the project at phases assigned.

- Inspector shall perform close visual observations at regular intervals and survey the overall progress of the project.

- Inspection schedule shall be coordinated with the Contractor’s representative to avoid delays to the project.
Longevity / Integrity

What makes it work
- Proper product selection
- Monolithic
- Sufficient barrier – impermeable
- Interface with other components
- Adhesion

What to do when something goes wrong
- Inspection
- Repairs
Advantages of Polymer Coatings

- Highest performing systems provide a protective layer which retards or prevents corrosion by isolating the substrate from contact with other materials.
- Formulated for moisture and surface tolerance enabling superior performance in underground structures.
- Strong barrier prevents infiltration and contains sewage within structure.
- Versatile spray application conforms to structures of all shapes and sizes.
- Aesthetics and surface characteristics provide ease in inspection and improved operation.