Extending Infrastructure Durability with Ultra-Weatherable FEVE Technology

Webinar for Roads & Bridges Magazine

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Summary of Webinar

• Explanation of FEVE technology
• Discussion of markets for FEVE technology
• Presentation of performance in exposure testing
• Life cycle cost advantages
• Examples of applied FEVE coatings
What is an FEVE Fluoropolymer?

1. A hybrid fluoropolymer resin with the ability to be used in standard coatings formulations like any other conventional coating resin

2. A high-performance resin that can withstand severe ultraviolet light exposure 2-3 times longer than conventional coatings resins
Fluoroethylene Vinyl Ether (FEVE) Resins

**FLUORINATED SEGMENTS:** Weatherability • Chemical • Resistance

**VINYL ETHER SEGMENTS:** Gloss • Solubility • Crosslinking
Advantages of FEVE Fluoropolymer Resins

- **Ambient Cure**
  - Field application

- **OH Functional**
  - Crosslinkable with isocyanates

- **Solvent Soluble**
  - Conventional application techniques (airless spray)
  - Wide range of gloss (90@60°)

- **Fluoropolymer Segments**
  - UV Resistance
  - Corrosion resistance
Markets for FEVE Resin-Containing Coatings

1. Architectural coatings for commercial buildings

2. Industrial maintenance coatings for water towers, bridges, assorted metal and concrete structures

3. Aerospace coatings

4. Applications in marine environments
QUV Weatherometer Exposure Testing

![Graph showing gloss retention over hours of QUV exposure for different coatings.](image)

- FEVE Coating
- Polysiloxane Coating
- Acrylic Urethane Coating

**Axes:**
- Y-axis: Gloss Retention (%)
- X-axis: Hours of QUV Exposure (UVB-313 Bulbs)
Sunshine Weatherometer Exposure Testing (Carbon Arc)
EMMAQUA Testing
(Outside Test Fence in Arizona)

![Graph showing gloss retention vs. radiant energy for FEVE coating, PVDF coating, and acrylic urethane coating.](image)
South Florida Test Fence Exposure

Gloss retention (%) vs. Years of Exposure

- FEVE Yellow Coating
- FEVE Clearcoat
Corrosion Resistance Test of FEVE Coatings

- **Location**: Suruga Bay Marine Test Station (offshore)
- **Length of Test**: 16 years
- **Coatings Systems on Test**:  
  - Zinc-rich primer, epoxy midcoat, acrylic urethane topcoat  
  - Zinc-rich primer, epoxy midcoat, fluorourethane topcoat
- **Thickness of Coating**:  
  - Primer: 3 mils  
  - Midcoat: 6 mils  
  - Topcoat: 1 mil (25 microns)
# Measurement of Total Erosion of the Topcoat

<table>
<thead>
<tr>
<th></th>
<th>Acrylic Urethane Topcoat</th>
<th>Fluorourethane Topcoat</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Initial Measurement</strong> (microns)</td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td><strong>Final Measurement</strong> (microns)</td>
<td>0 (after 13 years)</td>
<td>21</td>
</tr>
</tbody>
</table>
Life Cycle Cost Advantages - Part I

• Initial Cost of FEVE-based Topcoat:
  - 5% to 10% higher than standard polyurethane topcoat

• FEVE-Based Topcoat Life Expectation: 30 to 60 years

• Expected Repaints of Std. Polyurethane Topcoat (30 to 60 years):
  - 2 to 3 (based on topcoat erosion data from offshore test)

• Additional Costs of Repaints:
  - Facility downtime
  - Lodging of paint crew on offshore platform
### Breakdown of Total Cost of Recoating a Bridge*

<table>
<thead>
<tr>
<th></th>
<th>3 Coat Epoxy, 2 Coat Polyurethane System</th>
<th>3 Coat Epoxy, 2 Coat FEVE Urethane System</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Staging Costs</strong></td>
<td>$38.96 / m²</td>
<td>$38.96 / m²</td>
</tr>
<tr>
<td><strong>Surface Preparation</strong></td>
<td>$8.44 / m²</td>
<td>$8.44 / m²</td>
</tr>
<tr>
<td><strong>Labor Cost For Paint Application</strong></td>
<td>$26.22 / m²</td>
<td>$26.22 / m²</td>
</tr>
<tr>
<td><strong>Total Cost of Coatings</strong></td>
<td>$12.03 / m²</td>
<td>$15.96 / m²</td>
</tr>
<tr>
<td><strong>Total Repainting Cost</strong></td>
<td>$85.65 / m²</td>
<td>$89.87 / m²</td>
</tr>
</tbody>
</table>

*“Prices of Construction Materials and Wages” October 2006 (Published in Japan)*
## Estimation of Total Applied Cost Per Year (Coating System)

<table>
<thead>
<tr>
<th>Coating System</th>
<th>Total Repainting Cost</th>
<th>Estimated Life of Coating System</th>
<th>Total Applied Cost per year of Service</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polyurethane Topcoat System</td>
<td>$85.65</td>
<td>18</td>
<td>$4.76</td>
</tr>
<tr>
<td>FEVE Urethane Topcoat System</td>
<td>$89.87</td>
<td>30</td>
<td>$3.00</td>
</tr>
<tr>
<td>FEVE Urethane Topcoat System</td>
<td>$89.87</td>
<td>60</td>
<td>$1.50</td>
</tr>
<tr>
<td>FEVE Urethane Topcoat System</td>
<td>$94.21 (estimated)</td>
<td>30</td>
<td>$3.14</td>
</tr>
<tr>
<td>FEVE Urethane Topcoat System</td>
<td>$94.21 (estimated)</td>
<td>60</td>
<td>$1.57</td>
</tr>
</tbody>
</table>
Life Cycle Cost Advantages - Part II

• Initial Cost of FEVE-Modified Topcoat:
  - Depends on the level of modification. Will be 2% to 5% higher than standard polyurethane topcoat.

• FEVE-Modified Topcoat Life Expectation:
  - Will depend on the level of modification. Coatings can be fine tuned to last as long as necessary to meet both short-term objectives (cost constraints) and long-term objectives (elimination of one recoat with an improved aesthetic appearance).
Projects

Project Update: Tokiwa Bridge

- **Original coating scheme:**
  - 1 coat of lead-based primer
  - 2 coats of chlorinated rubber

- **Repainted with fluorourethane in 1986:**
  - Surface prepared to SSPC SP2/SP3
  - 2 coats of epoxy primer
  - 2 coats of fluorourethane
Projects

Project Update: Tokiwa Bridge

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<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>Initial Gloss</td>
<td>75</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Final Gloss</td>
<td>69</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gloss Retention</td>
<td>91%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Color Change</td>
<td>ΔE=3.5</td>
<td></td>
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</tbody>
</table>
Projects

Project: Shelby Street Bridge, Nashville TN

• Coated in 2004

• 3 coat system on steel:
  - Zinc-rich primer
  - Epoxy midcoat
  - Fluorourethane topcoat
Projects

Project: Gateway Bridge, Nashville TN

- Coated in 2004
- Red support girder coated with FEVE-containing coating
Projects

Project: Akashi-Kaikyo Ohashi Road & Train Bridge

• Coated in 1997
• Constructed as 100-year bridge
• Expectation is one recoat only
Projects

Project Update: Katsushika Harp Bridge

- Construction completed in 1986 (shop coating began in 1982)
- 3 coat system
- Concrete bridge piers
  - Elastic primer
  - 2 fluorourethane topcoats
- Steel encasement for earthquakes in 2007
Extending Infrastructure Durability with FEVE Technology

New Steel Encasement: Coated 2007

Original Concrete Foot: Coated 1987
Conclusion

For 32 years, FEVE resins have been included in exterior coatings for multiple end uses. Their excellent weatherability and corrosion resistance make them attractive for inclusion in topcoats for steel and concrete surfaces.
Acknowledgements

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For more information

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