Fluoropolymer Coatings for Buildings, Bridges, and Infrastructure

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Summary

Damage to buildings, bridges, and infrastructure by corrosion and other environmental processes costs billions of dollars per year. Paints and coatings can be used to protect existing and new infrastructure from degradation by the elements. Coatings based on fluoropolymer resins have lifetimes exceeding 30 years, leading to substantially lower life cycle costs compared to conventional coatings. Fluoropolymer coatings have been successfully used on over 150,000 structures worldwide.

Keywords: Paints, coatings, topcoats, corrosion, bridges, monumental buildings, water towers.

1. Introduction

Coatings provide a cost effective method of reducing structural degradation and preserving the appearance of buildings, bridges, and other infrastructure. Zinc rich primers have been used to extend corrosion protection for periods of 30 years or more. Conventional topcoats, such as polyurethane, alkyds, and epoxies, cannot match the performance of these primers, due to premature degradation by the elements, primarily ultraviolet (UV) radiation. Degradation allows corrosion initiators to penetrate the topcoat and begin to initiate corrosion. In addition, the appearance of the coating suffers.

Fluoropolymers offer excellent corrosion resistance and weatherability. However, conventional fluoropolymers are difficult to use in coatings, since they form films only at high temperatures and have poor solubility in solvents or water. A different class of fluoropolymers, called FEVE resins, has found widespread application in coatings, and overcome the factors limiting the use of fluoropolymers.

2. Fluoroethylene Vinyl Ether (FEVE) Based Coatings

FEVE resins, developed in the early 1980's in Japan, combine properties of fluoropolymers with those of conventional polyurethane resins, enabling their facile use in coatings. These resins have enabled the development of fluorourethane topcoats that will retain their appearance and prevent corrosion of metallic substrates for more than 30 years.

Coating weatherability influences both appearance and corrosion protection. FEVE based coatings have been demonstrated in both accelerated weathering tests and real time South Florida weathering to offer superior color and gloss retention. This means that the appearance of a structure will change very little over time. Retaining appearance is important for architectural and industrial maintenance applications.

Especially for bridges and similar infrastructure, corrosion protection is critical. These applications may require the use of heavy duty coating systems, usually consisting of a zinc rich primer, an epoxy or urethane middle coat, and a weatherable topcoat. Because they degrade only slowly over

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time, FEVE based coatings are able to impede the transport of corrosion initiators like chloride ion to the undercoats. In addition, FEVE fluorourethanes have been found by Electrochemical Impedance Spectroscopy to resist corrosion when compared to conventional topcoats.

3. Rehabilitation and Preservation of Infrastructure with FEVE Resins

FEVE resin based coatings have been used to restore buildings around the world. Because aesthetics are usually the most important factor in choosing a coating system for a building, they tend to be coated with epoxy primers with durable topcoats. Monumental buildings, multiple story buildings in large cities, tend to have the highest coating application costs. The use of FEVE coatings on these structures can substantially reduce the life cycle cost of the building. Examples of structures with FEVE topcoats include the Verizon Building and the George Fuller Building in New York, City Hall and the renovated San Francisco Centre dome, and the Peachtree Building in Atlanta.

Bridges, because of the importance of corrosion resistance, tend to use a heavy duty coating system. One bridge painted in the 1980's in Japan, the Tokiwa Bridge, was monitored closely over 21 years, and application costs noted, and life cycle costs calculated. Table 1 below shows the results of life cycle costs. While the competitive coating system had lower initial application costs, the FEVE coating system cost only half as much over the life of the coating. It was noted that the average gloss retention of the FEVE topcoat was 91%, while the average color change was 3.5 ΔE, which is not discernible to the average person. As a result of applications like the Tokiwa Bridge, the Japanese Ministry of Land, Transportation, and Infrastructure now requires the use of fluoropolymer topcoats on all bridges in Japan. Their specification suggests a minimum topcoat life of 30 years, with lifetimes exceeding 60 years in some instances. There are a large number of well known bridges in Japan that boast FEVE resin topcoats, including the Akashi Straits Bridge, the world's longest suspension bridge.

Table 2: Life Cycle Cost Analysis

Coating Type	Process	Cost, $/m^2	Life, Years	Cost, $/m^2/year
Chlorinated Rubber	Surface Preparation	$37.56		
	Coating	$15.53		
	Total	$53.09	8	$6.64
FEVE	Surface Preparation	$43.06		
	Coating	$35.08		
	Total	$78.14	>21	$3.72
	LCC Ratio			0.56

In the U.S., a large number of water towers have been coated with FEVE based coatings. Like bridges and monumental buildings, water towers are difficult to coat owing to their size and shape. Both corrosion resistance and appearance are important in this area. In some cases, maintenance coating cycles of as long as 30 years are possible.

4. Conclusions

FEVE topcoats can provide over 30 years of color and gloss retention, as well as corrosion protection on infrastructure of all kinds. As demonstrated in numerous projects, asset life cycle costs can be substantially reduced using FEVE coatings. By proper selection of coating systems, less expensive materials of construction can be used while still providing useful asset life. FEVE coatings are best used on infrastructure that is difficult to service like monumental buildings, bridges, and water towers.