August 2001

FINAL REPORT

THIN BONDED OVERLAY AND SURFACE LAMINATES

Federal Highway Administration
Demonstration Projects Program
ISTEA Section 6005

Bridge Deck Overlays Constructed by
The Ohio Department of Transportation

Bridge Numbers:
HAN - 75 - 1383
HAN - 235 - 0652

Prepared in cooperation with the Ohio Department of Transportation and the U.S. Department of Transportation, Federal Highway Administration

DISCLAIMER STATEMENT

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16. Abstract

This report describes the current condition and evaluates the effectiveness of a proprietary concrete overlay known as Microlite which was placed in 1994/95 on two different bridge decks in northwestern Ohio. These bridges candidates were submitted by the Ohio Department of Transportation (ODOT) and accepted by the Federal Highway Administration (FHWA) for inclusion in Thin Bonded Overlay and Surface Laminates Demonstration Program under ISTEA Section 6005.

The evaluation process included a visual inspection of the overlay conditions; a sounding inspection of both decks followed by taking random cores for visual examination and laboratory evaluation. The laboratory evaluation included determining chloride contents and permeability readings of the samples.

This report discusses the character of traffic using the structures and the salting practices. The report concludes that the overlays are performing extremely well even though there is evidence of surface cracking on one of the deck surfaces and both decks contain substantial amounts of chlorides at the reinforcing steel level.

17. Key Words Concrete bride deck overlay, Microlite High Performance Concrete Blend, rapid permability readings (coulombs), chloride contents, sounding, delamination, skid resistant, map cracking		18. Distribution Statement No Restrictions. This document is available to the public through the National Technical Information Service, Springfield, Virginia 22161	
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THN BONDED OVERLAY AND SURFACE LAMINATES

FINAL REPORT

OHIO DEPARTMENT OF TRANSPORTATION

BRIDGES IN HANCOCK COUNTY
HAN-75-1383
HAN-235-0652

This is the final evaluation and report on the experimental concrete overlays on two bridges in the State of Ohio. The two bridges are located in Hancock County near the City of Findlay, both crossing over I-75. One bridge (HAN-75-1383) carries County Road No. 313 and the other (HAN-235-0652) carries State Route 235; both over I-75.

BRIDGE DESCRIPTIONS

Both bridges consist of steel beams/girders with reinforced concrete decks. Bridge No. HAN-75-1383 is a 383' long, 31' wide, five (5) span bridge on a 32º skew. The bridge consists of four (4) lines of welded steel girders with four (4) spans being continuous over the piers and one (1) simple end span. The bridge was built in 1963.

Bridge No. HAN-235-0652 is a 292' long, 28' wide, four (4) span bridge on a 17º skew. The bridge consists of four (4) lines of wide flange, rolled steel beams continuous over the piers. The bridge was built in 1963.

PROJECT DESCRIPTION

The Ohio Department of Transportation (ODOT) selected the above-mentioned bridges as candidates for participating in the Federal Highway Administration (FHWA) Thin Bonded Overlay and Surface Laminates Demonstration Projects Program under ISTEA Section 6005. The material chosen by ODOT as an overlay material was Microlite. Microlite is an expanded volcanic mineral with a microcellular structure composed of tiny air cells. When combined with cement/concrete, the manufacturer claims improved workability, lower permeability, lighter weight and some insulating qualities.

ODOT chose to incorporate Microlite into their standard bridge deck overlay system with minor exceptions. The system requires ¼" scarification of the existing decks followed by sounding and removal of delaminated and other unsound areas of concrete. The minimum thickness of the overlay was 1 ¾" with some areas being thicker where unsound concrete was removed. In this case, areas of additional (variable thickness) removal averaged 30% of the deck area.

The mix design chosen for these overlays included:

Cement	580 lbs.
Microlite	125 lbs.
Mix water	300+/-10 lbs.
Coarse aggregate	
(No. 8 limestone)	1410 lbs. SSD
Fine aggregate	1150 lbs. SSD
Slump	5 +/- 2 inches
Air content	8 +/- 2 inches
Water/cementitious	0.44

The specific gravities used in the above mix design:

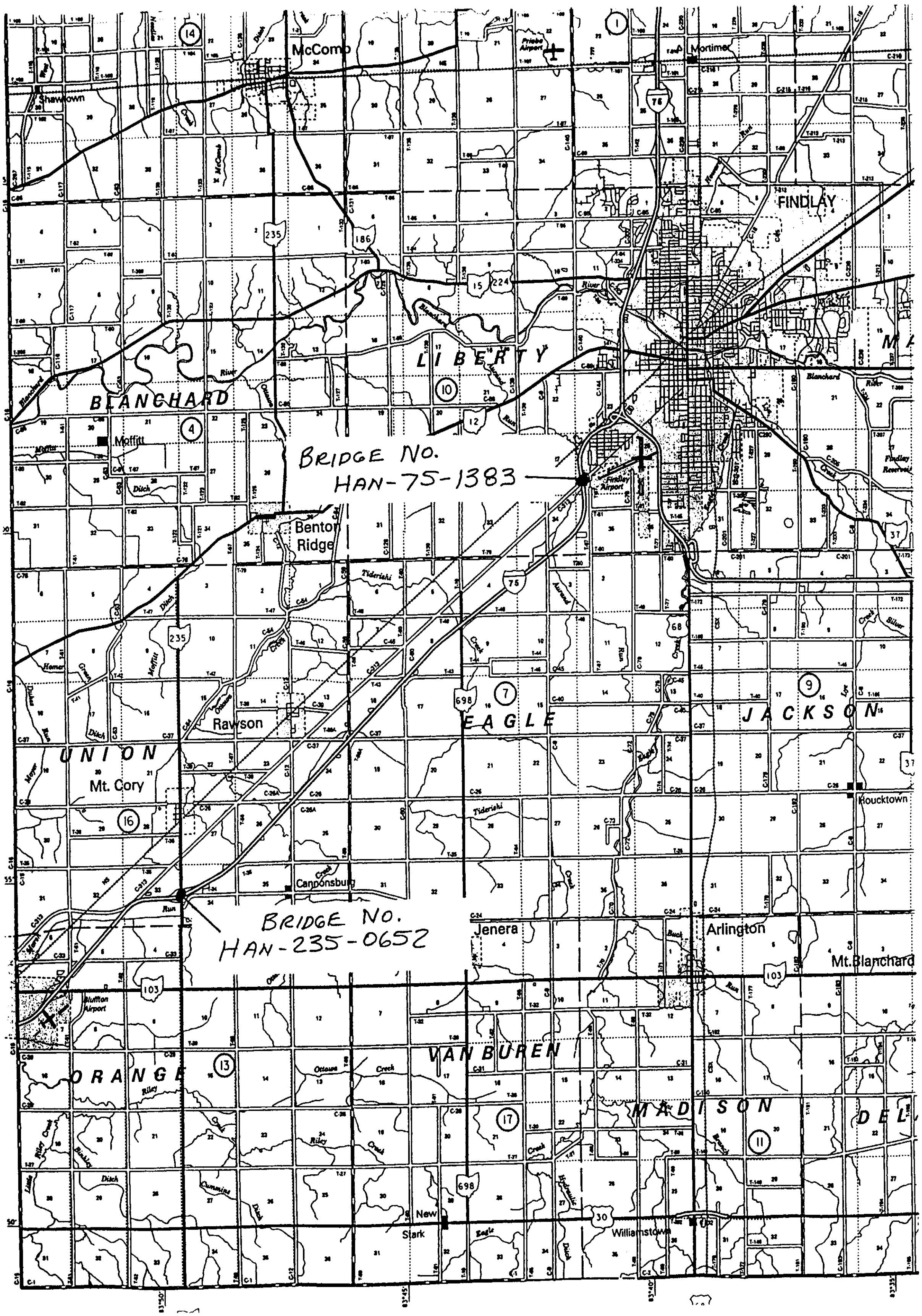
Sand	2.62
Limestone	2.65
Microlite	0.87

The overlays for both bridges were placed at two different times utilizing half width construction and maintaining one lane traffic at all times. The first phase overlay was placed on HAN-75-1383 on 9-19-94 and the second phase on 10-12-94. The first phase overlay on HAN-235-0652 was placed on 5-3-95 and the second phase placed on 6-6-95.

NOTE: More specifics about the specifications, construction techniques, construction problems; weather conditions, etc., can be found in the Initial Evaluation Report dated September 23, 1997 located in the Appendix.

INTERSTATE HIGHWAYS

PREPARED BY
THE OHIO DEPARTMENT OF TRANSPORTATION
OFFICE OF TECHNICAL SERVICES
GIS/MAPPING SECTION
DECEMBER 2000


BRIDGE NO.
HAN-75-1383
BRIDGE NO.
HAN-235-0652
McComb
Mortimer
Shawtown
FINDLAY
LIBERTY
BLANCHARD
Moffitt
Benton
Ridge
Rawson
EAGLE
JACKSON
UNION
Mt. Cory
Houcktown
Cannonsburg
Jenera
Arlington
Mt.Blanchard
ORANGE
VAN BUREN
MADISON
New
Stark
Williamstown

OVERLAY EVALUATION AS OF OCTOBER 19, 2000

On October 18 and 19, 2000, the bridge decks were inspected visually top and bottom, sounded and cored. The results are as follows:

HAN-75-1383

Visually, the overlay was intact with no obvious delaminations. There were a few, very minor cracks in the surface. The bottom side of the deck also looked very well characterized by a light gray color with no evidence of leakage.

After the visual examination, the deck was sounded with steel sounding rods and no delaminations were detected.

Five (5) cores were then taken at various locations; some at visible cracks and some at uncracked areas. The core bit used was 4" in diameter. All core drilling was done to a 6" +/- depth. Examinations of the cores taken revealed the following:

Core #1

- Taken at a crack in the surface
- The core broke off at 3 3/8" depth during removal
- No rebar was encountered
- The overlay was well bonded to the parent concrete

Core #2

- Taken at a crack
- Broke off at 4 ¼" during removal
- The break occurred at a corroding rebar
- The apparent crack in the surface continued through the overlay
- The overlay was well bonded to the parent concrete

Core #3

- Taken at an uncracked location
- Broke core off at 6 ½" depth
- Core went through intersecting rebars
- No corrosion noted on rebar
- Overlay was well bonded to parent concrete

Core #4

Taken at uncracked location
Core broke off at 3 ½"
Broke off at a corroding rebar
Overlay was well bonded to parent concrete

Core #5

Taken at a map-cracked area
Core broke off at 4" depth
Broke off at a corroded rebar
Cracks extended through ¾ of overlay thickness
Overlay was well bonded to parent concrete

HAN-235-0652

Visually, the overlay was intact with no apparent delaminations. There were many cracks on the surface; some transverse and some map type. It appeared that many of the cracks had been filled with an epoxy or methylmethacrylate. The bottom of the deck had some transverse cracks which exhibited efflorescence; three small (2 sq. ft. or less) areas of exposed bottom mat rebar, two areas of small (less than 2 sq. ft.) full depth patches and a few areas of apparent leakage (very minor).

The bridge deck was sounded with steel sounding rods and no delaminations were detected.

Six (6) cores were taken at various locations; some at visible cracks, some at uncracked areas and one at the center line where the two phase pours met. A 4" diameter core bit was used and drilling was to a depth of 7" +/-. Examination of the cores revealed the following:

Core #1

Core broke off at 7" depth
Rebar was encountered at 4" depth
Rebar was surrounded by overlay material
Overlay material was 5 ½" thick (apparently at a variable thickness area)
No corrosion noted on rebar
Overlay was well bonded to parent concrete

Core #2

Core broke off at 7 ½" depth
Taken at centerline (between two pours)
Rebar encountered at 3 ½" depth
Overlay material was 3" thick
No corrosion noted on rebar
Overlay was well bonded to parent concrete

Core #3

Core broke off at 4" depth
Overlay thickness varied from 1 ½" to 3 ¼"
Taken at area of two cracks in surface
One crack ¾" deep and one 1 ½" deep
Overlay was well bonded to parent concrete

Core #4

Taken at a cracked section
Overlay thickness varied from 2" to 4"
Broke off at 4 ¼" depth (at bottom of corroding rebar)
Crack in overlay extends to corroding rebar
Overlay well bonded to parent concrete

Core #5

Taken at an apparent good section (no cracks)
Overlay 2" thick
Rebar encountered at 3 ½" depth
Core broke off at 8" depth
Overlay well bonded to parent concrete

Core #6

Taken at a cracked location
Overlay 2" thick
Corroding rebar
Crack extended through entire section
Overlay well bonded to parent concrete

Some of the above cores were selected for further testing; including permeability and chloride content. The results are as follows:

PERMEABILITY

HAN-75-1383

Core No. 1 - 350 coulombs
Core No. 3 - 273 coulombs

HAN-235-0652

Core No. 1 – 284 coulombs
Core No. 2 – 445 coulombs

Note: The coulomb readings taken within 90 days after construction were 909 and 869.

CHLORIDE CONTENT

The chloride contents determined by ODOT Office of Materials Management, Cement and Concrete Section, from five (5) selected cores taken from the bridge were as follows:

HAN-75-1383

Core No.	Depth of Sample (from top of core)	Chloride Content (lb./cu yd)
5	½"	15.43
5	1"	5.05
3	Rebar level	3.34

HAN-235-0652

Core No.	Depth of Sample (from top of core)	Chloride Content (lb./cu yd)
5	½"	11.90
2	Rebar level	3.00
6	Rebar level	3.30

Half cell potential readings were not available because ODOT no longer uses or has access to the necessary equipment.

Skid testing on the overlays was conducted by ODOT on October 10, 2000. The results are as follows:

HAN-75-138

Eastbound	Westbound
34.3	36.2
35.3	36.4
33.2	36.4
35.4	36.4
34.0	36.1
35.5	38.1

HAN-235-0652

Northbound	Southbound
50.7	48.9
50.8	49.9
50.4	50.7

Skid numbers above 30.0 are considered good and in this case, the surface texture of the overlays is adequate to provide a skid resistant surface. Unfortunately, skid data immediately after construction is not available.

CONCLUSIONS

The Microlite Modified Concrete overlays used on these two bridge decks are holding up very well with no delaminations. The only visual imperfection noted is a significant amount of alligator cracking on bridge no. HAN-235-0652. The cracks, however, are tight and appear to have been sealed with a high molecular weight methacrylate (HMWM) sealer. Apparently these cracks appeared during and immediately after construction (probably due to drying/plastic shrinkage) and are not getting worse.

The bottoms of the decks still look very good, except for some minor leakage on HAN-235-0652. It is difficult to determine if the leakage stains were apparent before the overlay was placed or since.

The cores confirmed excellent bond with the original concrete surface. There was some evidence of corrosion taking place on the reinforcing steel, but again, it cannot be determined if this corrosion product was on the bars before the overlay was placed or if it occurred afterwards.

The chloride permeability readings determined from the cores are very good. The highest reading on bridge no. HAN-75-1383 was 350 and on bridge no. HAN-235-0652 was 445. Generally, chloride permeability readings below 100 are considered excellent.

The chloride content readings determined from powder samples from the cores at various levels were somewhat high, which does not correlate well with the permeability readings. The readings on bridge no. HAN-75-1383 were 15.43 lbs./cu yd at the ½" level, 5.05 lbs./cu yd at the 1" level and 3.34 at the rebar level. The readings for HAN-235-0652 ranged from 11.90 lbs./cu yd at the ½" level to 3.00 at the rebar level.

Generally, a chloride content of 2.0 lbs./cu yd is considered the threshold level for corrosion to take place. Using this threshold as a reference, the chloride contents are quite high at the ½" level on both of these bridges. On the other hand, one would expect the chloride contents to be higher near the top of the surface of the concrete because salt migrates through the concrete from the top down. The chloride content at the reinforcing steel level in the concrete is the most critical because the chlorides attack the steel, causing it to expand, which results in a concrete spall. In the case of an existing bridge already chlorides in the concrete at the time of the overlay. In the case of these particular bridges, it is not known what the chloride contents were at the time of the overlays because the samples were not taken.

Bridge No. HAN-75-1383 carries a significant amount of truck traffic (900 ADTT) due to the proximity of an asphalt plant, a concrete plant and a quarry. Bridge No. HAN-235-0652 is more rural and only carries 170 ADTT. HAN-75-1383 has a maximum span length of 93 feet and HAN-235-0652 has a maximum span length of 82 feet. Even though actual salt usage is difficult to determine, it appears that HAN-75-1383 is more heavily salted than HAN-235-1383 because of the amount of traffic it carries and the fact that it is located within a few hundred yards of the Hancock County Engineer's Office. Practically every salt truck leaving the County facility crosses this bridge (HAN-75-1383).

Even though HAN-75-1383 is more heavily traveled, has slightly longer span lengths and gets more salt applications, the wearing surface and the bottom side of the deck is in much better condition. This is not easily explainable, but could be due to the quality of concrete used in original construction or due to the fact that the built-up girders might be slightly less flexible than the rolled beams used for HAN-235-0652.

Overall, these overlays are performing very well and should continue to perform well for at least the next 5 years.

IMPLEMENTATION

This particular product (microlite) is performing well on the two bridges investigated, but there is little evidence that the material and procedures will result in bridge deck overlays that will outlast the conventional microsilica modified concrete overlays which have been used in Ohio since the early 1980's. On the other hand, a study which only includes two bridges is not a large enough sample when comparing to another product which has been used on several hundred bridges. Likewise, the age of these overlays is only six (6) years, while conventional microsilica concrete overlays have been found to last 10 – 15 years. Another factor to consider is that the two bridges in this sample are not mainline bridges, but rather overpasses, and as such have not seen the constant high speed truck traffic that many interstate bridges experience.

This author suggests:

1. Come back and re-evaluate these overlays after they are 10 years old.

2. Place 4 or 5 more of these overlays on mainline bridges where microsilica concrete overlays are also being placed on adjacent bridges and compare longevity side-by-side with microsilica overlays.

ACKNOWLEDGMENTS

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Mr. Matt Pfirsch, National Lime and Stone Company, for providing materials information and concrete mix design used.

Mr. Steven Wilson , Hancock County Engineer , for providing traffic count data.

APPENDIX A

PART 1
HAN - 235 - 0652

Han - 235-0652 Looking East

Map cracking of wearing surface

Typical cracking

Typical underside

Some previous patched areas; minor spalling; transverse cracks with efflorescence

Minor leakage

Sounding the deck

Coring operation

Patching core hole

Patched core hole

Core taken through the side of a reinforcing bar

Core showing variable thickness of overlay

Core taken at crack

Core taken in variable thickness area

Core showing crack propagating from corroded reinforcing steel in parent concrete

Core showing corrosion at reinforcing steel in parent concrete (upside down core)

Core taken at centerline construction joint

Core showing that not all reinforcing steel indicates corrosion activity

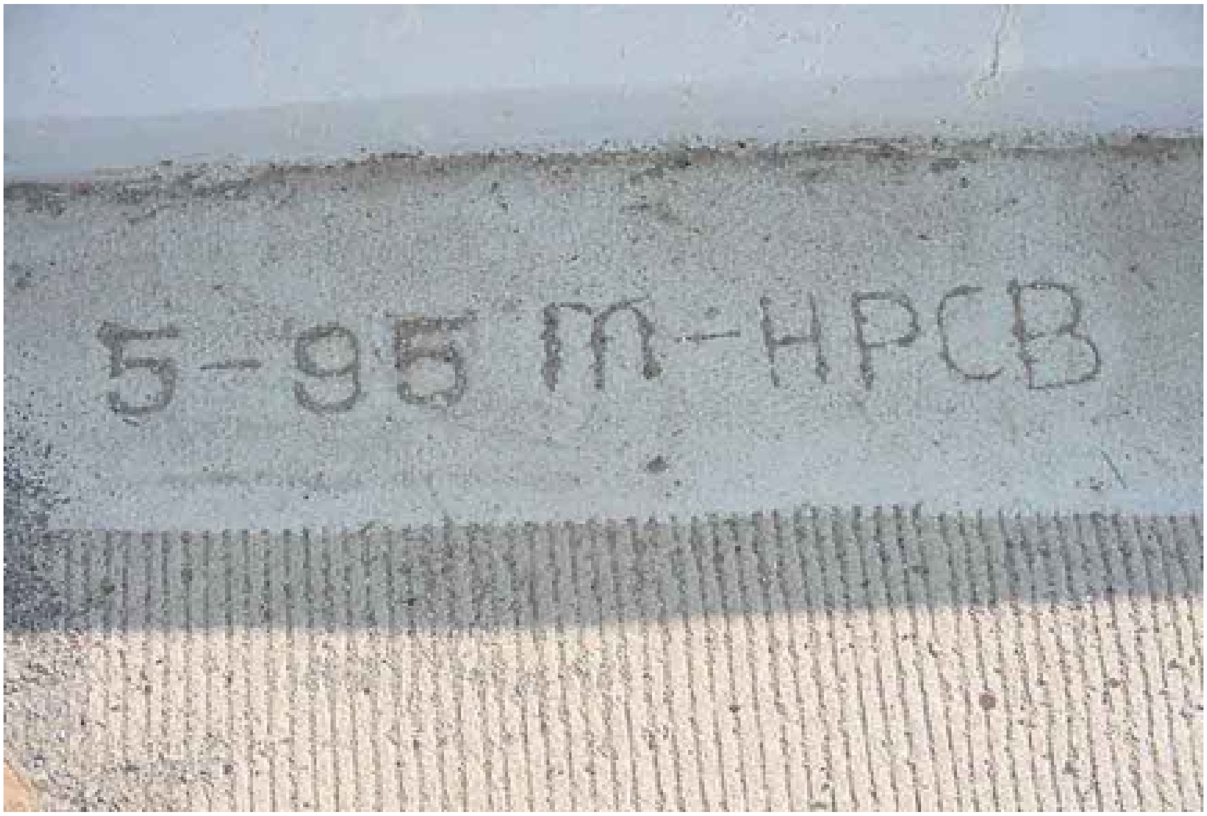
PART 2
HAN - 75 1383
(LIMA AVE.)

Wearing surface Lima Ave., looking southwest

Wearing surface looking southwest

Typical texture

Wearing surface



Stencil in overlay showing material and date


Looking at south side of bridge

I-75 under bridge looking North

Underside of bridge looking southwest

Typical underside condition

Wetting the deck prior to visual inspection

Sounding deck

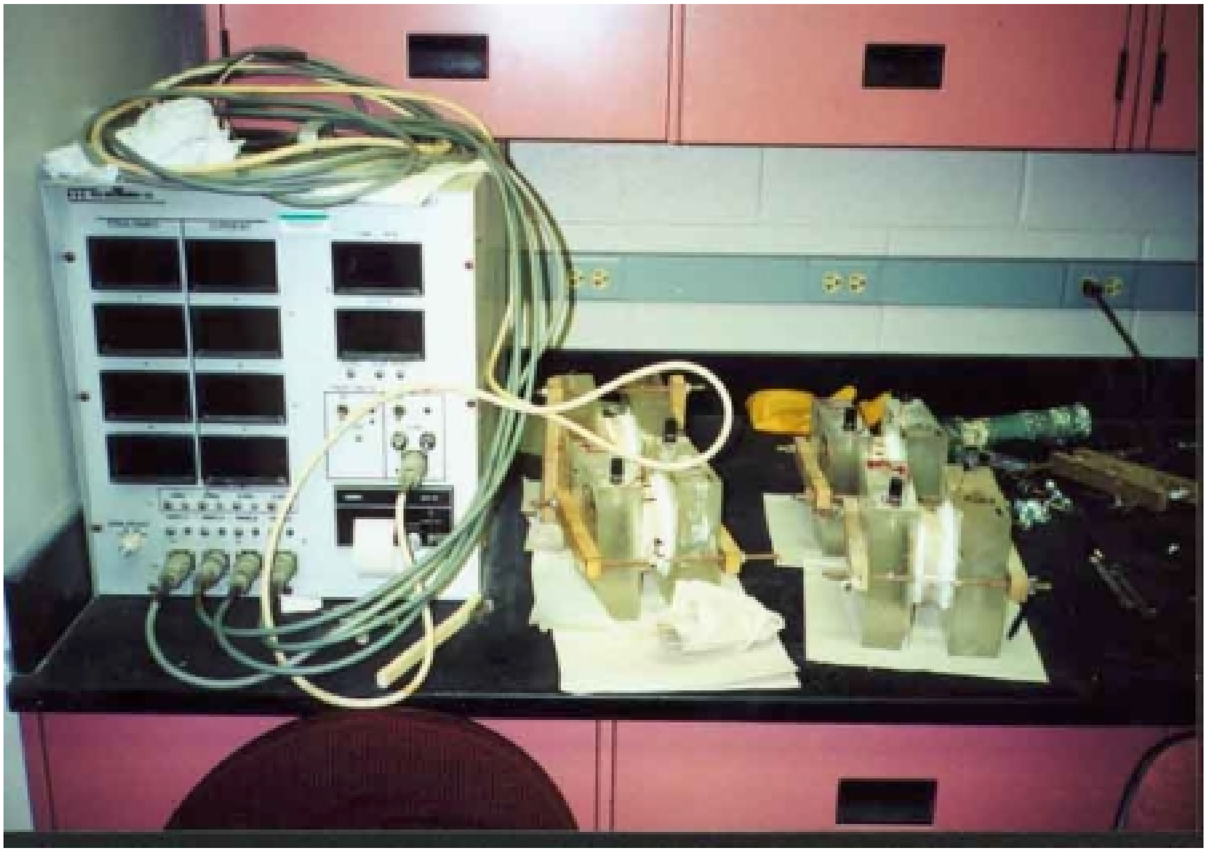
Typical loads using bridge

Drilling a core

Core showing bond line

Crack extending part way through overlay

A good core



“Rapid Chloride Permeability Testing”