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UNITED STATES GENERAL ACCOUNTING OFFICE
WASHINGTON, D C 20548

RESOURCES, COMMUNITY AND ECONOMIC DEVELOPMENT DIVISION

JULY 19, 1984

B-215618


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The Honorable Don J. Pease
House of Representatives

Dear Mr. Pease:

Subject: Use of Cathodic Protection to Combat Corrosion of Bridge Decks (GAO/RCED-84-165)

At your request, we are providing you information on the protection of reinforced concrete bridge roadway surfaces (decks) and the Federal Highway Administration's (FHWA's) efforts to promote a corrosion prevention technology known as cathodic protection, which uses a continuous electrical current to combat corrosion of the reinforcing steel in concrete bridge decks. As agreed with your office, we focused our review on obtaining and providing information on (1) FHWA views on cathodic protection, (2) research efforts undertaken, and (3) FHWA efforts to encourage the use of cathodic protection.

FHWA believes that the use of cathodic protection on reinforced concrete bridge decks can save billions of dollars. Since 1973, FHWA has spent about $1.5 million on research and development of cathodic protection. In addition, FHWA, during the past 9 years, has provided educational, financial, and technical assistance to states and local highway agencies participating in the cathodic protection demonstration project.

OBJECTIVES, SCOPE, AND METHODOLOGY

To respond to your request to obtain FHWA's views of cathodic protection, actions taken to encourage or require its use by states, and the extent of research done, we reviewed FHWA reports on cathodic protection, pertinent regulations, state evaluations of individual projects, and other related documents. We also discussed cathodic protection with responsible FHWA headquarters officials. We contacted state highway officials in California, the first state to use cathodic protection on bridges, and Ohio, which has several current demonstration projects. We did not

obtain agency comments on this report. However, we did discuss the contents of this report with the Associate Administrator for Engineering and Operations, FHWA; the Chief, Demonstration Projects Division, Office of Highway Operations, FHWA, who is responsible for FHWA's cathodic protection program; and the Chief, Bridge Division, Office of Engineering, FHWA. They agreed with the facts presented. We performed our review during the period from March 1984 to May 1984, and except as noted above, the review was made in accordance with generally accepted government auditing standards.

BRIDGE DECKS DETERIORATING MORE RAPIDLY THAN EXPECTED

Although bridge decks are normally expected to provide relatively maintenance-free service for about 40 years, FHWA has found that some unprotected bridge decks require major repair within 5 to 10 years and often must be replaced after 15 years of service. The major cause of this early deterioration is corrosion of the reinforcing steel bars in the bridge deck brought about by the salt either used to melt snow and ice or found in sea water. In reinforced bridge decks, steel corrosion occurs when the salt interacts, in an electrochemical process, with the moisture and oxygen in the concrete.

In 1979 we reported[1] that there were thousands of corroding bridge decks on the federal-aid highway system in 32 states. We noted that 27 of these 32 states reported that, unless repairs are completed in the next 3 to 5 years (by 1984), their salvageable bridge decks would have deteriorated to the point of requiring complete replacement, resulting in greatly increased repair costs. We reported, for example, that an FHWA study indicated that, if the 29,000 interstate highway bridge decks requiring minor repair in 1979 were neglected and corroded further to require moderate repair, the then-estimated repair cost of about $600 million would increase to about $5 billion (in 1975 dollars). However, according to FHWA, few bridge decks have been repaired through May 1984 due to a lack of funds.

FHWA's VIEWS ON CATHODIC PROTECTION

According to FHWA, one way of extending the life of corroding reinforced concrete bridge decks is cathodic protection. Cathodic protection involves applying a continuous electrical current in an amount sufficient to overcome the natural corrosive electrochemical process. When electrical current is applied to the reinforcing steel, the rate of corrosion will be reduced, and if enough electricity is applied, corrosion will be halted.

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[1] Solving Corrosion Problems of Bridge Surfaces Could Save Billions (PSAD-79-10, Jan. 19, 1979).

In an April 23, 1982, memorandum providing FHWA's position on cathodic protection, the FHWA Administrator said that the only rehabilitation technique[2] proven to stop corrosion in salt-contaminated bridge decks regardless of the concrete's chloride (i.e., salt) content is cathodic protection. He said that the promotion of cathodic protection is a high priority within FHWA and requested that its advantages be brought to the attention of state highway agencies. The Administrator also said that the use of cathodic protection, giving priority to sound but salt-contaminated bridge decks, can save billions of dollars. In this regard, a California state highway official told us that it costs about $3 to $4 per square yard to install a cathodic protection system versus $30 a square yard to replace a bridge deck.

FHWA RESEARCH ON CATHODIC PROTECTION

Since 1973, FHWA has spent over $5 million on research and development of bridge protection systems including cathodic protection. FHWA's accounting records do not provide detail on expenditures by bridge protection method. An FHWA cathodic protection researcher advised us that, based on his review of these bridge protection expenditures, about $1.5 million of this amount was for cathodic protection. FHWA coordinates research and experimental construction in cathodic protection with the states, highway authorities, private firms, and consultants under contract to FHWA in order to provide new insights into the corrosion problem and the means of combatting it. According to FHWA, research and field experiences have proven that cathodic protection can halt corrosion damage to salt-contaminated reinforced concrete bridge decks regardless of the concrete's salt content. Research and development on bridge deck protective systems continue to be FHWA priorities because of the rapidly evolving technology which holds the potential for further improvements.

In addition to continuing research on cathodic protection use for reinforced concrete bridge decks, FHWA's Demonstration Projects Division is developing projects to test cathodic protection on bridge substructures, which include beams, footings, columns, and deck bottoms. The Demonstrations Project Division is also planning to conduct a national symposium with the National Association of Corrosion Engineers to discuss corrosion of bridge decks and to promote cathodic protection.

FHWA's EFFORTS TO ENCOURAGE CATHODIC PROTECTION USE

In addition to the $1.5 million spent on research and development since 1973, FHWA, through its Demonstration Projects

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[2]While cathodic protection can prevent further bridge deck deterioration but not reverse existing deterioration, FHWA refers to cathodic protection as a rehabilitation technique.

Division, for the past 9 years has promoted the use of cathodic protection. Educational, technical, and funding assistance has been provided to 25 highway agencies for the construction and evaluation of more than 35 cathodic protection installations for demonstration purposes. To date, almost all of the reports from the states to FHWA's Demonstration Projects Division on past demonstration installations indicate that the cathodic protection systems are performing satisfactorily. Two of the projects experienced minor installation problems which have been resolved. FHWA plans to continue providing educational, technical, and financial assistance to state and local highway agencies for cathodic protection demonstrations. According to the Chief, Demonstration Projects Division, FHWA can and does fund installation of a state's first cathodic protection system as a demonstration project. Subsequent installations are not eligible for demonstration funds, but are eligible for federal-aid rehabilitation funding.

On January 10, 1984, FHWA issued revised rules on bridge deck protective systems, effective February 9, 1984. The new rule eliminated a list of acceptable protective systems for federal-aid participation in effect since May 1976 contained in the previous rules (23 C.F.R. Part 650, Subpart F), which included cathodic protection as one of four acceptable systems. Although the previous rules and policies did not exclude any particular protective system from use on a federal-aid project, the rules provided preferential treatment to the four systems because they were identified as being acceptable for federal-aid participation. According to FHWA, the rule was changed to enable each state to select a protective system based on local conditions and experience.

The Chief, Demonstration Projects Division, Office of Highway Operations, FHWA, who has the responsibility for promoting the use of new technologies such as cathodic protection, told us that the change in the regulation does not represent a change in FHWA's view of the value of cathodic protection. He noted that FHWA is planning to issue another memorandum highlighting cathodic protection's value. However, the Chief said that cathodic protection is not necessarily the most cost-effective method in every situation and the rule change reflects this in allowing states flexibility to choose a protective system based on local conditions and experience. For example, there are other types of protective systems which overlay the concrete on the bridge deck and prevent the salt from penetrating into the concrete. These systems are expected to have a service life ranging from 10 to 20 years as opposed to the projected 40-or-more-year expected life of cathodic protection systems. The Chief said that in a situation where a reinforced concrete bridge deck is to be replaced in 10 to 15 years, an overlay system may be more cost effective than cathodic protection.

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We are sending copies of this report to the Secretary of Transportation and the Administrator, Federal Highway Administration. Copies will also be available to other interested parties upon request.

Sincerely yours,

Joseph H. Carlone for

J. Dexter Peach
Director