Spiral Wound Liners – Leading Edge Technology
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Presentation Outline

• Gravity Pipeline Rehabilitation
• Spiral Wound Technology Overview
• Spiral Wound Design Considerations
• Features & Benefits of Spiral Wound Liners
• Typical Installation
• Case Studies
Gravity Pipeline Rehabilitation

- **Trenchless Methods**
  - CIPP
  - Pipe-Bursting
  - Slip-Lining
  - Spray-On; Epoxies & Geopolymers
  - Spiral Wound Liners
Gravity Pipeline Rehabilitation

• Trenchless Methods
  • CIPP
  • Pipe-Bursting
  • Slip-Lining
  • Spray-On; Epoxies & Geopolymers
  • **Spiral Wound Liners**
Presentation Outline

- Gravity Pipeline Rehabilitation
- **Spiral Wound Technology Overview**
  - History/Providers
  - Brief Process Description
  - PVC Profile Description
  - Installation Methods
- Spiral Wound Design Considerations
- Features & Benefits of Spiral Wound Liners
- Typical Installation
- Case Studies
Brief History of Spiral Wound Liners

• **Over 30 years** of installation history

• Technology originated out of Australia & Japan *(1980’s)*

• Introduced to United States in **1996**

• **Over 3 million feet installed in U.S. and 20 million worldwide**
Spiral Wound Providers

• Sekisui SPR Americas
• Contech Engineered Solutions (PE Liner)
• Danby Pipe Renovation (Grout-In-Place)
• SWP
Spiral Wound Liners – The Technology

- PVC Profile Strip with a continuously sealed spiral joint
  - Machine fabricated extruded PVC profile strips
  - Optional steel-reinforced strips for fixed diameter solutions

- Spool which feeds the continuous profile strip

- Winding Machine to form liner

- Installed Liner
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  • Spool located above ground powered hydraulically
  • Profile feeds through the manhole to winding machine in pipe

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  • 3 machines, vary by diameter range (tot. range 6” – 200”)
  • Traverse & static winding machines
  • Fixed diameter & grouted solutions

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Diameter Range
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- Installed Liner
  - Hydraulically sealed, fully structural pipe
  - Increased hydraulic efficiency
  - Typically 50 year design life
PVC Profile – Building block of Spiral Wound Liners

- Un-plasticized PVC compounds meeting the minimum cell classification requirements within ASTM F1697

- Mechanical lock - Sealing material compressed by male/female locks.

- PVC Profile varies with installation method
  - **Steel reinforcement**
  - Expandable

**Profile Example – SPR™**

- Co-extruded gasket
- Female lock
- Optional steel reinforcement (SPR™)
- Male lock
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Profile Example – SPR™ EX
• Un-plasticized PVC compounds meeting the minimum cell classification requirements within ASTM F1697

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• PVC Profile varies with installation method
  • Steel reinforcement
  • Expandable
Static Winding
• The winding machine is placed at the entry of the host pipe (bottom of manhole). The liner is formed by machine pushing profile upstream or downstream.

Traverse Winding
Spiral Winding – Static Vs. Traversing

Static Winding
• The winding machine is placed at the entry of the host pipe (bottom of manhole). The liner is formed by machine pushing profile upstream.

Traverse Winding
• The winding machine travels the length of the host pipe while simultaneously forming the liner. PVC profile is pulled and winding occurs inside the pipe.
Presentation Outline

• Gravity Pipeline Rehabilitation
• Spiral Wound Technology Overview
• **Spiral Wound Design Considerations**
  • ASTM F1741-18 – Fully Deteriorated
  • ASTM F1741-18 – Partially Deteriorated
  • Composite Designs
• Features & Benefits of Spiral Wound Liners
• Typical Installation
• Case Studies
Standards and Specifications

PVC Spiral Wound Liners meet the following Material Standards and Specifications

- **ASTM F1697-18** – Standard Specification for Poly(Vinyl Chloride) (PVC) Profile Strip for Machine Spiral-Wound Liner Pipe Rehabilitation of Existing Sewers and Conduit

- **ASTM F1741-18** - Standard Practice for Installation of Machine Spiral Wound PVC Liner Pipe for Rehabilitation of Existing Sewers and Conduit

International Standards

- **ATV DVWK M127-E**
- **WRc Type II philosophy (WRc Approved™ referencing ASTM design method)**
- **AS/NZS 2566.1 and variants**
• “The existing pipe is not structurally sound and cannot support soil, surcharge and live loads or is expected to reach this condition over the design life of the spiral wound liner pipe. This condition is evident when sections of the existing pipe are missing, the existing pipe has lost its original shape, or the existing pipe has corroded due to the effects of the fluid, atmosphere, or soil.”

• In short, the liner must be designed to resist all applied loads – soil, superimposed dead load, vehicular and hydrostatic.

X1.2.2.1 Liner Pipe Expanded Against Existing Pipe (With or Without Grouting) and liner pipe installed at a fixed diameter with the annular space non-structurally grouted:

\[
q_r = \frac{1}{N} \left[ \frac{32R_w B' E' s C (E_L I/D^3)}{E'} \right]^{1/2}
\]

(X1.4)
ASTM F1741-18: Partially Deteriorated

• "The existing pipe can support the soil and surcharge and live loads throughout the design life of the rehabilitated pipe, and the soil adjacent to the existing pipe must provide adequate side support. The conduit may have longitudinal cracks and some distortion of the diameter."

• In short, the liner within such a pipe must be designed to resist the hydrostatic load, applied by the water table, only. All other loads are resisted by the existing pipe.

• It is important to carefully consider the water table information provided – including what time of year any information was gathered (i.e. the potential differences between the end of summer and the end of winter).

X1.2.1.1 Liner pipe expanded against the existing pipe (with or without grouting) and liner pipe installed at a fixed diameter with the annular space non-structurally grouted:

\[ P = \frac{24KE_I}{(1 - v^2)D^3N} \]  
(X1.1)
Composite Designs

- Quoting from the ASTM:

“X1.3 Non-Circular Pipe—arched, oval, or rectangular shaped pipes or a combination thereof.

X1.3.1 The design of the spiral wound liner pipe for non-circular shaped pipes is complex and specific to each situation. The manufacturer shall be consulted for design recommendations for the rehabilitation of non-circular pipes. In larger sizes of non-circular pipes, a reinforcing framework for the steel reinforced profile strip liner may have to be temporarily installed to support the live grout load.”
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- Gravity Pipeline Rehabilitation
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- **Features & Benefits of Spiral Wound Liners**
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Features of Spiral Wound Liners

Improved Flow Characteristics

- Improved Manning’s n value (.009) – smoother pipe surface negates any minimal loss in cross-section

Corrosion & Chemical Resistance

PVC Profile Lock Integrity

Structural Integrity

<table>
<thead>
<tr>
<th>Type of Pipe</th>
<th>Manning’s n</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glass, brass, or copper</td>
<td>0.009 - 0.013</td>
</tr>
<tr>
<td>Smooth cement surface</td>
<td>0.010 - 0.013</td>
</tr>
<tr>
<td>Wood-stave</td>
<td>0.010 - 0.013</td>
</tr>
<tr>
<td>Vitrified sewer pipe</td>
<td>0.010 - 0.017</td>
</tr>
<tr>
<td>Cast-iron</td>
<td>0.011 - 0.015</td>
</tr>
<tr>
<td>Concrete, precast</td>
<td>0.011 - 0.015</td>
</tr>
<tr>
<td>Cement mortars surfaces</td>
<td>0.011 - 0.015</td>
</tr>
<tr>
<td>Common-clay drainage tile</td>
<td>0.011 - 0.017</td>
</tr>
<tr>
<td>Wrought iron</td>
<td>0.012 - 0.017</td>
</tr>
<tr>
<td>Brick with cement mortar</td>
<td>0.012 - 0.017</td>
</tr>
<tr>
<td>Riveted-steel</td>
<td>0.017 - 0.020</td>
</tr>
<tr>
<td>Cement rubble surfaces</td>
<td>0.017 - 0.030</td>
</tr>
<tr>
<td>Corrugated metal storm drain</td>
<td>0.020 - 0.024</td>
</tr>
</tbody>
</table>
Features of Spiral Wound Liners

Improved Flow Characteristics
- Improved Manning’s n value (.009) – smoother pipe surface negates any minimal loss in cross-section

Corrosion & Chemical Resistance
- Pipe grade PVC material; corrosion resistance tested successfully with all relevant ASTM’s & Regional Standards (i.e. “Green Book”)

PVC Profile Lock Integrity

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PVC Profile Lock Integrity

- *Mechanical lock provides continuous tight seal impervious to water or root intrusion*

Structural Integrity

Lock Integrity

- *3rd Party at labs throughout the world.*
- *US tests at Ramtech Labs in Los Angeles, CA*
- *Spiral Wound Liners adopted into Green Book Section 500-1.13*

Pressure and Vacuum-ALL PASS

- *Per ASTM F1697*
- *74kPa (10.7 psi) for Internal Pressure*
- *-74kPa (-10.7 PSI) for Vacuum*
- *5% Pipe Deflection & 10 degree bend*
Features of Spiral Wound Liners

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PVC Profile Lock Integrity
- Mechanical lock provides continuous tight seal impervious to water or root intrusion

Structural Integrity
- Fully structural solution – Typically 50 year design life
- Earthquake resistant
Benefits of Spiral Wound Liners

Little/No Bypass

- Installations in live flow
- Flow can go through machine and liner during installation

Mechanical Process

No Site Excavation
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Mechanical Process

- PVC profile manufactured in factory
- PVC profile locked into pipe onsite
- Guaranteed repeatable mechanical properties
- Site conditions DO NOT impact product quality
- No chemical/thermal processes onsite

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No Site Excavation
• 100% Trenchless
• Minimize social impact
Benefits of Spiral Wound Liners

Environmentally Friendly

- Styrene & VOC Free
- No unpleasant odor
- No wastewater
- No waste products
- Minimal fuel operating machines onsite – little carbon footprint
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- **Typical Installation**
  - Installation Methods
  - Steps of Typical Installation
- Case Studies
Installation Methods

- **Static Winding**
  - Tight Fitting – No Grout
  - 6” – 42” circular pipelines

- **Traverse Winding**
  - Tight Fitting – No Grout
  - 40” – 60” circular pipelines

- **Traverse/Static Winding**
  - Grout Required
  - 36” – 216” circular/non-circular pipelines
The SPR™EX Method - Expansion

6” - 42”

Static Winding Machine forms and “pushes” liner downstream

The steel wire is pulled within the profile, severing the secondary lock and expanding the profile tightly against the host pipe wall.

Steel Wire

Primary Lock  Secondary Lock

1/4/2019
3 Installation Methods

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SPR™TF Method – Tight Fit

Introduced to USA - 2018

40” - 60”

Equipment traverses the host pipe while the profile strip locks together. No annular space remains between the host pipe and the liner

SPR™TF profile contains 3 seals that are engaged during winding
3 Installation Methods

- **SPR™EX**
  - Static Winding
  - Tight Fitting – No Grout
  - 6” – 42” circular pipelines

- **SPR™TF**
  - Traverse Winding
  - Tight Fitting – No Grout
  - 40” – 60” circular pipelines

- **SPR™**
  - Traverse/Static Winding
  - Grout Required
  - 36” – 216” circular/non-circular pipelines
36” – 216”

Installed by either static or traversing winding machine. Annular space remains, requiring grout.

SPR™ winds both round & non-round shapes and can negotiate radius bends.
Typical Installation Steps

Pre-Installation

• Pipe is cleaned and inspected
• Laterals are located and logged

Installation

• Strip of PVC Profile is fed from spool above ground
• Liner is constructed onsite inside the pipe

Post-Installation

• Laterals immediately reinstated
• Liner ends are cut and sealed
  • Hydrophillic foam, epoxy mortar grout, etc.
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Case Study – SPR™EX in CA

Scope
• ~40 culverts needing rehabilitation
• Diameter range: 12” – 24”
• Project in Upper Newport Bay, CA

Challenges

Solution
Case Study – SPR™EX in CA

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• Difficult pipe locations
• Monitoring tidal flows

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Solution
• SPR™EX Spiral Wound Liner
• 1,000+ ft. installed
• Installation & material met environmentally sensitive/difficult location needs
Case Study – SPR™ in Kansas City

Scope
• 125 year old circular brick pipe
• Diameter of 114” and ~1,000’ long
• Project in Kansas City, MO

Challenges

Solution
Case Study – SPR™ in Kansas City

Scope
• 125 year old circular brick pipe
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Challenges
• Pipe under 4 lanes of traffic
• Depths of up to 35 feet
• Two sweeping 90° bends
• Significant deflections at crown of pipe

Solution
Case Study – SPR™ in Kansas City

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• 125 year old circular brick pipe
• Diameter of 114” and ~1,000’ long
• Project in Kansas City, MO

Challenges
• Pipe under 4 lanes of traffic
• Depths of up to 35 feet
• Two sweeping 90° bends
• Significant deflections at crown of pipe

Solution
• 100” ID SPR™ liner & grout
• Cross-sectional loss still improved flow (increased Manning coefficient)
• Minimal impact – Just one lane closure for less than 2 weeks
Live Flow Installs Typically Without Bypass

*Improved Flow Characteristics*

**Mechanical Process**

*Corrosion Resistance*

**No Site Excavation**

*PVC Profile Lock Integrity.*

**Structural Integrity**

*Contact us for any questions regarding Spiral Wound Rehab*

[www.sekisuispra.com](http://www.sekisuispra.com) 866-627-7772