Introduction

The Federal Aid Highway Program Manual[1] requires a system to protect the reinforcing steel from corrosion for all new and resurfaced bridge decks. The Federal Highway Administration Office of Research and Development has undertaken a study to determine which of the proposed methods are effective. (1, 2) Two methods used in Iowa have been found to be effective, the LSDC-Low Slump Dense Concrete overlay (Iowa system), and polymer modified concrete. Federal study discovered that the maximum threshold depth to which chlorides penetrated into Iowa system concrete was 1.4 inches after 830 daily salt applications. The one problem that appeared with the Iowa system approach concerned consolidation. When densities were 92 to 94 percent of rodded unit weight, the threshold depth for corrosion dropped to 3.4 inches.

To date, more than 340 bridges throughout Iowa have been, or are being, surfaced or resurfaced with Low Slump Dense Concrete (Iowa system). These bridges were let, for the most part, allowing either the latex modified or Iowa system. Although the service history of bridges let using the Iowa system has been good, it was felt that further investigation was warranted.

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1. U.S. Dept. of Transportation, FHWA, Federal Aid Highway Program Manual, Vol. 6, Ch. 7, Sect. 2, Subsection 7.

Based on preliminary reports, the Federal Highway Administration gave approval to use the Iowa system for the 1974 construction season, provided in-place densities would be checked with nuclear apparatus.[2] With the issuance of the Program Manual in April, 1976, the Iowa system became the first recommended procedure when reinforcing steel is not replaced on a restoration project. At the time this approval was given, it was suggested that Iowa conduct a laboratory study similar to that done by Federal Highway Administration researchers.

Purpose

The purpose of this investigation was to determine the comparative effectiveness of standard D-57 concrete and Iowa system Low Slump Dense Concrete in preventing threshold levels of chloride from penetrating the concrete slabs to the reinforcing steel.

2. Letter from Leon Larson, FHWA Div. Engr. to Mr. Joseph R. Coupal, Jr., Dir. of Highways, ISHC, ref. 07-195 dated Feb. 7, 1974.

Summary and Conclusions

Iowa contractors show a definite preference for the LSDC (Iowa system) method of preventing corrosion in bridge deck reinforcing steel. This method appears to be a valid system, as long as the reinforcing steel has a minimum of 1½ inches of cover. Iowa Department of Transportation Standard Specifications[3] require a minimum of 2 inches of cover. This laboratory study indicates that is sufficient to prevent corrosion for a limited number of salt applications.

A minimum plastic concrete density of 98% of the standard rodded density does not appear to be especially hard to achieve under laboratory conditions. Field application of these overlays has verified that 98% density is not difficult to obtain with the proper equipment.

Active corrosion determinations using a copper sulfate reference voltage were not conclusive in this study. Some of the contributing factors to this were:

1. Steel too deep. The Iowa system reinforcing steel was under 3¼ inches of clear cover to the top bar and the D-57 under 3½ inches.
2. Improper ground. Ground points A and B are actually hooks placed in the plastic concrete during fabrication to facilitate handling. Some question exists as to their electrical continuity with the reinforcing mat.

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3. Iowa Dept. of Transportation Standard Specifications, 798, 800.

Ground point C had mill scale present at the time of connection, again leaving doubt as to the electrical intregity of the ground.

3. Varying amounts of moisture in the slabs at the time of electrical potential measurements.

4. It is recognized that for steel embedded in concrete to corrode, the environment cannot be basic. Since the test slabs were cast and tested indoors, it was doubtful that this neutral environment was ever obtained. To verify this, cores were taken to include a small section of reinforcing steel within the core, and pH determinations were made on the concrete immediately adjacent to the steel. The pH readings on both the Iowa System and D-57 mixes were 12.3. This very basic pH verifies the existence of a non-corrosive environment.

The potential for steel corrosion, based on chloride content at varying depths, appears to be effectively prevented by the Iowa System. The chlorides present in the Iowa System at 1- to 1½-inch depth were less than one third the value needed to induce corrosion, whereas the D-57 concrete at the same depth had more than enough chloride present to induce corrosion.