Ultra Weatherable Fluoropolymer Coatings For Bridges

*How to Learn to Love Paint*

*Or*

*Toward the 100 Year Bridge Coating*
The Problem With Painting

- The High Cost of Painting
  - Revenue loss
  - Actual cost of painting
  - Costs to the driving public
  - Environmental costs

- The High Cost of Painting
  - Repeat after only 15 years
Why Paint?

• **Prevent Corrosion**
  – Zinc rich primers
  – 2-3 coat systems
  – Long term corrosion prevention

• **Preserve Appearance**
  – Appearance integral to bridge design and image
  – Long term preservation of appearance

• **How?**
  – FEVE fluoropolymer coatings
FEVE Fluoropolymer Coatings

• **Characteristics**
  – Ultra-weatherable
  – Soluble and compatible with water
  – Standard coating chemistry
  – Standard application equipment
  – Field or shop application
  – Wide range of gloss and color possible
  – Improved corrosion resistance
Preservation of Appearance

- Resistance to UV Light

![Graph showing gloss retention over hours of QUV-A exposure for different materials: Fluorourethane, Polyester Urethane, Acrylic Urethane, and Siloxane.](graph.png)
Preservation of Appearance

- **Resistance to UV Light**

![Graph showing the preservation of appearance resistance to UV Light for different materials.](EMMAQUA TEST)

- FEVE
- PVDF
- Polyurethane
Preservation of Appearance

- Resistance to UV Light

![Graph showing gloss retention over years of exposure for FEVE Yellow Coating and FEVE Clearcoat.]
Preservation of Appearance

<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td>20 Years</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unwashed Coating</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Washed Coating</td>
<td></td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Gloss Retention, %</th>
<th>Color Change, ΔE</th>
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<tbody>
<tr>
<td>Unwashed Coating</td>
<td>92%</td>
<td>3.5</td>
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<tr>
<td>Washed Coating</td>
<td>100%</td>
<td>2.3</td>
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</table>
Preservation of Appearance

Uosaki Bridge
21 Years

Hirase River Bridge
20 Years

Nikko River Bridge
20 Years
Corrosion Prevention

- Causes of Corrosion
  - UV degradation
  - Water
  - Oxygen
  - Salt
  - Acid rain
  - Industrial pollution
Corrosion Prevention

- Electrochemical Impedance Spectroscopy (EIS)
- Zinc rich primer/epoxy/topcoat
- Effectiveness of topcoat in preventing corrosion
- Accelerated weathering followed by salt fog test
- Smaller change in impedance, better corrosion resistance

![Graph showing impedance vs. time for different materials](image-url)

- FEVE
- Polyurethane
- Chlorinated Rubber
- Alkyd
Corrosion Prevention

Change in Topcoat Thickness Over Time

- **Function of Topcoat in Corrosion Prevention**
  - Prevents transit of corrosion initiators

- **Weathering Reduces Topcoat Thickness**
  - Increase chances of corrosion initiator transmission
  - Initiate corrosion of zinc rich primer
Corrosion Prevention
Change in Topcoat Thickness Over Time

- Test Platform, Suruga Bay, Japan
- 250 m Offshore
- Test Coatings and Metals in Corrosive Environment
- Zinc Rich Primer/Epoxy/Urethane
- Zinc Rich Primer/Epoxy/Fluoropolymer

<table>
<thead>
<tr>
<th>Test Site</th>
<th>Years</th>
<th>Coating Type</th>
<th>Initial</th>
<th>Final</th>
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<tbody>
<tr>
<td>Suruga Bay, Japan</td>
<td>16</td>
<td>FEVE</td>
<td>25 µm</td>
<td>21 µm</td>
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<tr>
<td>Suruga Bay, Japan</td>
<td>12</td>
<td>Urethane</td>
<td>25 µm</td>
<td>0 (12 Years)</td>
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</table>
## Comparative Life Cycle Costs

<table>
<thead>
<tr>
<th>Coating Type</th>
<th>Process</th>
<th>Cost, $/m²</th>
<th>Initial Cost Ratio</th>
<th>Coating Life, Years</th>
<th>Cost/Year, $/m²</th>
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</thead>
<tbody>
<tr>
<td>Chlorinated Rubber</td>
<td>Surface Preparation</td>
<td>$10.08</td>
<td>0.19</td>
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<td></td>
<td>Staging</td>
<td>$27.48</td>
<td>0.52</td>
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<td></td>
<td>Coating</td>
<td>$15.53</td>
<td>0.29</td>
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<td>Total</td>
<td>$53.09</td>
<td>1.00</td>
<td>8</td>
<td>$6.64</td>
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<tr>
<td>FEVE Coating</td>
<td>Surface Preparation</td>
<td>$10.08</td>
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<td></td>
<td>Staging</td>
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<td>Coating</td>
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<td>Total</td>
<td>$78.14</td>
<td>1.47</td>
<td>&gt;21</td>
<td>$3.72</td>
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<td>LCC Ratio</td>
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<td>0.56</td>
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Comparative Life Cycle Costs

<table>
<thead>
<tr>
<th>Bridge</th>
<th>Daiichi Mukayama</th>
<th>Uosaki</th>
<th>Onsen</th>
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<tr>
<td>Life of FEVE Coating</td>
<td>&gt;19 years</td>
<td>&gt;21 years</td>
<td>&gt;21 years</td>
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<tr>
<td>Repainting of Competitive Coating</td>
<td>1 time</td>
<td>2 times</td>
<td>1 time</td>
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<tr>
<td>LCC Ratio</td>
<td>0.84</td>
<td>0.49</td>
<td>0.83</td>
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Bridge Coating Standards in Japan

• Japanese Road Association
  – Specifications for new construction and maintenance coatings
  – Fluoropolymer topcoats required on all steel bridges in Japan

• Japanese Industrial Standard JIS K-5659
  – Coating specification for fluoropolymer topcoats
# Toward the 100 Year Bridge Coating

<table>
<thead>
<tr>
<th>Process</th>
<th>Paints and operation</th>
<th>Amount (g/㎡)</th>
<th>Dry Film Thickness (μm)</th>
<th>Interval</th>
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<tbody>
<tr>
<td><strong>&lt;Mill maker&gt;</strong></td>
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<tr>
<td>Surface Treatment</td>
<td>Blasting ISO Sa2 1/2 (SSPC SP-10)</td>
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<tr>
<td>Primer</td>
<td>Inorganic Zinc Rich Primer</td>
<td>160</td>
<td>15</td>
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<td><strong>&lt;Fabricator&gt;</strong></td>
<td>Shop Applied Coatings</td>
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<tr>
<td>Second Surface Treatment</td>
<td>Blasting ISO Sa2 1/2 (SSPC SP-10)</td>
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<tr>
<td>Protective primer</td>
<td>Inorganic Zinc Rich Primer</td>
<td>600</td>
<td>75</td>
<td>4 hours</td>
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<tr>
<td>Mist Coat</td>
<td>Epoxy</td>
<td>160</td>
<td>—</td>
<td>2〜10days</td>
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<tr>
<td>Under Coat</td>
<td>Epoxy</td>
<td>540</td>
<td>120</td>
<td>1〜10days</td>
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<td>Middle Coat</td>
<td>Fluorourethane</td>
<td>170</td>
<td>30</td>
<td>1〜10days</td>
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<tr>
<td>Top Coat</td>
<td>Fluorourethane</td>
<td>140</td>
<td>25</td>
<td>1〜10days</td>
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</tbody>
</table>
Advantages of Fluoropolymer Coatings

• Substantial Life Cycle Cost Reduction
• Improved Corrosion Resistance
• Improved Bridge Appearance
• Closer Match of Coating Life with Bridge Life
• Environmental Benefits
  – Reduced solvent and CO2 emissions
• Reduction in Other Costs
  – Traffic diversion
  – Overspray costs
Bridge Problems in Japan
Bridge Problems in Japan
AGC Chemicals Americas
Exton, PA

IBTTA Maintenance Conference
Kansas City, MO

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