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16. ABSTRACT

Introduction: Subsequent to the continued construction of the Interstate Highway System, the State Highway Department s have endeavored to maintain them free of ice and snow. This "clear pavement policy" has been obtained through increased use of sodium and sometimes calcium chloride. The result has been that salt has penetrated the concrete and caused the steel to rust in the same manner as observed in marine structures (Ref. 1 and 2).

The deterioration of the decks of the highway structures has been so extensive that in 1970, concern was voiced for the durability of some 200,000 bridges in the United States (Ref. 3).

Even though there are descriptions in the literature describing techniques for measuring the halfcell potentials of concrete encased reinforcing steel (Ref. 1,2, 3) and otherwise evaluating the properties of the concrete associated with the corrosion of reinforcing (Ref. 5, 6) there is only one report in the literature that describes the use of cathodic protection of an atmospherically exposed superstructure of a bridge (Ref. 7).
However, even in this latter case, cathodic protection of the deck unit itself was not attempted.

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PRELIMINARY INVESTIGATION OF

CATHODIC PROTECTION OF A BRIDGE DECK

By

R. F. Stratfull
Senior Corrosion Engineer

November 1973

ACKNOWLEDGEMENT

The contents of this report reflect the views of the Transportation Laboratory who is responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official views or policies of the State of California, or the Federal Highway Administration. This report does not constitute a standard, specification, or regulation.

The author wishes to acknowledge the work and other contributions of the staff at the California Division of Highways Transportation Laboratory, including Messrs G.H.C. Chang, Principle Assistant, P. J. Jurach, E. Maggenti, and T. L. Scrimsher. Also to Messrs R. E. Hay of the FHWA, and J. Fontana of the Brookhaven National Laboratory, for their assistance in the polymer experiment. The support and contributions of Messrs D. R. Higgins and G. A. Hood of the California Department of Transportation, Office of Structures, is also acknowledged.

PRELIMINARY INVESTIGATION OF

CATHODIC PROTECTION OF A BRIDGE DECK

Introduction

Subsequent to the continued construction of the Interstate Highway System, the State Highway Departments have endeavored to maintain them free of ice and snow. This "clear pavement policy" has been obtained through increased use of sodium and sometimes calcium chloride. The result has been that salt has penetrated the concrete and caused the steel to rust in the same manner as observed in marine structures (Ref. 1 and 2).

The deterioration of the decks of the highway structures has been so extensive that in 1970, concern was voiced for the durability of some 200,000 bridges in the United States (Ref. 3).

Even though there are descriptions in the literature describing techniques for measuring the halfcell potentials of concrete encased reinforcing steel (Ref. 1,2,3,) and otherwise evaluating the properties of the concrete associated with the corrosion of reinforcing (Ref. 5,6), there is only one report in the literature that describes the use of cathodic protection of an atmospherically exposed superstructure of a bridge (Ref. 7). However, even in this latter case, cathodic protection of the deck unit itself was not attempted.

Theory of Application

Concrete, when wet, has an electrical resistivity in the range of 10,000 ohm cm (Ref. 8). Therefore, in order to transport current from an anode in a horizontal direction past each parallel and crossing piece of reinforcing steel mat would result in extremely high voltages. However, if a highly conductive material were spread across the top of the bridge deck, then the high resistance of the concrete would only enter in that part of the circuit which is the vertical distance of the concrete cover over the reinforcing steel.

Electrically Conductive Overlay

One material investigated as an electrically conductive overlay was coke breeze. It was found that coke breeze could be mixed with about 17% asphalt and still have a specific electrical resistance of about 50 ohm cm. However, the stability of the asphalt-coke breeze mixture with this percentage of asphalt is not expected to be sufficiently great to support the impact loading of vehicles. Therefore, it was decided to overlay the asphalt-coke breeze with a 2-inch thick layer of normal highway quality asphalt concrete pavement.

To test the composite design of the asphalt-coke breeze and asphalt concrete, a test pavement was placed for further evaluation.

After placing the test pavement, a truck loaded to maximum legal weight limit passed over the section 3802 times without evidence of failure. The result was that the pavement was judged to have a high probability of success to withstand vehicular traffic.

Electrical Testing

In order to test the theory for application of cathodic protection, loose coke breeze was placed on a new but unused bridge deck.

As shown by Figures 1 and 2, the cathodic protection currents can spread for a minimum radius of about 25 feet and adequately polarize the reinforcing steel. This test was considered a particularly severe test of the theory of protection because the loose and dry coke breeze had a specific electrical resistance in the range of 200 ohm cm.

Actual Installation

The Sly Park Bridge is located approximately 55 miles east of Sacramento, California, at an elevation of about 4000 feet in the Sierra Nevada Mountains on U.S. Highway 50.

The structure was scheduled for repair because about 12% of the surface area of the bridge deck was spalled due to the steel corrosion.

The composite asphalt-coke breeze and asphalt concrete pavement was placed with iron anodes being used in the coke breeze section.

Currently, 98% of the deck is being maintained at a polarized potential of more negative than -0.85 to the saturated copper-copper sulfate halfcell with an impressed voltage of about 2.5 volts and a current flow of about 2.3 amperes to seven operating anodes.

The surface area of the bridge deck under cathodic protection is about 3000 square feet, and the estimate current density to the reinforcing steel is about 1.5 ma/sq.ft.

Using a commutated D.C. ohmmeter, the gross circuit resistance between one anode and the reinforcing steel was about 1.2 ohms.

At present, the test installation has been in place for approximately three months and has electrically and structurally withstood the impact of traffic without any sign of failure.

REFERENCES

1. Spellman, D. L.; Stratfull, R. F.
"Chlorides and Bridge Deck Deterioration"
Highway Research Record No. 328.

2. Stratfull, R. F.
"The Corrosion of Steel in a Reinforced Concrete Bridge"
Corrosion, Vol. 13, No. 3, March 1957.

3. "Concrete Bridge Deck Durability"
NCHRP Synthesis No. 4, L.C. Card No. 74-607396,
Highway Research Board, (1970).

4. Tremper, Bailey; Beaton, J. L.; Stratfull, R. F.
"Corrosion of Reinforcing Steel and Repair of Concrete in a Marine Environment"
Highway Research Board, Bulletin 182, 1958

5. Beaton, J. L.; Stratfull, R. F.
"Environmental Influence on Corrosion of Reinforcing in Concrete Bridge Structures"
Highway Research Record No. 14, 1963

6. Stratfull, R. F.; Van Matre, V.
"Corrosion Autopsy of a Structurally Unsound Bridge Deck"
Highway Research Record No. 433, 1973.

7. Stratfull, R. F.
"Progress Report on Inhibiting the Corrosion of Steel in a Reinforced Concrete Bridge"
Corrosion, Vol. 15, No. 6, June 1959.

8. Stratfull, R. F.
"How Chlorides Affect Concrete Used with Reinforcing Steel"
Materials Protection, Vol. 7, No. 3, March 1968.

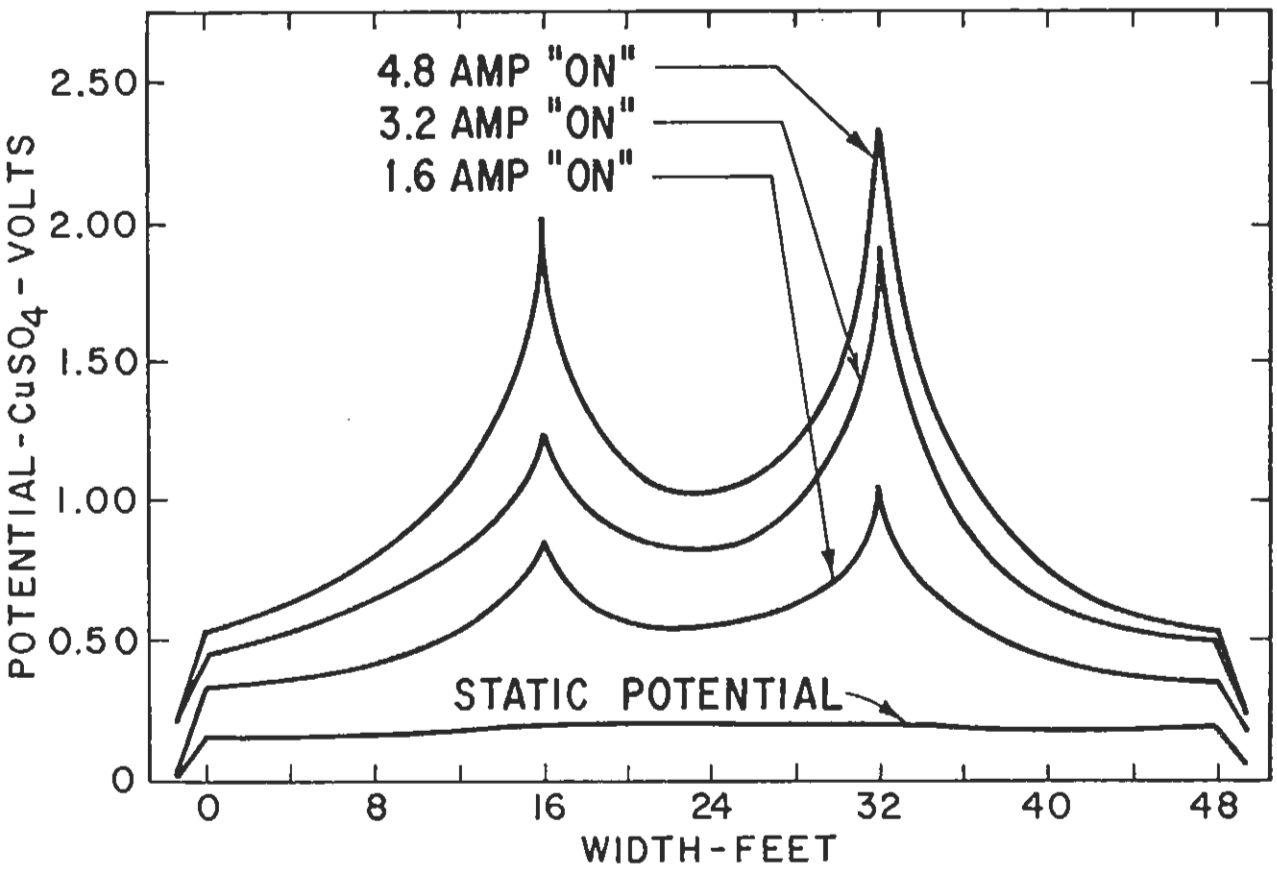

Figure 1. Distribution of potentials with current on, two anodes.

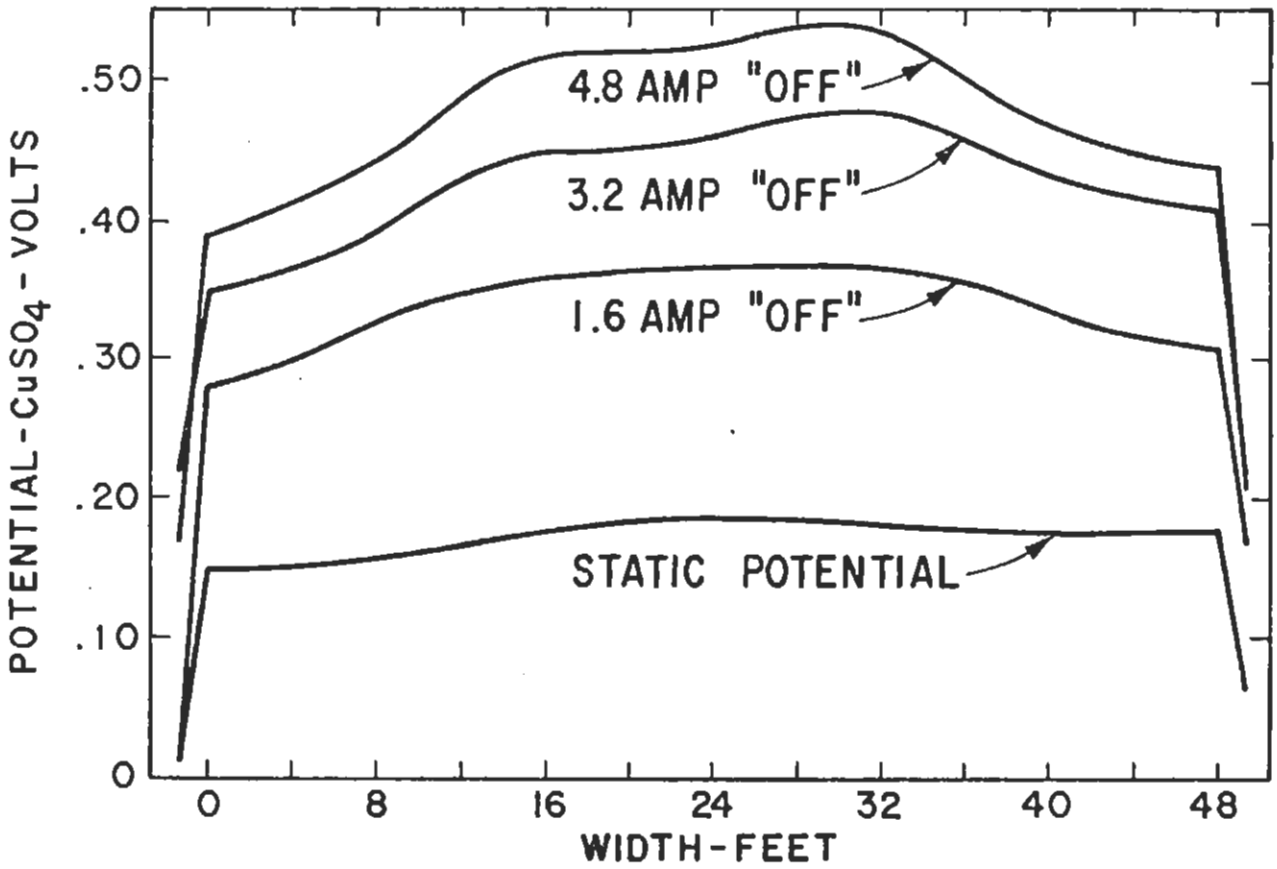

Figure 2. Distribution of polarized potentials - two anodes.

HUGH P. GODARD
Box 519, R.R. 3
Bath, Ontario
Canada

31 August 1973

Mr. Richard F. Stratfull
RT. #1, Box 190-D
West Sacramento, California 95691
U.S.A.

Dear Dick:

Tenny Hull tells me that you will have a paper on cathodic protection of highway bridge decks at the forthcoming Phoenix meeting of NACE.

I understand that your complete report is committed to "Highway Research Record" of the Highway Research Board, but like Tenny, hope that this will not prevent you publishing some of it in M.P.P.

Your new (soon anyway) editor is looking for such material.

With best regards,

Hugh P. Godard

HPG:lmd

Copy to:

Mr. T. T. Hull
N.A.C.E.
2400 West Loop South
Houston, Texas 77027

October 1, 1973

Mr. T. T. Hull
N. A. C. E.
2400 West Loop South
Houston, Texas 77027

Dear Tenny:

Enclosed is a paper "Preliminary Investigation of Cathodic Protection of a Bridge Deck" submitted for publication.

If you have any questions, please do not hesitate to contact me.

Best Regards,

R. F. Stratfull
Senior Corrosion Engineer

RFS:fp

Attachment

cc:H.P. Godard, w/o attach.

SURNAME AND DATE				