Use of Polymer Overlays or Sealers on New Bridges

Tech Transfer Summary

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Use of Polymer Overlays or Sealers on New Bridges

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This research project investigated optimum timing for using polymer overlays and sealers as preventive maintenance (PM) options to extend the service life of concrete bridge decks.

Objective

The main objective of this study was to develop guidelines for Iowa DOT that can aid in identifying optimum timing for application of polymer concrete overlays or sealers on new bridge decks and its effect on expected service life. The criteria for selecting polymer overlays, sealers, or using both was defined. The research also provides a framework to include assessment of cost-benefit ratio as a factor for application of such systems.

Background & Problem Statement

Constructing concrete bridge decks with extended service lives is of paramount importance for Departments of Transportation as decks are directly exposed to deicers, cracking, reinforcement corrosion and surface deterioration affect the overall service life. Further, the quality of the deck impacts the public through ride quality, bridge appearance and maintenance-related delays. Progressive deterioration of concrete bridge decks can result in poor ride quality as well as a decrease in concrete resistance to deicers.

One option to ensure long-term durability and extend service life of concrete bridge decks is preventive maintenance using polymer overlays and sealers. Polymer overlays and sealers provide protection from deterioration mechanisms by inhibiting both the ingress of chlorides and chemicals and also reduce corrosion rates by limiting moisture. Identifying the optimum time to install polymer overlays or sealers is key to maximizing the benefit-to-cost ratio of this type of preventive maintenance.

Research Description

The basis of this research study was reviewing available literature and surveys on the use of polymer concrete overlays and sealers. Literature review included the description of the materials used for polymer concrete overlays and sealers, recommended practices for application and quality assurance testing, construction considerations, and a summary of survey results and expected costs.

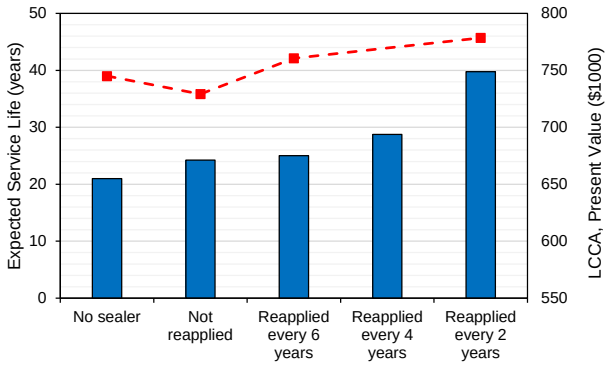
The method of selection for the use of polymer concrete overlays and sealers as preventive maintenance options along with the optimum timing of their application as indicated in the literature was described.

Service life models were developed for a hypothetical “typical” bridge in Iowa to study optimum timing of applying preventive maintenance using polymer overlays and/or sealers. Recommendations for optimum timing of applying preventive maintenance are also provided based on the results of the service life models and the benefit to cost ratio.

Key Findings

The findings of this study can be summarized as:

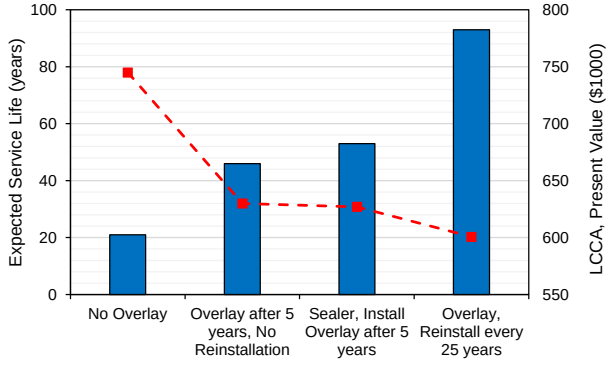
1. Polymer overlays and sealers should not be used on deteriorated decks or decks in need for major repairs, as they will not be effective.
2. With exception to cost, polymer overlays have several advantages over sealers, including restoring skid resistance and appearance.
3. The results of the service life modeling show that optimum timing for installing preventive maintenance is within the first 10 years of bridge construction. This agrees with the recommendations found in the literature.
4. The service life modeling results indicate that Polyester Polymer Concrete (PPC) overlays yield longer service life when compared to Multi-Layer Epoxy (MLE) overlays. This is mainly attributed to the greater thickness of the PPC overlay. It is noted that the model assumes that both overlays will have the same delaminated area at the end of their service life. In reality, this rate of delamination is dependent on installation quality, material formulation, surface preparation, traffic levels, and weather exposure.
5. Life-cycle cost analysis (LCCA) indicated that the use of preventive maintenance approaches will result in significant savings. The results show that the most cost-effective option over a 100-year period of service is to install an overlay at the time of construction and to reinstall it every 25 years. For bridges with expected life of 50 years, the service life models and LCCA indicate that the best results were obtained when a hybrid preventive maintenance approach is used, which consists of applying a sealer immediately after bridge construction and installing a polymer overlay after approximately 5 years. This approach maximizes the benefit from each system as sealers will seal early age cracks forming on the deck while overlays will be applied prior to any significant chloride ingress. Applying the polymer overlays after 5 years will also give sufficient time for shrinkage cracks to form in the deck, which may limit the reflection of these cracks through the overlay.



Expected service life and LCCA (considered period of 100 years) for concrete deck with deck-penetrating sealers reapplied at various intervals.

Summary of service life model results for new deck, delayed application of overlay.

Deck Age at Overlay Application (years)	Prepare surface only, limited depth of removal		Remove top 1/2" of surface prior to overlay	
	1-inch PPC	0.4-inch MLE	1-inch PPC	0.4-inch MLE
No overlay	21	21	21	21
0	43	41	43	41
5	46	37	42	35
10	35	29	42	32
15	22	22	31	31
20	20	20	21	21
Sealer at 0 years + Overlay at 5 years	53	41	--	--



Expected service life and LCCA (considered period of 100 years) for concrete deck with different polymer overlay installation options.

Implementation Benefits and Recommendations

The contents of this research study may be used as general guidelines for Iowa DOT to choose optimum timing for application of preventive maintenance such as polymer overlays and sealers. The cost-benefit analysis showed that significant life cycle cost savings may be achieved if preventive maintenance is applied within the first 10 years. Therefore, it is recommended that these preventive maintenance approaches be applied early in the life of new bridges.