

Fluoropolymer Topcoats Show Promise for Durability

Condensed from "Fluoropolymer Topcoats for Bridges," by Winn Dardan, AGC Chemicals Americas

While the development and widespread use of polyurethanes and polysiloxanes have increased the longevity of topcoats, there still exist considerable differences in the long-term durability of zinc-rich primers and topcoats.

Fluoropolymers, developed in the 1960s, have always offered intriguing possibilities for coatings. Their desirable properties include extreme weatherability and chemical resistance, low surface energy for anti-graffiti properties, and corrosion resistance.

The use of fluoropolymer resins for topcoats would allow for the retention of desirable topcoat properties (corrosion protection, original color and gloss) for as long or longer than those achieved by zinc-rich primers. Unfortunately, the application characteristics of fluoropolymers have limited their use in field-applied coatings. Most fluoropolymers form films only at high temperatures, either by melting or coalescing from solvents. Adhesion of fluoropolymers to metal is poor, but can be improved by the addition

of other resins, which can compromise other physical properties. In addition, many fluoropolymers are difficult to recoat due to their low surface energy.

To address these shortcomings, researchers in Japan developed a group of products known generically as FEVE (fluoroethylene vinyl ether) resins in the early 1980s. Coatings made from them offer the weatherability of fluoropolymers combined with properties found in conventional coatings like polyurethanes. Coating properties can be modified by slight changes in the structure of the FEVE resin, which are soluble in solvents, and can be made water-compatible, making them familiar and easy to use in the field. The chemistry used in formulating FEVE-based coatings is exactly the same as that of conventional polyurethanes, and application equipment is exactly the same as well. Thus, FEVE coatings can be applied in the shop for new construction, or in the field for bridge rehabilitation.

Although initially somewhat more expensive than urethanes or siloxanes, fluoropolymers offer considerable reductions in coating life cycle costs, in bridge downtime, and in traffic problems during repainting.

Coatings made with FEVE resins also offer excellent corrosion resistance. Zinc-rich primers are the main defense against

corrosion on steel bridges. Conventional topcoats gradually lose thickness and erode over time due to degradation by UV light, rain, wind, and chemicals. When the conventional topcoat erodes completely, the midcoat begins to degrade, increasing the probability of corrosion. Fluorourethanes do not lose significant thickness over time, and therefore continue to impede the movement of corrosion initiators through the topcoat.

Recently, bridge designers have begun to explore the use of more varied colors in bridge topcoats, moving away from standard lighter colors like yellow and grey. Fluorourethane topcoats

offer the possibility of using unconventional colors for bridges, while ensuring the designer that the original gloss and appearance will remain intact for many years.

Most of the long-term research on FEVE-based coatings has been done in Japan. In the 1980s, a series of bridges were recoated, usually half with a FEVE-based topcoat, and the other half with a topcoat commonly in use at the time. The condition of these bridges was monitored over time, and as a result, FEVE topcoats

have now been used on dozens of bridges in Japan. Probably the best known is the Akashi Straits Bridge, which is the world's longest suspension bridge. The bridge is over 12,000 feet in length, with the single longest span of over 6,000 feet. The bridge was opened in 1994. Coatings were primarily shop applied and finished in the field. Multiple FEVE topcoats are meant to give a coating life in excess of 60 years.

Based on extensive testing over the past 25 years, the Japanese Ministry of Land, Transport, and Infrastructure issued its new national specifications for coatings for steel bridges in August 2008. "Japanese Specifications for Steel Bridge Coatings" requires fluoropolymer topcoats on all bridges in Japan, for both new construction and rehabilitation. Bridges topcoated with fluoropolymer resins are expected to have useful lives, exceeding 50 years in some cases, to significantly reduce costs associated with recoating bridges in the field, and to postpone the need for recoating of new bridges.

FEVE fluorourethanes are beginning to find application in the U.S. as well. A series of bridges in Nashville, TN, have been fully or partially topcoated with fluorourethanes: the Shelby Street Bridge, Gateway Bridge, the Woodland Street Bridge, and the Victory Memorial Bridge.



The Akashi Straits Bridge in Japan
Courtesy of Winn Dardan