NCHRP
National Cooperative Highway Research Program

RESEARCH RESULTS DIGEST

December 1996 Number 215

These **Digests** are issued in the interest of providing an early awareness of the research results emanating from projects in the NCHRP. By making these results known as they are developed, it is hoped that the potential users of the research findings will be encouraged toward their early implementation in operating practices. Persons wanting to pursue the project subject matter in greater depth may do so through contact with the Cooperative Research Programs Staff, Transportation Research Board, 2101 Constitution Ave., N.W., Washington, D.C. 20418.

Subject Areas: IIC Bridges, Other Structures, and Hydraulics and Hydrology; IIIC Maintenance

Responsible Senior Program Officer: Crawford F. Jencks

Protocol for In-Service Evaluation of Bridges with Epoxy-Coated Reinforcing Steel

An NCHRP digest announcing the results of NCHRP Project 10-37B, "Protocol for the Evaluation of Existing Bridges Containing Epoxy-Coated Reinforcing Steel." The digest describes an agency report, prepared by Dr. Richard E. Weyers, Associated Materials Engineers, Blacksburg, Virginia, now available from the NCHRP.

ABSTRACT

Research and experience indicate the potential for future failures in the performance of epoxy-coated reinforcing steel in concrete bridges. Although not yet experiencing failures and seeing little sign they will, many transportation departments will be examining their existing structures in light of this potential for failure. To foster a better understanding of the problem, a resource document to guide these examinations and to provide some uniformity in the data collected has been prepared. The data to be collected will help define failure mechanisms, improve the prediction of failures, and guide improvements in the corrosion protection of reinforced concrete bridges.

BACKGROUND

Information about chloride-ion-induced corrosion of steel in Portland cement concrete is well known, as is the severity and extent of the early deterioration of steel-reinforced concrete bridge components in the United States. The severity and extent of the chloride corrosion deterioration of steel-reinforced concrete bridge components is a function of the in-place concrete characteristics and environmental exposure conditions. The concrete characteristics of importance are the type and degree of cracking and the effective chloride diffusion rate through concrete. Subsidence cracking is significantly more important to durability than structural negative moment cracking, as an example. The degree of cracking is related to construction practices and design. The effective chloride diffusion rate is a function of the permeability of the concrete, combined effects of the degree of consolidation and water-to-cement ratio, and ambient temperature profiles.

Environmental exposure conditions that influence the severity and extent of steel corrosion deterioration of concrete bridges are the amount or concentration of chloride present, exposure type (continuous or discrete time periods), and exposure condition (uniform or localized). The extent of the corrosion deterioration of a bridge deck in a severe deicer salt exposure climate may be similar to a bridge deck in a moderate deicer salt exposure climate, but the severity of the deterioration would be significantly different at the same exposure age. Likewise, the extent and severity of a reinforced concrete bridge column in a heavy deicer salt exposure region is going to be significantly different than a column in a warm marine environment at the same exposure age—even though both environments may be classified as severe.

In the early 1970s, research began on how to use various applications of epoxy-coated steel reinforcement in concrete to protect against the corrosion of steel reinforcement and subsequent damage to concrete structures. Primarily, applications have been directed at bridge decks; this practice continues, but other applications have included concrete elements such as bridge substructures, parapet walls, safety barriers, and some pavements. However, a review of the international state of the practice, which included epoxy-coated reinforcement (ECR) specifications and laboratory and field corrosion performance investigations, demonstrated that ECR corrodes. Thus, the question is not whether ECR will corrode, but when ECR will corrode in various environmental exposure conditions. Early long-term protection estimates were based on the theory of ECR being a chloride barrier system. More recent studies have demonstrated that the corrosion protection mechanism for ECR is an electrochemical barrier; the coating acts as a high-resistance coating that reduces the rate of the cathodic (noncorroding site) reaction that, in turn, reduces the rate of the anode (corroding site) reaction.

RESULTS

A state-of-the-practice review was conducted to provide a basis for the types of investigation plans being recommended and to provide background information to users. Four ECR field investigation plans were developed that include recommended surveys and test methods that reflect the objectives of the investigation. The four investigation plans and objectives are as follows:

1. Assessment for Additional Protection. The objective is to determine if a surface protection method that would significantly retard or prevent further chloride ingress would extend the service life of existing bridge members built with ECR.

2. Present Corrosion Resistant State. The objective is to determine the degree of protection currently being provided by ECR.

3. Identification of ECR Corrosion Resistant Properties. The objective is to identify those coating properties that significantly influence the corrosion protection performance of ECR.

4. Remaining Service Life. The objective is to estimate the remaining corrosion protection service life of bridge members built with ECR.

Implementation of the field investigation plans is presented in the report and includes bridge selection; planning of field investigations; field surveys; laboratory testing, equipment, and test methods; and investigation cost estimates. Implementation of the recommended investigation plans could be used to assist in assessing ECR performance within a state and among states.

The report's Table of Contents, provided as Appendix A, indicates the depth and breadth of coverage provided by the report

Dr. Richard E. Weyers' report documenting NCHRP Project 10-37B, "A Protocol for the Evaluation of Existing Bridges Containing Epoxy-Coated Reinforcing Steel," is available for loan on request to: the Cooperative Research Programs, 2101 Constitution Avenue, N.W., Washington, DC 20418.

The report may be purchased for $10.00, including postage. A check or money order, payable to Transportation Research Board, must accompany all orders. Payment may be made by VISA, MasterCard, or American Express. Only charge cards will be accepted by telephone (202-334-3214) or fax (202-334-2519). Be sure to include the expiration date. Mail orders to TRB Publications Office, 2101 Constitution Avenue, N.W., Washington, DC 20418.

Appendix A

Protocol for In-Service Evaluation of Bridges with Epoxy-Coated Reinforcing Steel

Dr. Richard E. Weyers, Associated Materials Engineers, Blacksburg, Virginia

TABLE OF CONTENTS

TRANSPORTATION RESEARCH BOARD
National Research Council
2101 Constitution Avenue, N.W.
Washington, DC 20418

NON-PROFIT ORG.
U.S. POSTAGE
PAID
WASHINGTON, DC
PERMIT NO. 8970

000021-02 *
Materials Engineer
Idaho-DOT
P O Box 7129
Boise ID 83707-1129