

EPOXY-COATED REBAR DELIVERS COST EFFECTIVE VALUE FOR PARKING GARAGES



Concrete Reinforcing Steel Institute



*I*ntroduction

*Epoxy coating . . .
a cost-effective,
durable corrosion
protection system.*



*L*ow
*initial
cost*

In the last 25 years, the cost of maintaining, rehabilitating and reconstructing corrosion-damaged reinforced concrete structures has rapidly escalated, necessitating more cost-effective corrosion protection systems. With this need, epoxy-coated reinforcement has gained widespread acceptance as a means to extend the service life of parking garages, bridges and other reinforced concrete structures susceptible to corrosion.

To better manage these costs and to assure maximum return on investment, many owners and specifiers are employing life-cycle cost analysis to evaluate future expenditures and to justify corrosion protection strategies.

Epoxy-coated reinforcement was first used in 1973. Since then, thousands of structures have been constructed with this material. Many—particularly those built in the 1970s and early 1980s—have now reached corrosive conditions due to exposure to deicing salts, seawater or harsh chemicals. Field research has shown that the epoxy-coated reinforcement in these structures is performing very well, and is significantly increasing the service life and in turn, reducing life-cycle costs.

Excellent corrosion-protection performance, coupled with a low initial cost has made epoxy-coated reinforcement a sound value for most reinforced concrete structures. When compared to other alternative protection systems (or no corrosion protection at all), epoxy-coated reinforcement offers low life-cycle costs and is a very cost-effective strategy.

To evaluate the life-cycle cost of any durability strategy, a designer must determine the initial construction and material costs. Since its first use in the early 1970s, the cost of epoxy-coated reinforcement has dropped significantly. Early on, epoxy coating added 80% to 120% to the cost of uncoated reinforcement. As use and production grew, the cost to specifiers decreased. Presently, the cost of epoxy coating typically adds about \$0.10 to \$0.20 per pound to the cost of steel reinforcement. For most structures, coating all rebar will usually only increase the total structural cost by 1% to 3%. For park-

COST EFFECTIVE . . . EPOXY-COATED REBAR

ing decks the added cost is typically in the range of \$0.40 to \$0.80 per square foot.

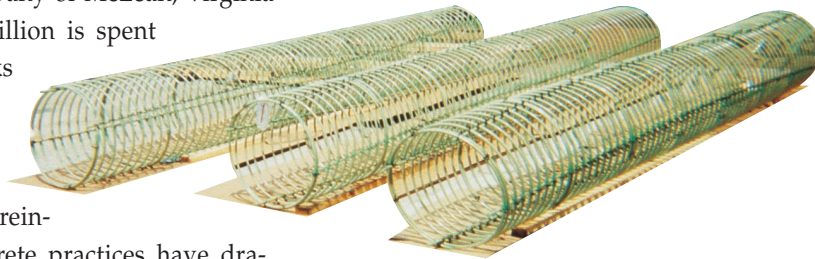
Compare these costs to the high cost of maintenance, repair and reconstruction. Patching repair can run \$20 to \$35 per square foot or more. Combined with the potential for user inconvenience, loss of service and revenue plus reduced safety, the cost of corrosion-induced damage is very high compared to the low cost of epoxy-coated reinforcement.

Before the use of epoxy-coated rebar, specifiers were becoming acutely aware of the short life expectancy of structures built without corrosion protection. With respect to bridges, in 1974 the National Bureau of Standards reported that, "Bridges are experiencing deterioration within 5 to 10 years of service." In 1979, The General Accounting Office reported that 160,000 bridges in the U.S. had significant corrosion problems. Although historical data is generally unavailable, unprotected parking structures have similar corrosion experience. The Parking Market Research Company of McLean, Virginia estimates that at least \$600 million is spent annually to repair parking decks in the U.S., much of which is the direct result of inadequate corrosion protection.

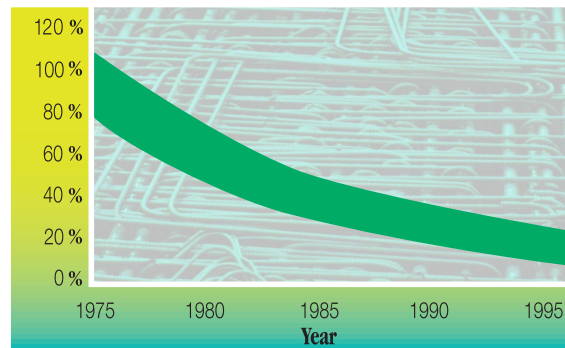
The use of epoxy-coated reinforcement and improved concrete practices have dramatically improved these statistics, and enhanced the durability of reinforced concrete structures over the last 25 years. Numerous research studies have confirmed that epoxy-coated reinforcement is significantly extending the life of parking garages, concrete bridges and other structures in corrosive environments. For example, studies by the Minnesota, Michigan, Pennsylvania, New York, Indiana, California, and West Virginia Departments of Transportation all show that many older bridges have now reached corrosive conditions, and that the epoxy-coated rebar is helping to protect against corrosion and associated concrete damage. Similar findings have also been observed on parking garages.



Performance



Epoxy-coated rebar extends service life and lowers life-cycle costs.

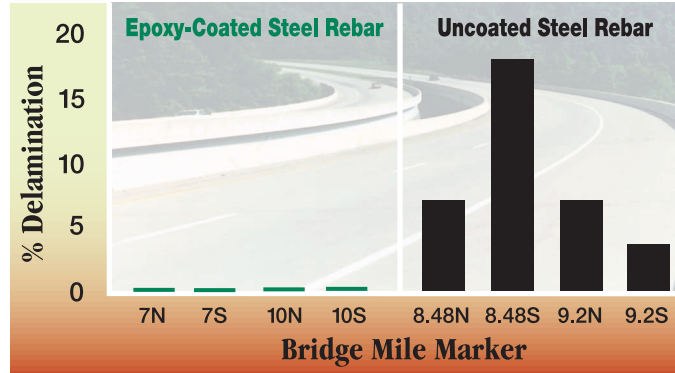


**Additional Cost to Epoxy Coat Rebar—
as a % of Reinforcing Steel Cost**





Comparison of Bridge Decks Constructed with and without Epoxy-Coated Rebar



West Virginia I-79 Bridge Deck
Delamination after Twenty Years

In West Virginia, side-by-side performance of 8 bridge decks on Interstate 79 near Charleston, four constructed with and four without epoxy-coated reinforcement, clearly demonstrates the value of specifying epoxy-coating. After 20 years of service, corrosion-induced concrete damage is widespread on the decks built

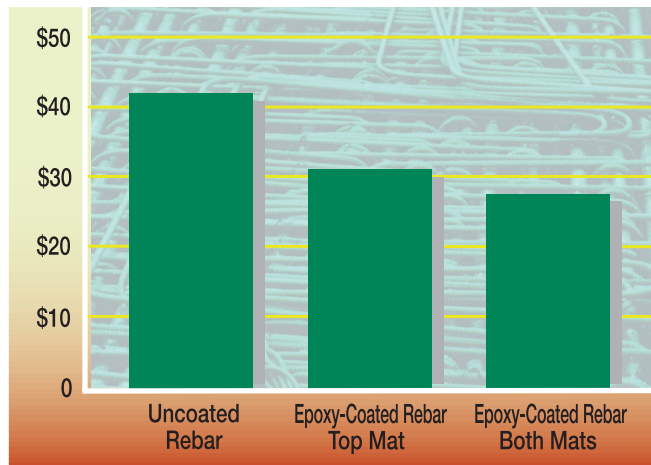
with uncoated rebar and is virtually non-existent on the decks with coated steel in the top mat of reinforcement.

Corrosion protection economics

“The investment in epoxy-coated rebar is often recouped with as little as a 1 to 2 year life extension.”

Longer serviceable life, low initial outlay, and the high cost associated with concrete repair/replacement make epoxy-coated reinforcement a tremendous value for most corrosion-susceptible applications, based on life-cycle cost analysis. Annual return on investment typically ranges from 15% to 20% for many severe corrosion applications—a sound investment in most financial situations. Further, the *payback* period required to offset the modest premium for specifying epoxy coating is often as little as a one-to-two year life extension.

Its low life-cycle costs compare favorably to other protection schemes, and make epoxy-coated reinforcement one of the most cost-effective alternatives for corrosion protection of reinforced concrete structures.



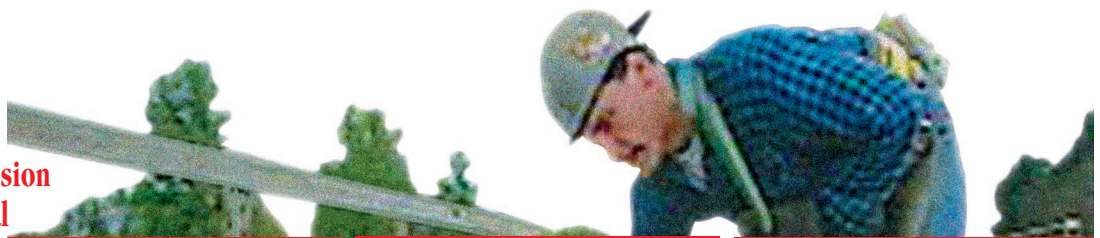
Net Present Cost—Typical Parking Garage
(per square foot)

COST EFFECTIVE . . . EPOXY-COATED REBAR

The following example of a typical life-cycle cost analysis representative of a parking garage in a northern, deicing salt environment illustrates the relative cost-effectiveness of epoxy-coated reinforcement.

Sample cost analysis

Life-cycle Cost Analysis of Epoxy-Coated Rebar Corrosion Protection Systems for Typical Parking Garage



	Uncoated Rebar—Parking Deck	Epoxy-Coated Rebar—Top Mat	Epoxy-Coated Rebar—Both Mats
Added Cost of Protection System	NA	\$0.15 per lb.	\$0.15 per lb.
Initial Investment ¹ (construction & protection)	\$25 per sf	\$25.30 per sf	\$25.60 per sf
Discount Rate	4%	4%	4%
Life Extension ² from Protection System	NA	15 years	25 years
Service Life	15 years	30 years	40 years
Repair/Rehab Cost ³	\$10.00 per sf	\$10.00 per sf	\$10.00 per sf
Annual Rate of Return On Investment	NA	27%	22%
Net Present Cost (per sq. ft.)	\$42	\$31	\$28

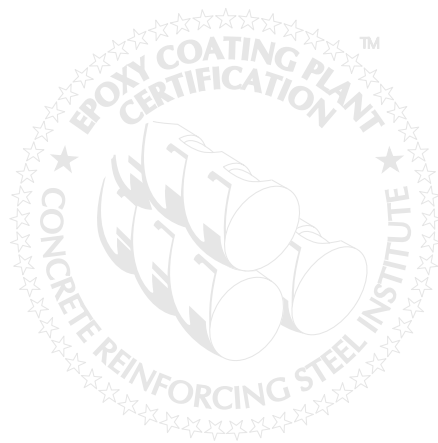
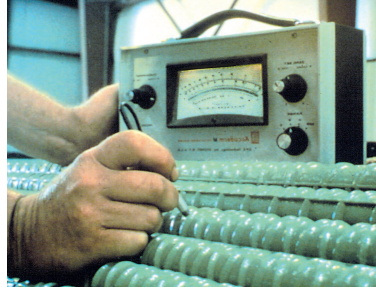
Note 1: Although actual costs may differ, this analysis and the relative life-cycle costs are representative of many “typical” parking garages. The above costs are provided for illustrative purposes only; their validity should be verified for any given project. For more detailed information regarding the derivation of this table, contact CRSI. The actual cost of construction and of epoxy-coated reinforcement will vary depending on factors such as location, complexity, design, loading and timing.

Note 2: The estimated service life extensions for the epoxy-coated alternatives are based on conservative estimates derived from the Federal Highway Administration’s study “Corrosion Resistant Reinforcement for Concrete Components.” This study evaluated epoxy coatings under a series of severe, “worst-case” test conditions. In actual practice, with the use of quality material, proper handling and construction practices, service life extensions in excess of these values may be possible.

Note 3: The Repair/Rehabilitation estimate includes costs for patching, engineering and lost revenues.



Quality
*Higher quality
improves
performance,
lowers life-cycle
costs, and enhances
the overall
cost effectiveness
of epoxy-coated
reinforcement.*



CERTIFIED PLANT

Specifying and insisting on high quality epoxy coating application, and on proper handling and construction practices in the field will help maximize the benefits of epoxy coating. While past field performance demonstrates the benefits of the epoxy coating protection system, research has repeatedly shown that improving coating quality significantly enhances performance.

CRSI has instituted a voluntary plant certification program for epoxy coating applicators to help ensure a consistently high quality end product. In addition, continual refinement of the standard specifications is further ensuring this quality. Standards for epoxy-coated reinforcement are available from the American Society of Testing and Materials, and the American Association of State Highway and Transportation Officials.



Epoxy-coated reinforced structures have proven their worth in the last 25 years. Research has shown that epoxy coating has outperformed the original projected life-cycle. The service life of many structures has increased resulting in reduced life-cycle costs.

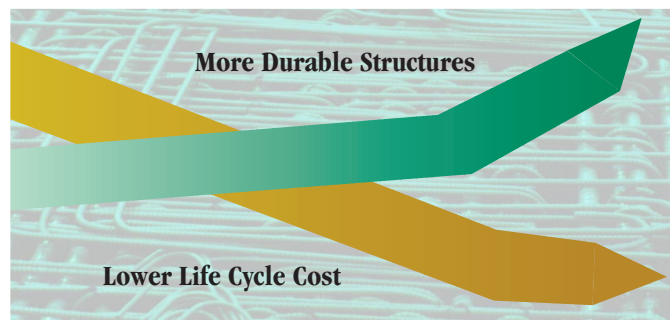
Voluntary programs, instituted by applicators, are helping to produce a very high quality product. When use increased and production costs decreased, the low initial cost of epoxy coating proved to be even more cost effective. The investment in epoxy-coated rebar is often recouped in the 1st or 2nd year of the service life extension—making this one of the most effective corrosion protection investments available and a good value.

Specify epoxy-coated rebar for your next project in corrosive environments and get a cost effective material that extends the structure's service life.



Summary

Value



For more information regarding epoxy-coated reinforcement, the CRSI Plant Certification Program for Epoxy Coating Applicators, or life-cycle cost analysis of corrosion protection systems, contact the Concrete Reinforcing Steel Institute at:

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Epoxy-Coated Reinforcement

- *Protects Against Corrosion*
- *Extends Service Life*
- *Reduces Life-Cycle Costs*
- *Low Initial Investment*
- *Cost-Effective*
- *Good Value*



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