Assessment of ODOT’s Conduit Service Life Prediction Methodology

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RUSS COLLEGE OF ENGINEERING AND TECHNOLOGY
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Part 1: What are we doing?
Overview Part 1

• Objective
• Methodology
• Inventory & Field Inspections
• Laboratory Testing
• Preliminary Data Analysis
• Accelerated Laboratory Degradation Test (Preview)

Part 2: Observations from Field Inspections
Objective
Objective

This project aims to evaluate and improve ODOT’s methods for estimating the service life of conduits (concrete, thermoplastic, and metal pipes), to provide an update on current conditions and acquire more information on service life of coatings and other components.

Results will be incorporated into Volume 2 of the L&D Manual.
Methodology
Methodology

• Inventory Selection
• Field Inspections
  – Verification of Inventory Information
  – Application of ODOT & ORITE Rating systems
  – Collection of Water and Backfill Soil Samples
• Laboratory Testing
• Data Analysis
Inventory Selection

314 Culverts Selected

www.dot.state.oh.us
214 Culverts Inspected

Districts: 1, 3, 4, 5, 6, 8, 9, 10, 11, 12.

- Concrete Pipes (96)
- Metal Pipes (86)
- HDPE Pipes (32)
Culverts NOT Inspected

100 Culverts NOT Inspected

- Unavailable to access for full inspection (35)
- Box Culvert/Bridge (20)
- Replaced (7)
- Not Found (38)

(50% Concrete, 48% Metal, 2% HDPE)
Verification Inventory Data

- Installation year
- Length
- Span
- Rise
- Number of cells
- Shape
- Wall Thickness
- Type of protection coating
- Headwall type
- Cover over pipe
- Backfill type
- Corrugation Profile
- Metallic coating
- Class of pipe
Inspection Pipe Condition (1)

- Cracking
- Delamination & Spalling
- Scaling
- Aggregate & mortar loss
- Exposed Reinforcing steel
- % Corrosion
- Rust (degree)
- % Perforated
- % Pitting
- Inlet
- Outlet
- Pipe Slope
- Settlement
- Headwall
- Joints
- Depth Sediment
- Depth Drainage Flow
- Drainage Flow Velocity
Inspection Pipe Condition (2)

- Size streambed material
- % Protection remaining
- Description Invert/Interface
- Softening of concrete
- Prospector Pick’s observation
- Metal Thickness
- % Invert/Interface Perforated

- ORITE Pipe Scale
- ODOT Pipe Scale
- ODOT Joint Scale
- Abrasion Level
Rating Scales

**ODOT**
- 9 Excellent
- 8 Very Good
- 7 Good
- 6 Satisfactory
- 5 Fair
- 4 Poor
- 3 Serious
- 2 Critical
- 1 Imminent Failure
- 0 Failed

**ORITE**
- 9 Excellent
- 8 Very Good
- 7 Good
- 6 Fair
- 5 Fair to Marginal
- 4 Marginal
- 3 Poor
- 2 Very Poor
- 1 Critical
- 0 Failure
Laboratory Testing
Water & Backfill Soil Chemistry

- Water pH
- Water Resistivity
- Backfill Soil pH

- Backfill Soil Resistivity

Water content of
- Chlorides (Cl)
- Sulfates (SO4)

PC 300 Sensor
Miller 400D Soil Box
Dionex IC25 Ion Chromatograph
Preliminary Data Analysis
Stream Water pH map*

*Average value per county

Retrieved from ODOT, 1982
## ODOT and ORITE Rating

<table>
<thead>
<tr>
<th>District</th>
<th>Concrete pipes</th>
<th>Metal pipes</th>
<th>HDPE pipes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Age (yr) (ORITE) (ODOT)</td>
<td>Age (yr) (ORITE) (ODOT)</td>
<td>Age (yr) (ORITE) (ODOT)</td>
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</tbody>
</table>

*All values are Average values for each District.*
Concrete Pipe (Preliminary best fit Model*)

Based on ODOT Rating System

\[
Rate = -0.3 \text{Age} + 0.56 pH_w - 0.62 \text{Flowvel} - 1.73 \times 10^{-5} \rho_w - 0.004 SO_4 - 0.2 \text{Span} + 6.899
\]

\[R^2 = 0.509\]

Based on ORITE Rating System

\[
Rate = -0.21 \text{Age} + 0.4 pH_w - 0.53 \text{Flowvel} - 2.09 \times 10^{-5} \rho_w - 0.005 SO_4 - 0.004 \text{Length} + 5.608
\]

\[R^2 = 0.506\]

*Preliminary Models based on only 60% of current Data
Metal Pipe (Preliminary Model*)

Models obtained showed no practical application

• Age was a statistically not significant predictor
• When significant Age, its coefficient was (+) positive.

HDPE Pipe (Preliminary Model)

Condition of HDPE is related more to the Installation work than to any site variable.

*Preliminary Models based on only 60% of current Data
Accelerated Laboratory Degradation Test (preview)
Modified L.A. Abrasion Machine

Los Angeles Abrasion Machine was modified

Aluminized Coating

<table>
<thead>
<tr>
<th>Initial Condition</th>
<th>After 500,000 rev.</th>
<th>After 1,000,000 rev.</th>
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<tbody>
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<td>Aluminized 2</td>
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<td>Aluminized 3</td>
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<tr>
<td>Galvanized (control)</td>
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</table>
Polymeric Coating

Initial Condition          After 500,000 rev.          After 1,000,000 rev.

Polymeric 1

Polymeric 2

Polymeric 3

Galvanized (control)
Part 2: Observations from Field Inspection
Overview Part 2

• Concrete Pipes
  – Durability / Pipe Protection / Other Issues

• Galvanized Corrugated Metal Pipes
  – Durability / Pipe Protection / Other Issues
  (Aluminized Corrugated Metal pipe)
  (Spiral Rib Aluminized Metal Pipe)

• HDPE Pipes
  – Durability / Other Issues

• Aluminum Pipes
  – Durability / Other Issues
Concrete Pipes
Durability

**JAC-124-17.7 (2009)**  
Acidic Site, pH: 2.5

**BEL-800-14.16 (1951)**  
Neutral pH, pH: 7.0
Durability

**GRE-72-6.82 (1961)** External deterioration caused by Road Salt
Pipe Protection

**COS-36-18.26**  Vitrified Clay  
**TUS-39-20.19**  Epoxy Coated
Other Issues

**LIC-40-29.57** Separation last section

**VAN-637-2.86** Lack of cover on reinforcing bars
Galvanized Corrugated Metal Pipes
Durability

**COS-541-1.02 (1993)**
- pH: 6.7
- Abrasion level: 4

**GRE-380-6.92 (1961)**
- pH: 7.9
- Abrasion level: 1
Pipe Protection

Bituminous Coated with Paved invert
- ATH-691-2.09
- ATH-681-4.82
- COS-36-17.59
- COL-172-8.05
- CLE-743-1.36
- CLE-222-9.04
- CLI-380-0.43
- KNO-661-1.98*
- MEI-33-0.87*

Concrete Paving
- MRW-95-14.81*
- DEL-521-6.55*

Concrete Paving with vitrified Clay Trough
- TUS-39-21.95

Polymeric Coating
- PER-13-17.49
- TUS-416-1.64
- LIC-668-0.07

* Pipe was unavailable for full inspection
Concrete Paving

MRW-95-14.81 (Pipe was not rated)
Concrete Paving with Vitrified Clay Trough

TUS-39-21.95
Bituminous Coating with Paved Invert

**CLE-222-9.04**  
Cover over pipe: 1ft

**COL-172-8.05**  
Cover over pipe: 9 ft
Deterioration Rate vs. Cover Height

- **BC+P from Interim Report**
- **Current Project**

![Graph showing the relationship between Deterioration Number/Age and Cover (ft)]
Polymeric Coating

LIC-668-0.007 (1985)
Other Issues

ROS-50-30.86 Deflections

COS-541-1.02 Joint problems
Aluminized Corrugated Metal Pipe

GRE-68-4.42 Light rust around circumference of the re-rolled ends
Spiral Rib Aluminized Metal Pipe

CUY- 271

CUY- 480
Spiral Rib Aluminized Metal Pipe

LAK-90
HDPE Pipes
Durability

MEI-248-0.48 Abrasion Level: 4
Other Issues

LIC-661-10.82  Inlet dropped off. Reversed curvature at top. Dimples at shoulder.
Other Issues

**GUE-313-8.59** Wall crushing at springline. There is no soil column in-between
Other Issues

**LIC-40-19.38** Circumferential cracks. Deflection due to Guardrail post inappropriate installation.
Other Issues

PER-93-6.61  Longitudinal crack at crown
Construction Project PERRY County

PER-155-3.19  PER-669-4.7
# HDPE Rating

## District Maintenance vs. Construction Project

### ORITE Rating

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### ODOT Rating

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Aluminum Pipes
Durability
Durability
Other Issues
Conclusions

• At this point, observations and findings do not contradict previous research results obtained by ODOT and others.
• This project is ongoing.
Create for Good.