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AN EVALUATION OF CHEM-TRETE BSM SILANE SURFACE TREATMENT

A CONSTRUCTION REPORT

By

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Prepared by

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Division of Research and Demonstration
Bureau of Transportation Structures Research

In cooperation with

U. S. Department of Transportation
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16. Abstract

This report presents the findings from the construction phase of a study undertaken to evaluate the performance of a relatively new sealant type material (Chem-Trete, BSM) as a protective treatment for concrete bridge decks. The study will compare the performance of Chem-Trete applications on two, ten year old bridge decks to that of two comparison decks on which latex modified concrete (LMC) overlays were constructed.

The installation of Chem-Trete was found to be relatively simple, fast and thus minimized interference with traffic compared to the construction requirements of other currently used bridge deck protective systems (e.g., LMC and waterproofing membranes). The in-place costs for Chem-Trete in this study were only about 1/5 that for the LMC.

Chem-Trete's effectiveness as a protective treatment remains to be determined. A description of a three year monitoring effort which will be the basis for this assessment is included.

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1.0 INTRODUCTION

Many highway agencies are seeking to determine the most cost-effective method of protecting bridge decks from the spalling distress which results from accelerated corrosion of reinforcing steel induced by deicing salts.

Over the past several years, latex modified concrete (LMC) and waterproofing membrane systems have been successfully used for the protection of New Jersey bridge decks. A relatively new penetrating sealer, Chem-Trete, has been identified by the FHWA as an alternate, low-cost treatment which holds promise for protecting against spalling of concrete surfaces. As a result, the FHWA is encouraging experimental use of this material on both new and existing (sound, air-entrained) bridge decks.

Laboratory testing conducted by the FHWA and various states indicate significant reductions in water absorption and chloride ion penetration of concrete treated with Chem-Trete.[1] For example, in comparison to untreated control specimens, Chem-Trete has reportedly decreased water absorption by a factor of 10 and chloride intrusion content by a factor of 6.

Based on these favorable reports by others, in 1982 the Department's laboratory conducted a limited evaluation of sealant-type products for the Materials Committee. The results from that evaluation indicated that Chem-Trete was sufficiently effective to warrant field evaluation. Accordingly, the Department's Bridge unit, charged with monitoring the condition of structures statewide, selected four adjoining bridges for this trial intallation. The New Jersey Department of Transportation construction contract (Route I-195, Sections 1C and 2B, Contract No. 2) specified two different type bridge deck protective systems for the following structures:

[1]FHWA FCP Annual Progress Report, Year Ending September 30, 1979, Project No. 4K, Task 3, pp. 139-140.

Bridge No.	Location	Protective System
1134-163	EB over Route U.S. 130	Chem-Trete BSM
1134-164	WB over Route U.S. 130	Dylex Latex 1186 LMC
1134-167	EB over N.J. Turnpike	Chem-Trete BSM
1134-168	WB over N.J. Turnpike	Dylex Latex 1186 LMC

These structures, located in Hamilton Township, Mercer County, were originally constructed in 1973. The current AADT is 11,800 vehicles per day.

2.0 OBJECTIVES

In this study, the performance of Chem-Trete will be compared to the base condition data (see Table 1) obtained prior to sealant applications and to the performance of LMC overlays. The specific objectives are:

To determine the effectiveness of Chem-Trete in preventing the intrusion of chlorides and moisture into bridge deck concrete.

To estimate the economic benefits to be derived from the use of Chem-Trete as a alternative to currently approved protective systems (i.e., LMC and waterproofing membranes).

3.0 PROJECT DETAILS

3.1 PRECONSTRUCTION CONDITION SURVEY

Study decks were evaluated prior to treatment with Chem-Trete and LMC to determined (1) their general condition with respect to cracks, etc., (2) the degree of chloride contamination, (3) the level of corrosion activity, and (4) the relative degree of moisture present. The results of this preconstruction survey are summarized in Table 1. A diagram depicting a typical deck sampling plan for performance testing is shown in the Appendix.

TABLE 1: RESULTS OF PRECONSTRUCTION SURVEY OF STUDY DECKS

BRIDGE NO.[a] & SURVEY DATE	DECK CONDITION (VISUAL ASSESSMENT)	PROPOSED TREATMENT	AVERAGE CHLORIDE CONTENT,[b] LB/CY			% OF ELECTRICAL POTENTIAL MEASUREMENTS >0.35V[d]	% OF ELECTRICAL RESISTANCE MEASUREMENTS <100KΩ[e]
			SURFACE TO 1"	1" TO 2"	% OF SAMPLES >2.0[c]		
1134-163 6-8-82	Generally good, some fine cracking; no leakage	Chemtrete	1.39	1.49	20	0 (N=83)	90
1134-164 6-9-82	Generally good, some fine transverse cracks; efflorescence under north and south parapets	LMC	2.58	0.41	40	1 (N=83)	90
1134-167 6-8-82	Light scaling; some fine cracks; efflorescence under north and south parapets; water leakage at west backwall under parapet	Chemtrete	1.24	1.76	35	0 (N=123)	100
1134-168 6-9-82	Generally good, some fine cracks, some efflorescence and leakage	LMC	3.62	0.84	50	0 (N=97)	90

NOTES:
[a]All structures had been in service for approximately ten years at this survey.
[b]Determined by the analysis of ten samples from each depth.
[c]2.0 lb/cy is the threshold level beyond which it is highly probable that corrosion will occur.
[d]Measurements >0.35 indicates the occurrence of active corrosion.
[e]Measurements <100KΩ indicate the presence of moisture (N=10 for all decks).

Based on a comparison of Table 1 data to the condition survey criteria developed by the FHWA,[2] study structures would be classified in Category 3 - "Light to No Active Corrosion."

MATERIALS

Description: Chem-Trete BSM; a water miscible, colorless, penetrating water-repellent treatment.

Manufacturer: Dynamit Nobel of America, Inc.

Generic Composition: 40% (wt/wt) alkly trialkoxy silane, 60% (wt/wt) ethyl alcohol. Viscosity at 20°C = 1.00 MPA-s max.

CONSTRUCTION SEQUENCE

On each structure, installation of Chem-Trete was accomplished in two stages, each consisting of treating about one-half the structure width. The basic procedure involved (1) closing of the planned work area to traffic, (2) surface preparation, (3) sealant application, then (4) reopening the area to traffic after the surfaces were visibly dry. This work was accomplished on the first half of a Chem-Trete deck in approximately 10 hours. Several days later, the procedure was repeated on the remaining half of the test bridge. Thus, the actual total time required to complete the Chem-Trete installation on each bridge was roughly 2.5 working days.

SURFACE PREPARATION

The deck, parapet and brush curb areas were sandblasted and cleaned with compressed air to remove oil, dirt, dust and other foreign materials. This cleaning was accomplished approximately two hours prior to treatment with Chem-Trete

[2]FHWA Transmittal 188, April 1976, Section 2, Subsection 7

3.3.2 SEALANT APPLICATION

The construction sequence described in Section 3.3 was employed to facilitate treatment shortly after surface preparation to ensure application to uncontaminated surfaces, to minimize interference with traffic and to accommodate the contractor's construction schedule. The silane solution was applied with an standard, low-pressure, airless garden-type sprayer with a fan nozzle. Surfaces were saturated using an overlapping spray pattern to ensure complete coverage. Two representatives of the sealant manufacturer were present during the first day to provide guidance and assistance. No problems were encountered and coverage rates were within the recommended range of 120 to 125 s.f./gal. (see Table 2).

TABLE 2: SEALANT APPLICATION DATA

BRIDGE NO.	DATE OF APPLICATION	WEATHER AND TEMPERATURE	AREA COVERED SQ.FT.	COVERAGE RATE SQ.FT./GAL.	REMARKS
1134-163	11-03-82	Overcast (73^{o}F)	7,308	125	Surfaces were damp
	11-16-82	Clear (28^{o}F)	8,469		
1134-167	11-11-82	Clear (54^{o}F)	7,128		
	11-19-82	Overcast (58^{o}F)	5,829	122	

3.4 PENETRATION TESTS

Based on the manufacturer's literature, when properly applied a Chem-Trete application should penetrate concrete surfaces to a depth of 1/4 to 5/16 of an inch. To determine the depth of sealant penetration into the study decks,

three 4-inch diameter cores were cut from shoulder areas on each of the two treated structures. The cores were saw-cut vertically in the lab and a water soluble red dye applied to the exposed surfaces. Protected areas of the concrete (i.e., near the wearing surface) were expected to repel the dye solution. In these first tests, all surfaces of the sawed specimen accepted the dye, suggesting that the Chem-Trete had not penetrated the concrete and thus, may not have afforded adequate protection. Representatives of the manufacturer consulted and they advised that based on past experience, testing of a sawed surface could mask test results. That is, the cutting action of a saw blade could conceivably carry particles from the untreated portion of the specimen, impress them onto the treated surface (e.g., 1/4 to 5/16 inch from the top surface) and thus present an apparently untreated surface for testing. Consequently, the penetration test procedure was modified as suggested by the manufacturer. Basically, this entailed mechanically fracturing (rather than sawing) a field specimen to expose an internal face upon which the dye penetration test was repeated. Results of the modified dye penetration test revealed that the top 1/16 inch of the core did repel the dye, indicating that the silane solution had indeed penetated the concrete, although not to the expected depth. observation is illustrated in Figure 1.

Since the observed depth of penetration was considerably less expected, additional testing of several remaining cores will be performed to gauge the effectiveness of Chem-Trete in preventing water penetration. This latter testing (employing a manufacturer-recommended procedure) will determine the percent of water absorption through the wearing surface. The results of this lab work will be included in a subsequent report.

3.4.1 RUT-DEPTH MEASUREMENTS

Initial rut-depth measurements were taken in the outer lane wheelpaths of each test bridge. This information will serve as base data for documenting

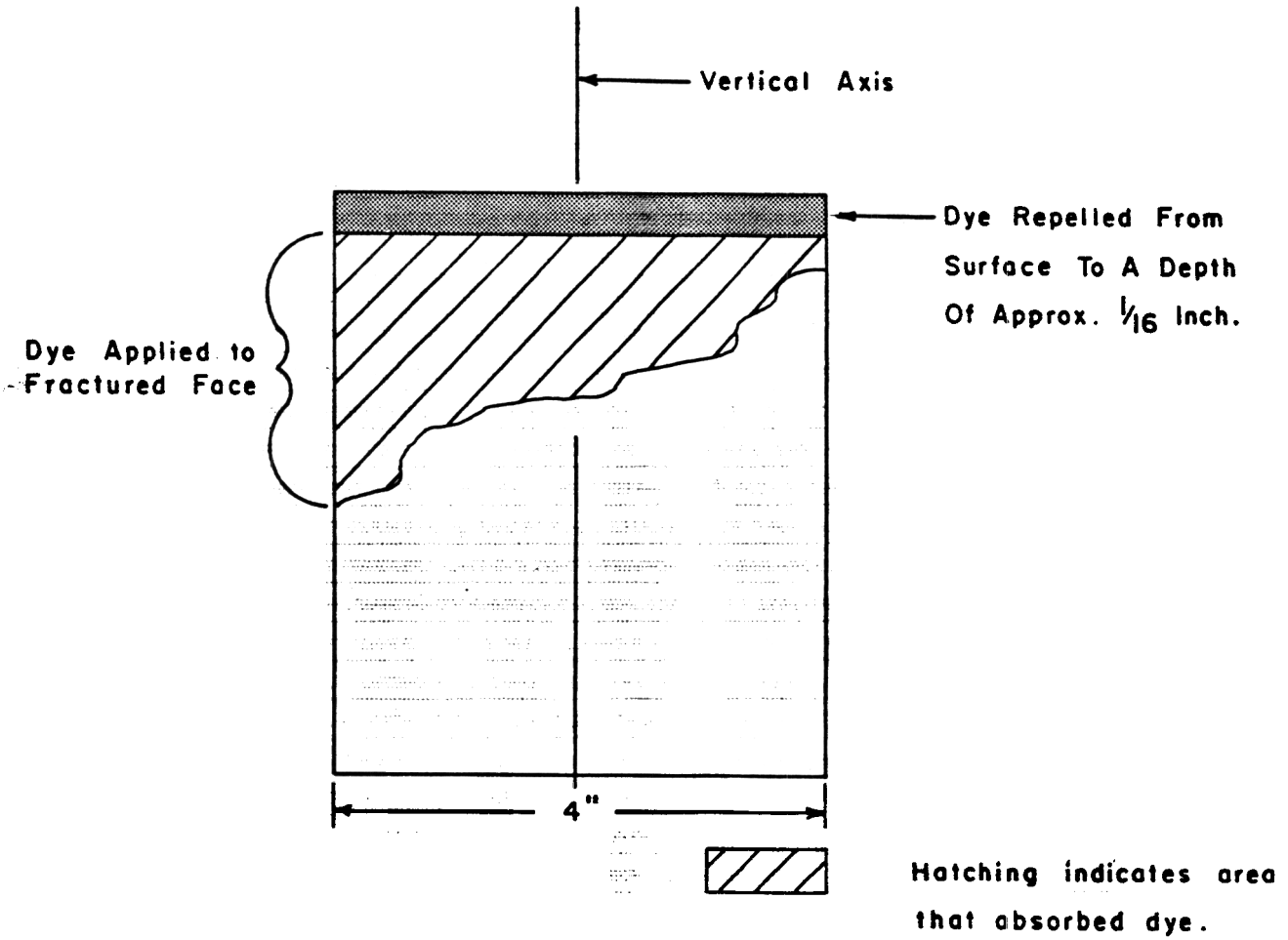


Figure : SKETCH SHOWING RESULTS OF MODIFIED DYE PENETRATION TEST

(4-inch diameter core)

surface wear. The average measurement was less than 1/16 inch on each deck.

3.5 COSTS

A summary of pertinent project costs is provided in Table 3.

TABLE 3: SUMMARY OF LATEX MODIFIED CONCRETE AND CHEM-TRETE COSTS

Item	Contract Unit Cost, In-Place
Chem-Trete BSM	$8.00/sy ($0.89/sf)
Latex Modified Concrete	$1,100/cy ($4.25/sf)

Although project unit costs for the two items are not directly comparable, they can be evaluated in terms of area covered. That is, converting the prices in Table 3 to a common base (i.e., cost per square foot) shows that Chem-Trete BSM is only about one-fifth the cost of the LMC overlay. Information from field forces indicates a similar reduction in traffic protection costs.

4.0 MONITORING PROGRAM

The Department's Bridge Design unit will monitor the performance of both systems (LMC and Chem-Trete) annually over the next three year period. Test data will be collected on each of the parameters measured in the preconstruction survey (see Table 1). In addition, rut depth measurements (in the outer lane wheel paths) will be obtained on the Chem-Trete decks to document surface wear. Another chloride content analysis of all study decks (LMC and Chem-Trete) will be conducted at the conclusion of the three year evaluation period to determine the overall effectiveness of the systems in preventing the further intrusion of chlorides.

5.0 CONCLUSIONS

The effectiveness of Chem-Trete will be be determined from performance data collected over the next three years. However, from a construction

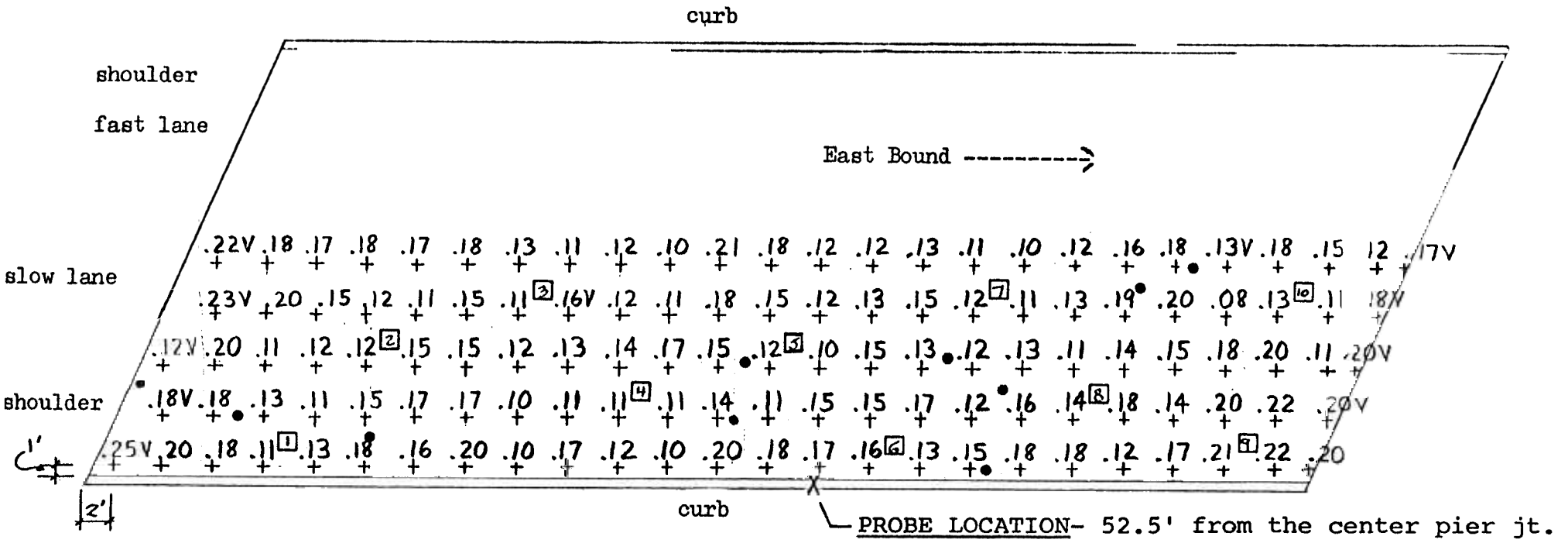
standpoint, Chem-Trete exhibits several distinct advantages compared to some other bridge deck protective systems currently used in New Jersey. These initial benefits include:

1) Sealant application is simple, relatively fast and permits reopening of decks within hours of installation. Thus, interference with traffic is minimized.

2) Relatively low installation cost -- if Chem-Trete proves to be an effective protective system, its use could result in substantial cost savings. (Chem-Trete costs only about 1/4 to 1/5 as much as a waterproofing membrane system and latex modified concrete overlay, respectively.)*

*Based on costs from this and other recently completed Department projects.

APPENDIX: TYPICAL DECK SAMPLING PLAN FOR PERFORMANCE TESTING



RESISTIVITY	TAKEN 6/8/82	
	FORWARD	REVERSE
1	$8.0 \times 10^3 \Omega$	$1.0 \times 10^4 \Omega$
2	$2.6 \times 10^4 \Omega$	$3.0 \times 10^4 \Omega$
3	$3.5 \times 10^4 \Omega$	$3.3 \times 10^4 \Omega$
4	$1.0 \times 10^4 \Omega$	$1.0 \times 10^4 \Omega$
5	$7.5 \times 10^4 \Omega$	$7.0 \times 10^4 \Omega$
6	$4.4 \times 10^3 \Omega$	$7.0 \times 10^3 \Omega$
7	$2.1 \times 10^4 \Omega$	$2.3 \times 10^4 \Omega$
8	$1.1 \times 10^4 \Omega$	$1.6 \times 10^4 \Omega$
9	$1.2 \times 10^4 \Omega$	$1.2 \times 10^4 \Omega$
10	$2.0 \times 10^4 \Omega$	$2.0 \times 10^4 \Omega$

DECK CONDITION SURVEY
RESISTIVITY / HALF CELL TESTS
LOCATION: Rt 195 E.B./ NJTpk.
Span 2
STRUCTURE NO: 1134-167
DATE : JUNE 8, 1982
DRAWN BY: P.J.K.
CREW: DJW, JEK, BKR

● Chloride Location

	Station	Off Set
1	5.0'	9.0'
2	15.0'	6.0'
3	28.0'	4.0'
4	64.0'	6.0'
5	65.0'	11.5'
6	85.0'	12.0'
7	89.0'	0.5'
8	90.5'	9.0'
9	104.0'	19.0'
10	109.0'	21.0'