COMPARISON OF STANDARD AND DEEP BRIDGE DECK OVERLAY PERFORMANCES

MDOT
Michigan Department of Transportation

CONSTRUCTION AND TECHNOLOGY DIVISION

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16. Abstract

This report compares the performance of deep and standard bridge deck overlays on three structures after six years of service. The bridges cross over I-75 in Saginaw County and have light ADT's (1000 to 2000 vehicles per day). An inspection of the evaluated structures showed cracking on the deep overlays occurred predominantly in the joint areas, while the standard overlay had random cracking over the majority of the deck. Shear tests on the bonded surface between the overlay and the existing deck showed good bonding strength on both the deep and standard overlays. Overall, the deep overlays performed better than the standard overlay, but this study was limited.

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MICHIGAN DEPARTMENT OF TRANSPORTATION
MDOT

Comparison of Standard and Deep Bridge Deck Overlay Performances

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Research Project 97 TI-1872
Research Report No. R-1368

Lansing, February 1999

INTRODUCTION

On July 17, 1997, the Bridge Committee requested that the Structural Unit of MDOT's Construction and Technology Division, investigate the performance of deep overlays as compared to the standard 38 mm overlay. Since the construction cost of the deep overlays has been similar to the standard overlays, better performance would provide support for more frequent use of the deep overlay

The deep overlay consists of removing deck concrete below the top reinforcement, replacing any deficient existing rebar and placing Grade 45 D Modified Concrete, which provides a 75 mm cover over the top transverse reinforcement. The Grade 45 D Modified concrete must have a minimum 28-day compressive strength of 31 MPa. Typical details of deep overlays are shown in Figures 1, 3, and 5. The standard overlay consists of hydro-demolishing 19 mm of the top deck surface and placing a latex modified concrete surfacing mixture to provide about 75 mm cover over the top reinforcement. Typical details of standard overlays are shown in Figures 2, 4, and 6.

Three structures were selected to compare the performance of deep versus standard overlays. The selected structures were S04 (Busch Road), S05 (Townline Road), and S06 (Curtis Road) of 73171. All of the structures have four spans supported by steel beams and carry traffic over I-75 in Saginaw County. S06 (Curtis Road) is a cantilevered structure with a cantilever length of 2.3 m, while S04 (Busch Road) and S05 (Townline Road) are of simple support design. S04 (Busch Road) has a total length of 91 m with a skew angle of 45° and six beams spaced at 1.9 m. S05 (Townline Road) has a total length of 81 m with a skew angle of 38° and six beams spaced at 1.9 m. S06 (Curtis Road) has a total length of 78 m with a skew angle of 36° and six beams spaced at 1.8 m.

The rehabilitation of these structures was let to contract as a package in March 1991 and completed in October 1991. All of the structures were rehabilitated by the same contractor, and are in the same general area with similar traffic and environmental exposure, which helps validate the performance comparison. At the time of evaluation, in June 1998, the overlays were nearly seven years old and had weathered six winters. Both S04 (Busch Road) and S05 (Townline Road) have deep overlays and S06 (Curtis Road) has a standard overlay. Traffic on S04 (Busch Road) and S05 (Townline Road) was light (ADT under 1000), with S04 carrying a few heavy waste hauling trucks. The traffic volume on S06 (Curtis Road) is also light (ADT less than 2000) and it also carries a few waste hauling trucks.

PROCEDURE

The deck of each structure was chain dragged to determine delaminations. The areas of delamination were outlined and filled in with diagonal lines using orange paint. All the visible cracking was then marked with yellow paint. The decks were wetted and allowed to dry revealing minor cracking, which was marked with pink paint. The decks were photographed from the height of approximately six meters from a lift bucket. Three cores were taken from each of the structures and were tested for shearing strength to determine the bond characteristics of the overlays. The shear test method used is MDOT's in-house direct shear test.

RESULTS

Cracking on the two deep overlay structures, S04 (Busch Road) and S05 (Townline Road) is predominantly in the joint areas, with a few long diagonal cracks located at the "acute angle" corner of the deck (see Figure 13). The diagonal cracks are attributed to the skew of the bridge deck and not the result of the overlay. The standard overlay structure, S06 (Curtis Road), has severe random cracking at the joints, and light random cracking throughout the deck.

Figures 24 through 26 show representative cores taken from the three structures. The results of the shear tests on the cores showed good bonding strength on both the deep and standard overlays, and are shown in Appendix A. One core from S04 (Busch Road), which had one of the lower readings at 3070 KPa, broke at the reinforcement steel. Another core, from S05 (Townline Road), had sand at the bond line and tested at 2610 KPa. For the standard overlay, two of the cores were too short for shearing testing. The core that could be tested had a shear strength value of 4620 KPa.

CONCLUSION

The initial reaction is to conclude that the deep overlay method will provide a longer lasting deck as compared to a standard overlay with the cost of both overlay methods being comparable. Although, comparing prices within one contract can be misleading due to different bidding practices contractors often employ. It appears that the cost for the latex modified concrete, used on the standard overlay, can offset the cost for the extra labor, equipment, and material needed for the deep overlay. Overall, the deep overlays performed better than the standard overlay, but this study was limited.

Another issue regarding deep overlays, not covered within this report, is the potential of punching through the deck when removing the additional concrete for the deep overlay. When this happens, the cost and labor for the deep overlay increases greatly because of the forming required on the underside of the deck. For this reason, the latest department policy is to limit the use of deep overlays to bridge decks with deck underside deficiencies (i.e., visible spalls, delamination, wet areas, or patches) less than 5 percent. Since bridge management engineers anticipate the life expectancy for a deep overlay to be 25 to 30 years, as compared to a standard overlay, 10 to 15 years, the emphasis will be to provide the deep overlay earlier in the life of the bridge deck.

FIGURES

Figure 1 - Deep Overlay (typical detail)
(US customary units used on plans)

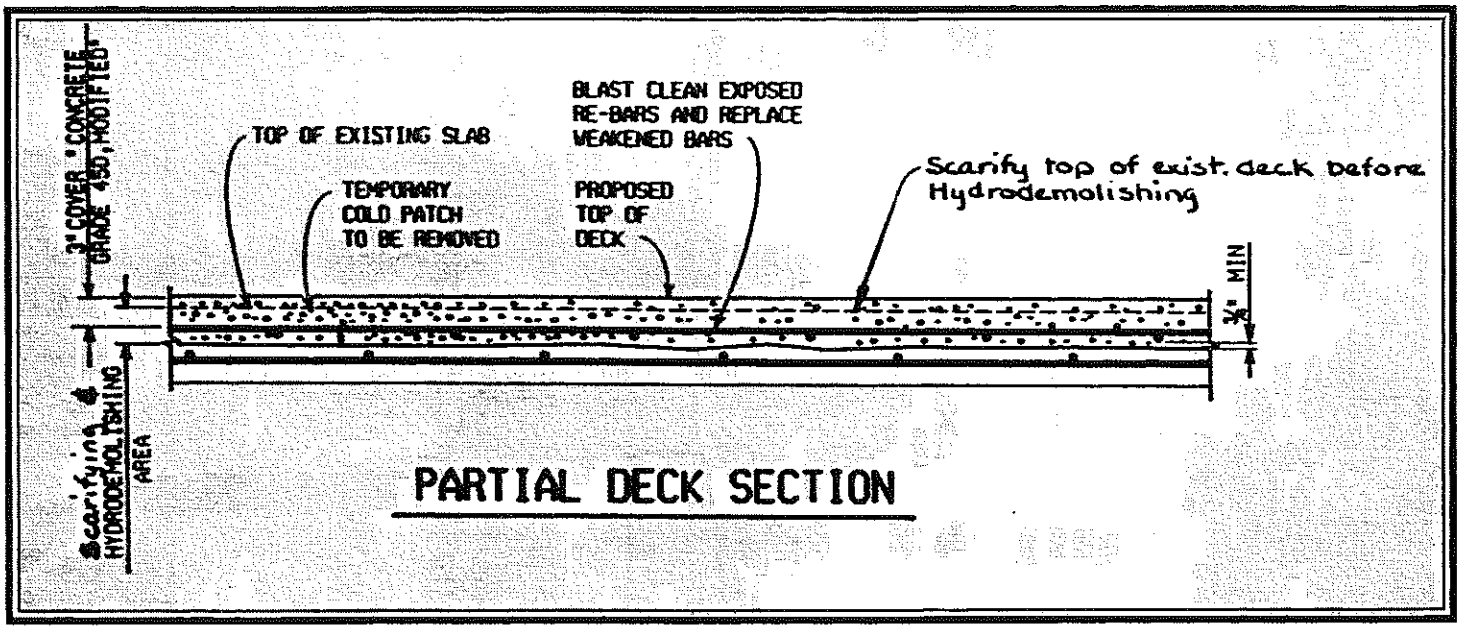


Figure 2 - Standard Overlay (typical detail)
(US customary units used on plans)

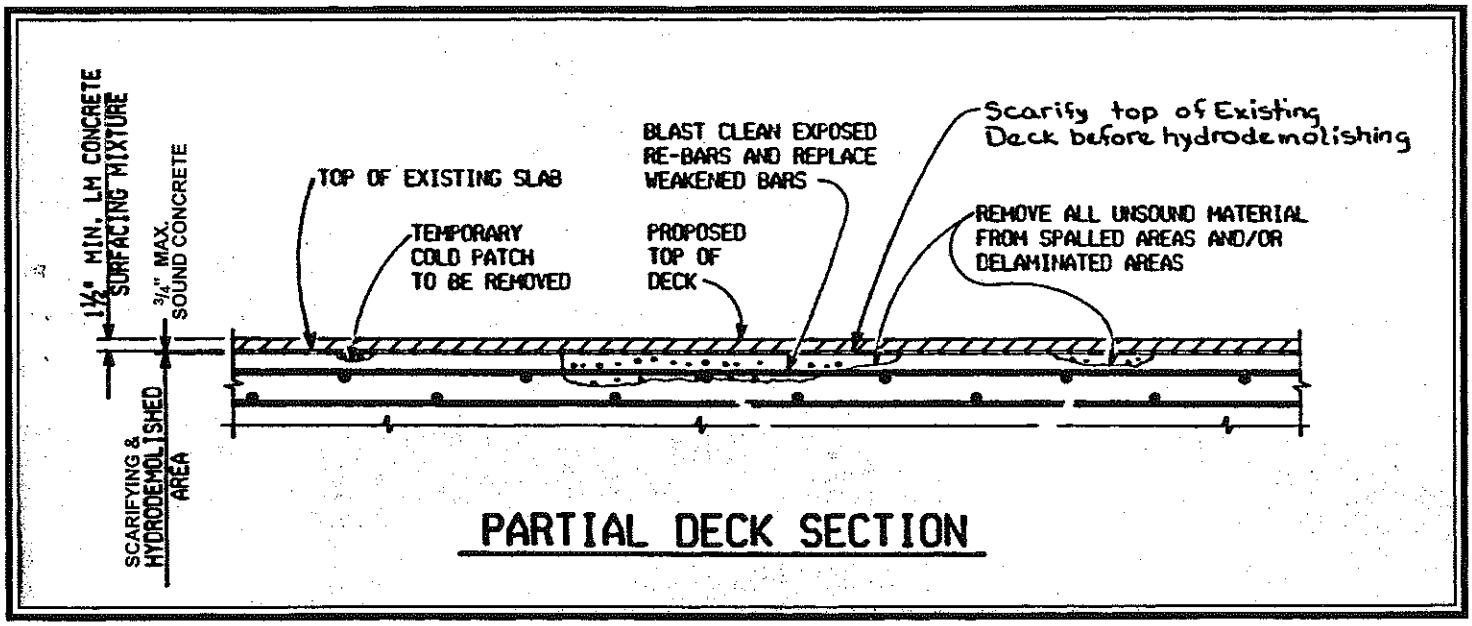


Figure 3 - Deep Overlay Construction Joint (Typical)
(US customary units used on plans)

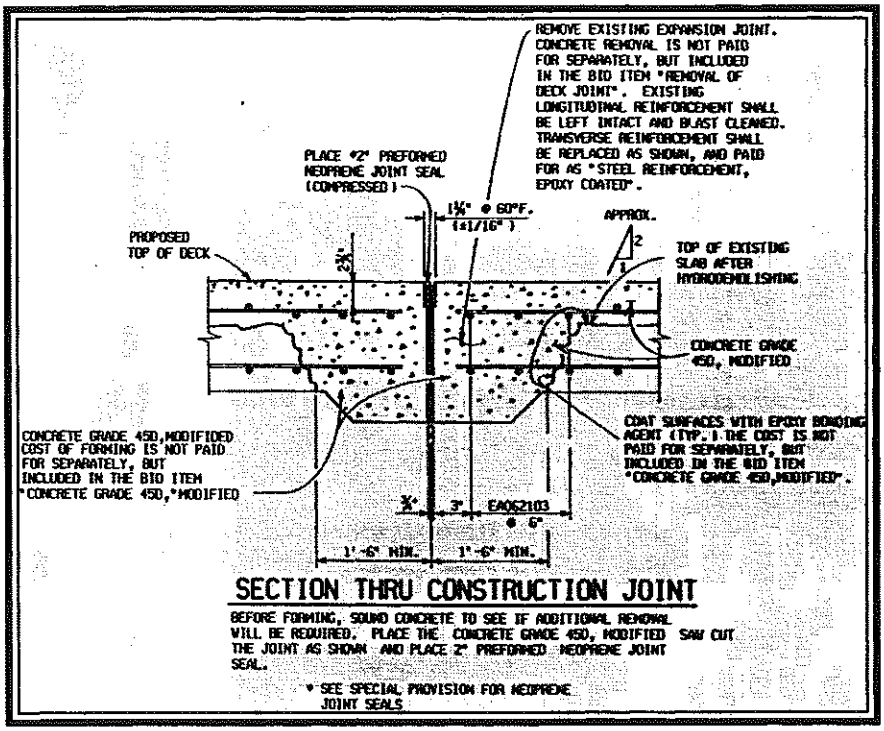


Figure 4 - Standard Overlay Construction Joint (Typical)
(US customary units used on plans)

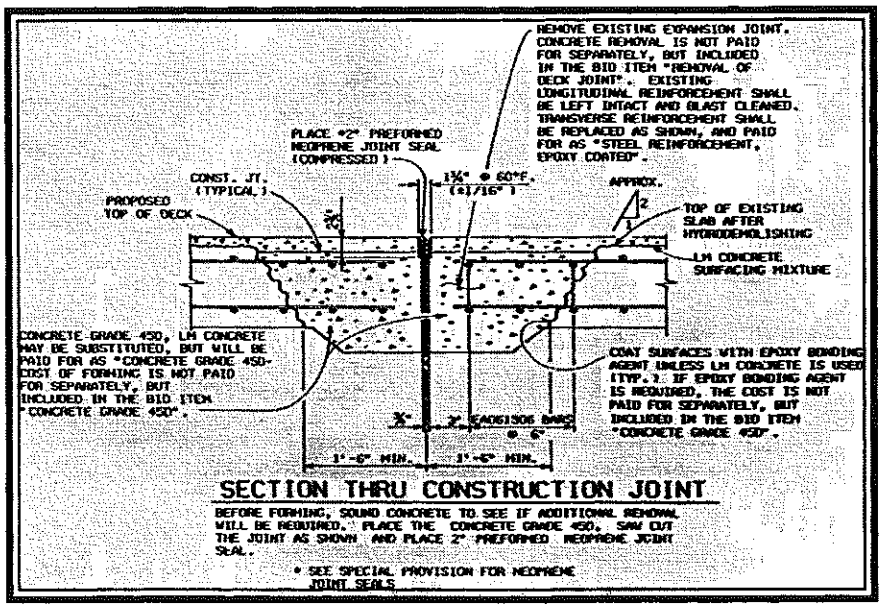


Figure 5 - Deep Overlay Expansion Joint (Typical)
(US customary units used on plans)

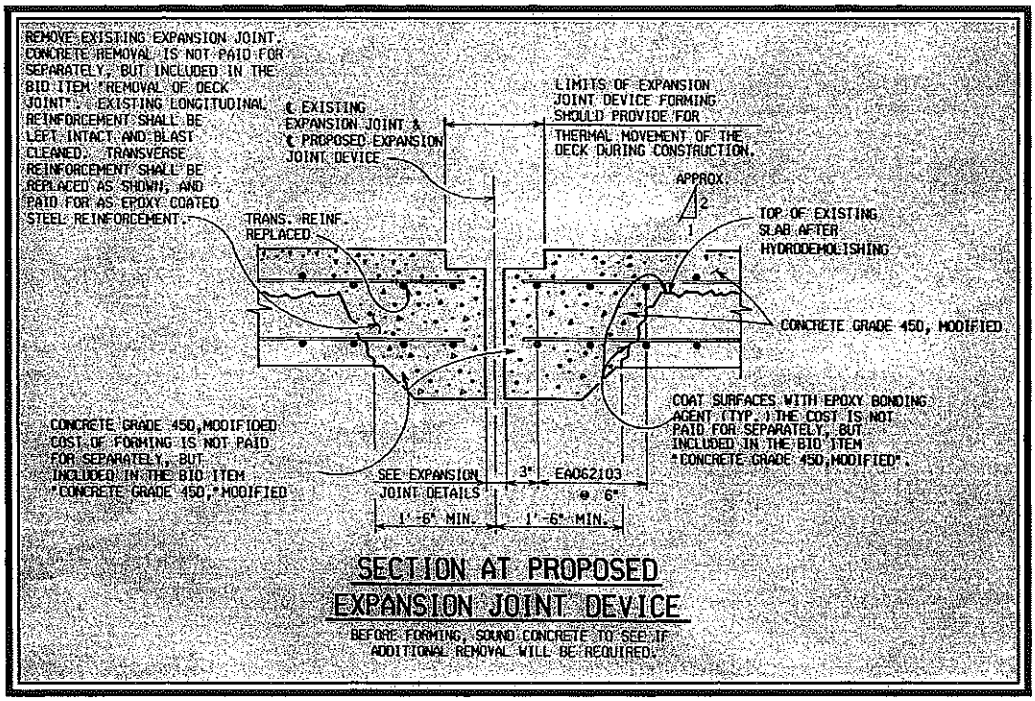


Figure 6 - Standard Overlay Expansion Joint (Typical)
(US customary units used on plans)

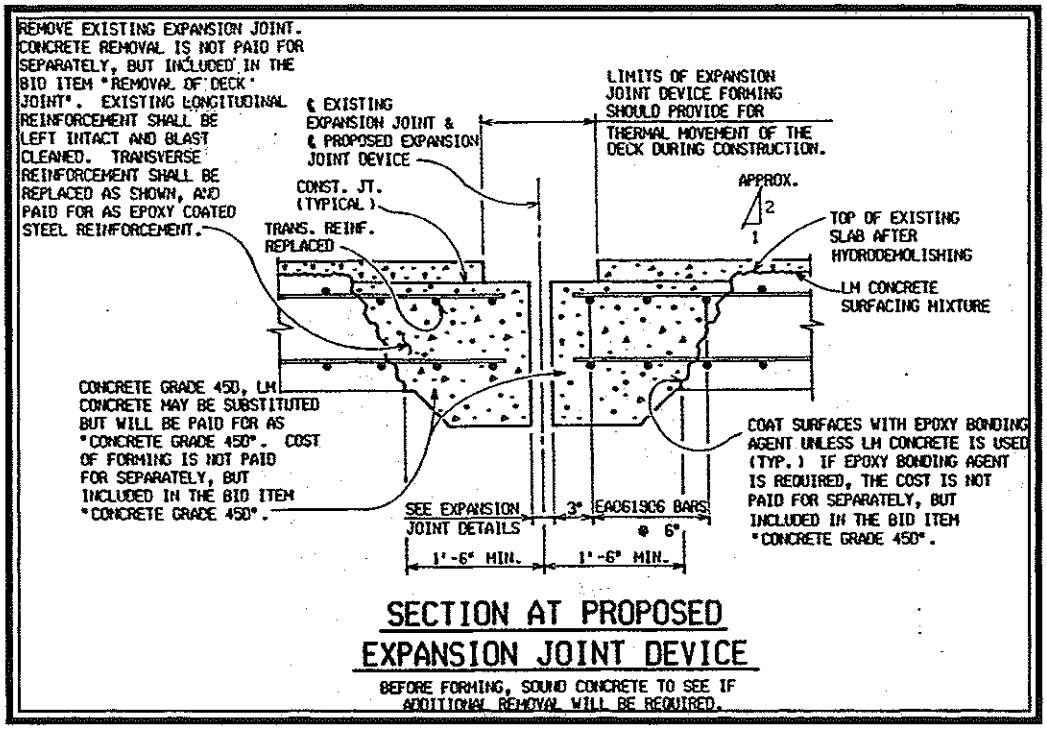


Figure 7 - S04 of 73131 - Span 1
Deep Overlay

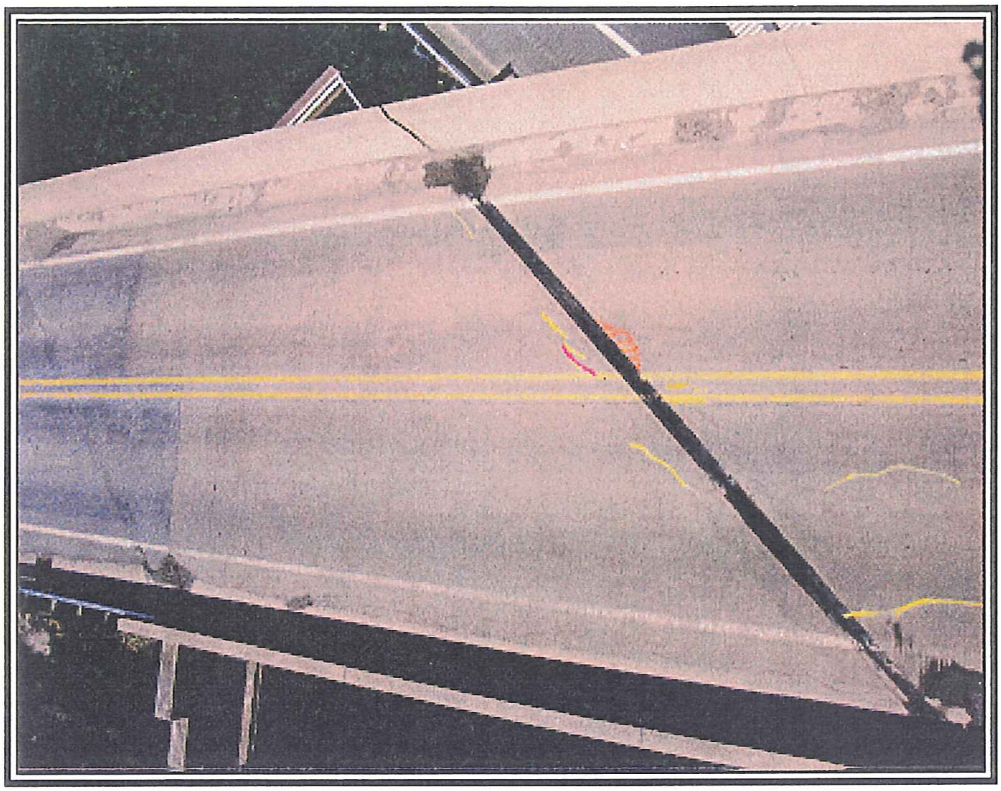


Figure 8 - S04 of 73131 - Span 2
Deep Overlay

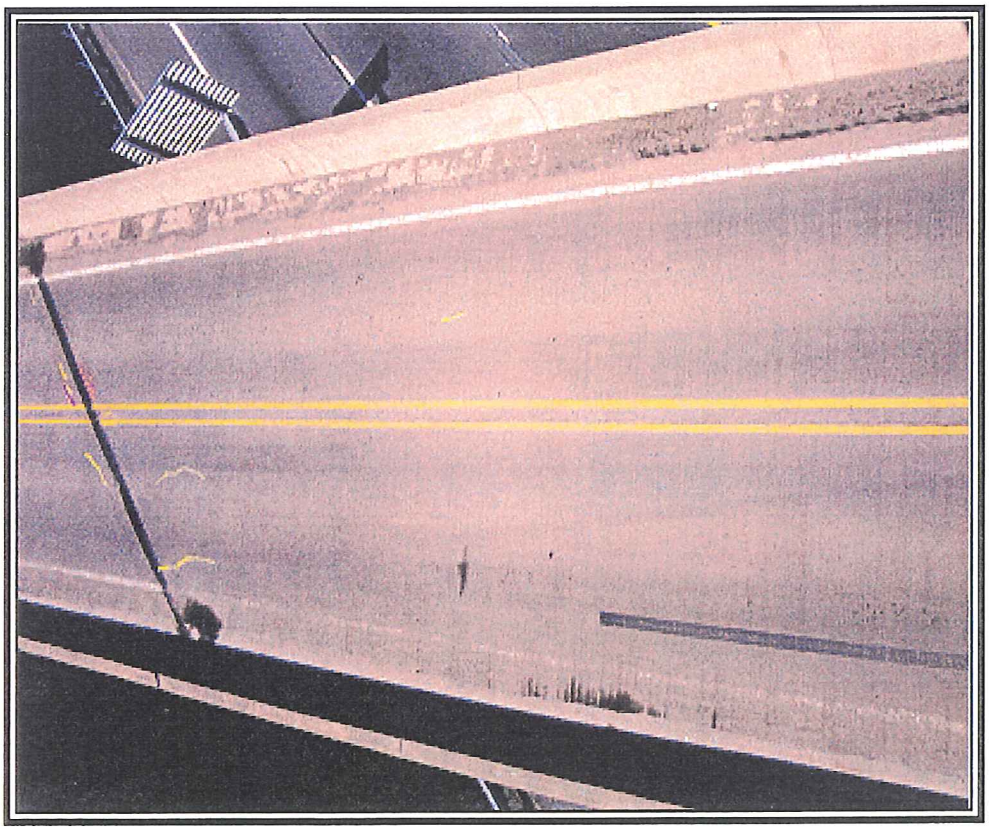


Figure 9 - S04 of 73131 - Pier 2
Deep Overlay

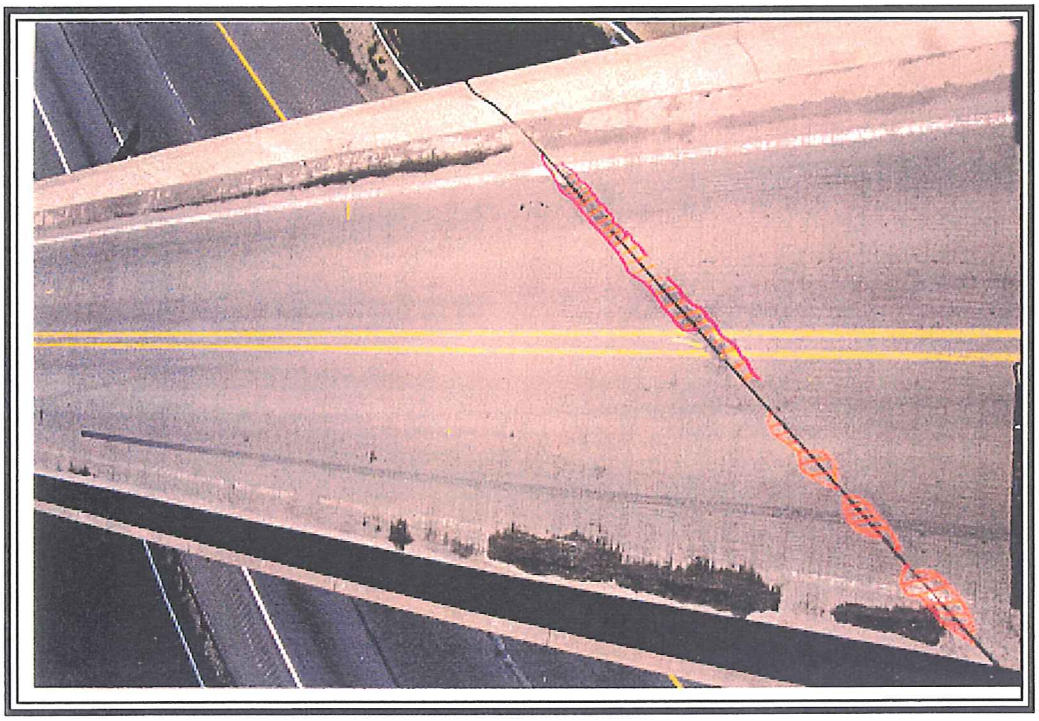


Figure 10 - S04 of 73131 - Span 3
Deep Overlay

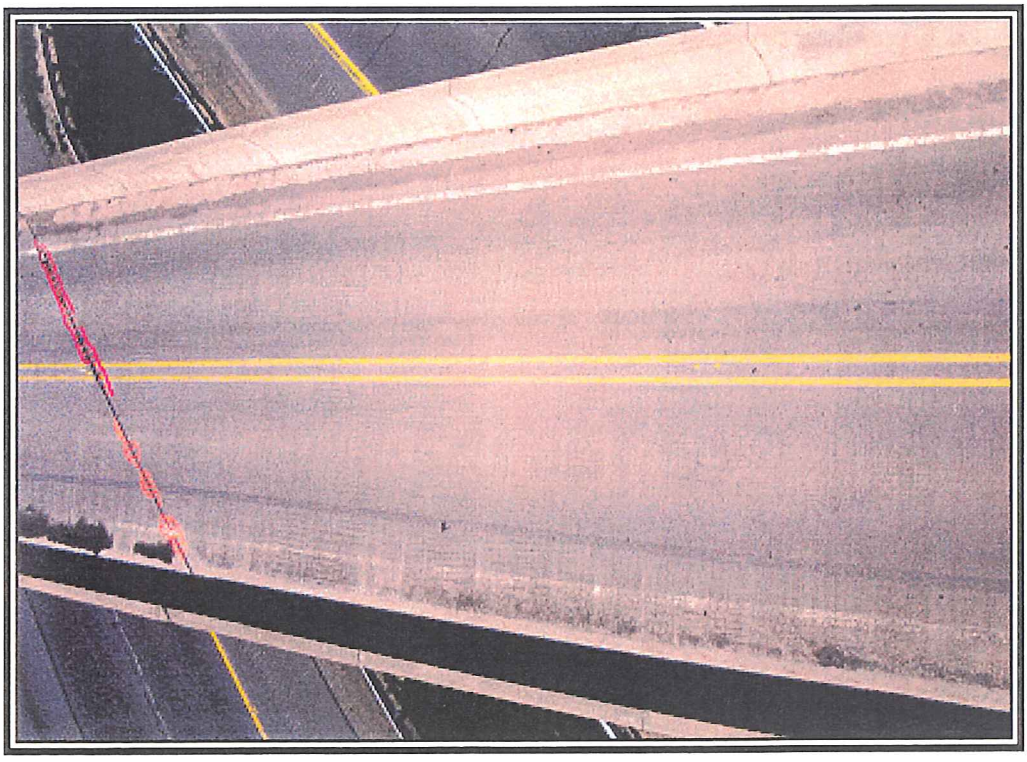


Figure 11 - S04 of 73131 - Pier 3
Deep Overlay

Figure 12 - S04 of 73131 - Span 4
Deep Overlay

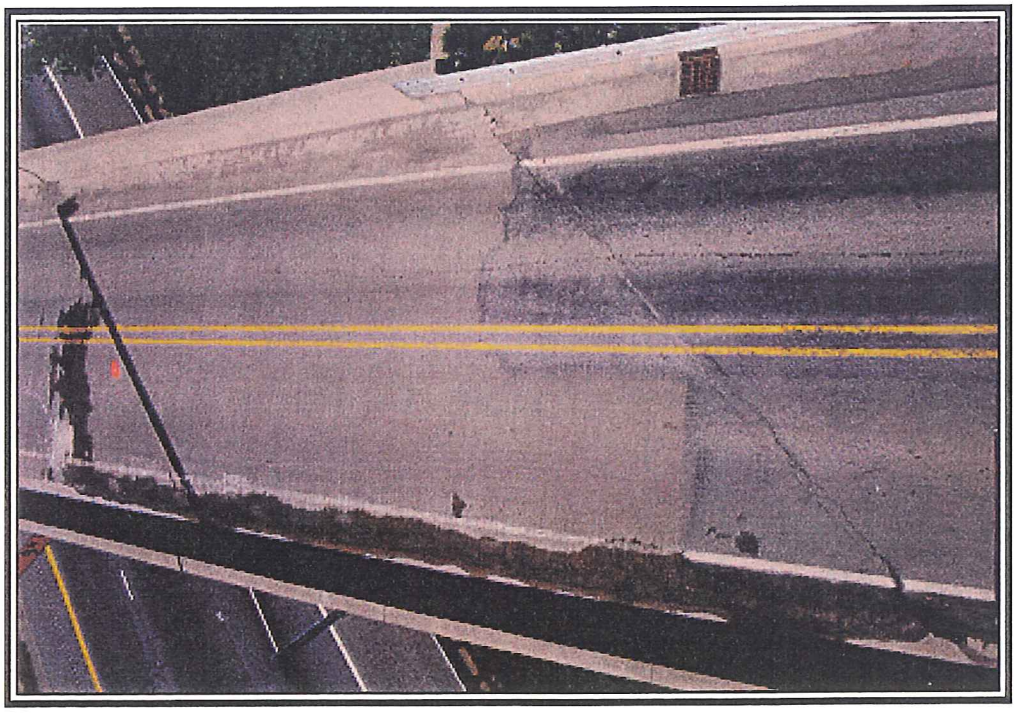


Figure 13 - S05 of 73131 - Span 1
Deep Overlay

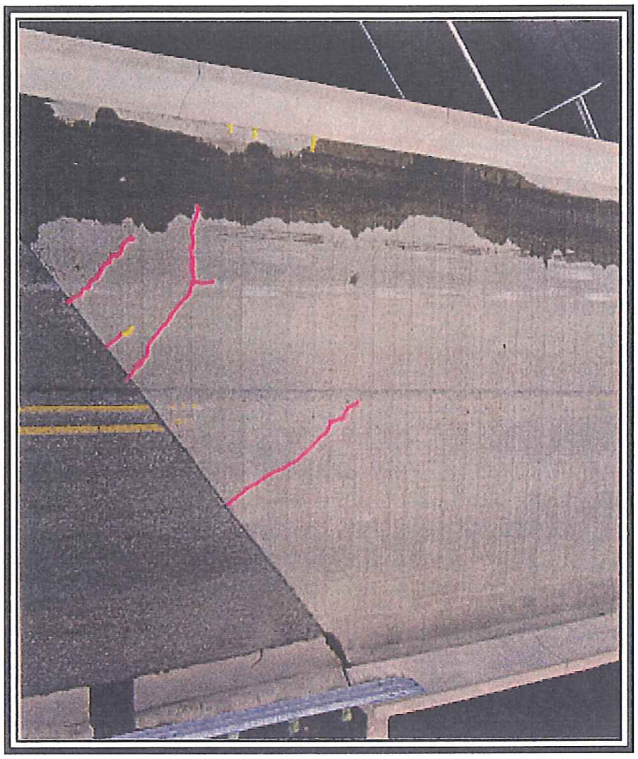


Figure 14 - S05 of 73131 - Pier 1
Deep Overlay

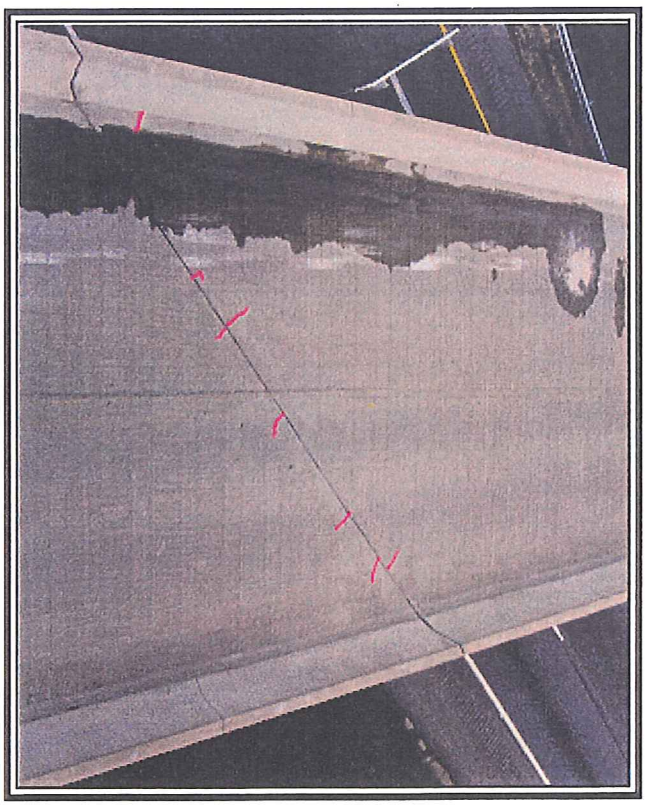


Figure 15 - S05 of 73131 - Span 2
Deep Overlay

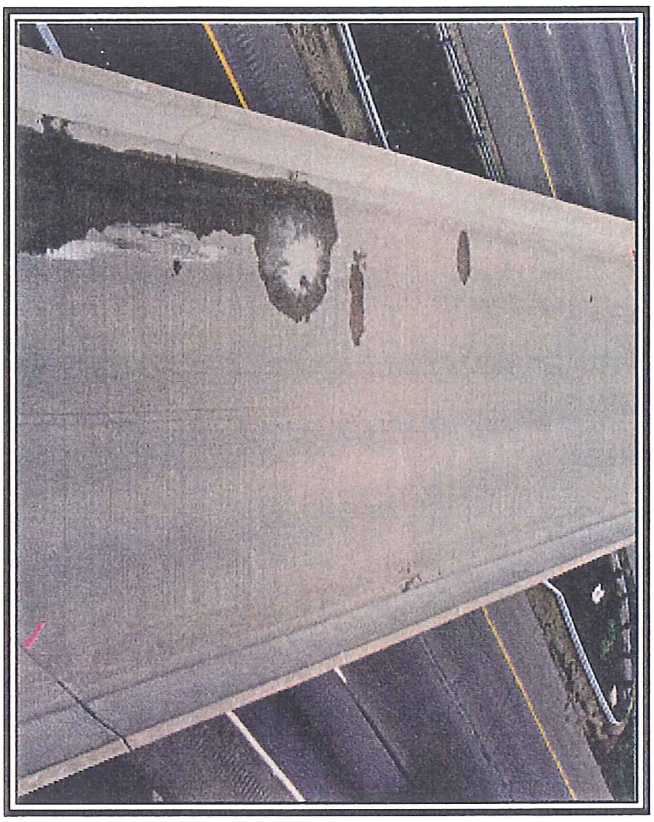


Figure 16 - S05 of 73131 - Pier 2
Deep Overlay

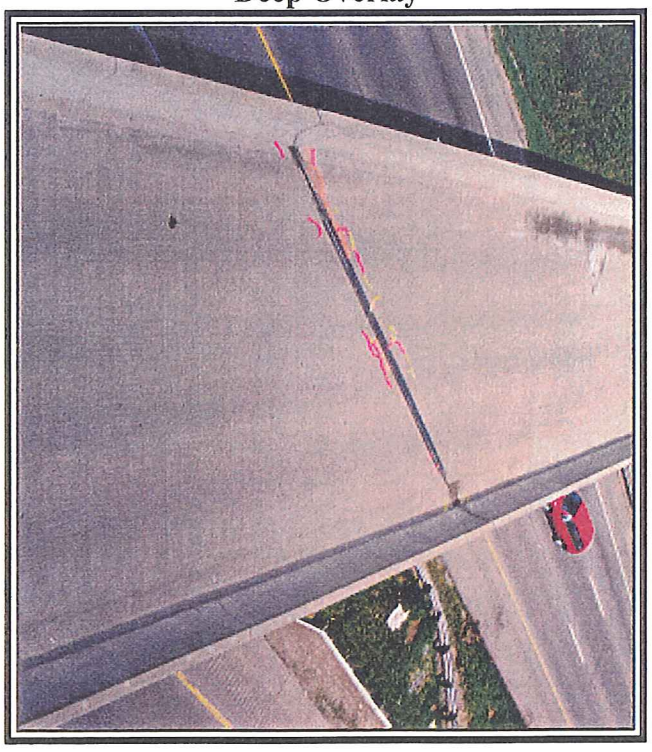


Figure 17 - S05 of 73131 - Span 3
Deep Overlay

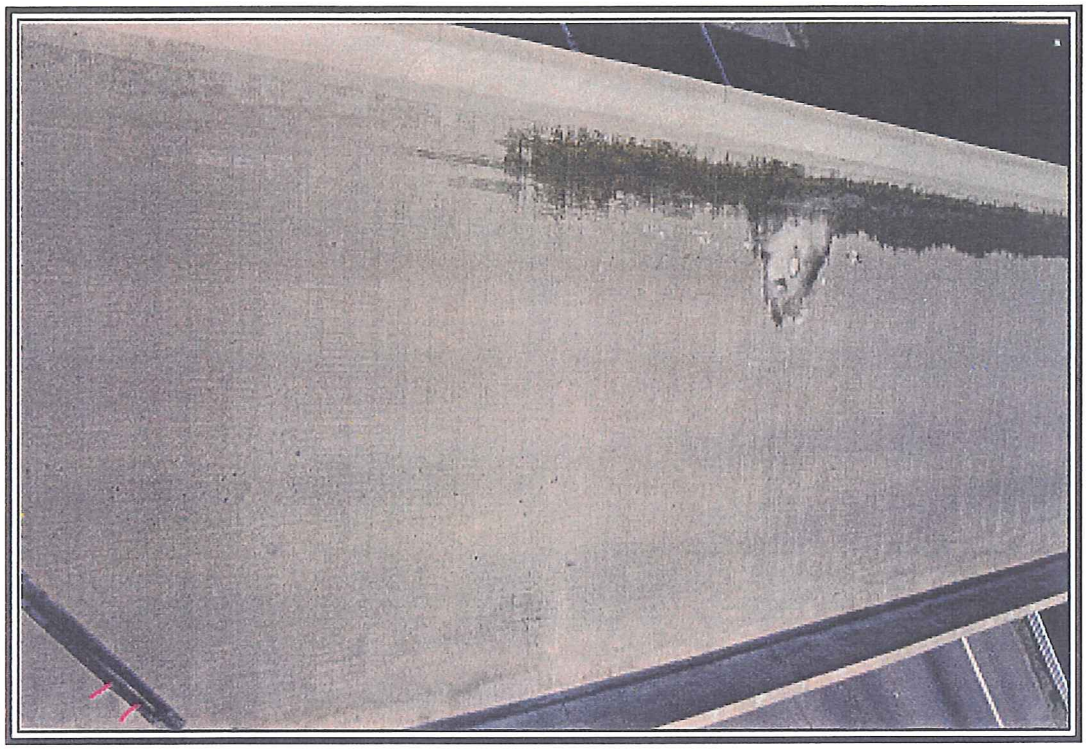


Figure 18 - S05 of 73131 - Pier 3
Deep Overlay

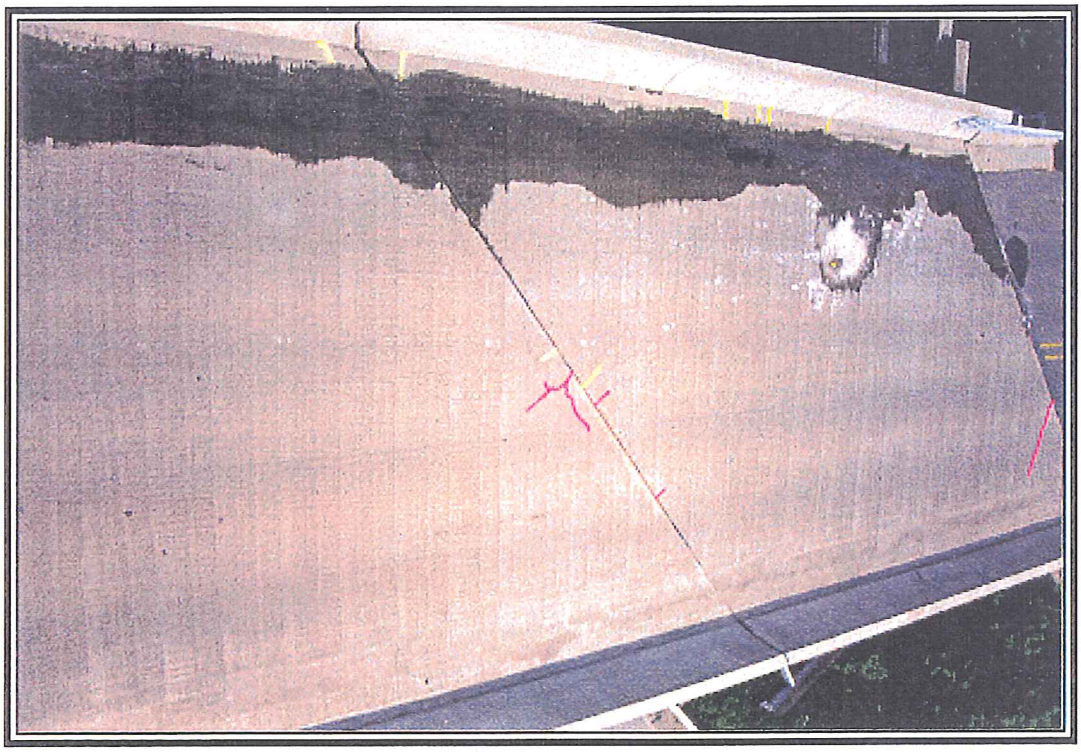


Figure 19 - S06 of 73131 - Span 1
Standard Overlay

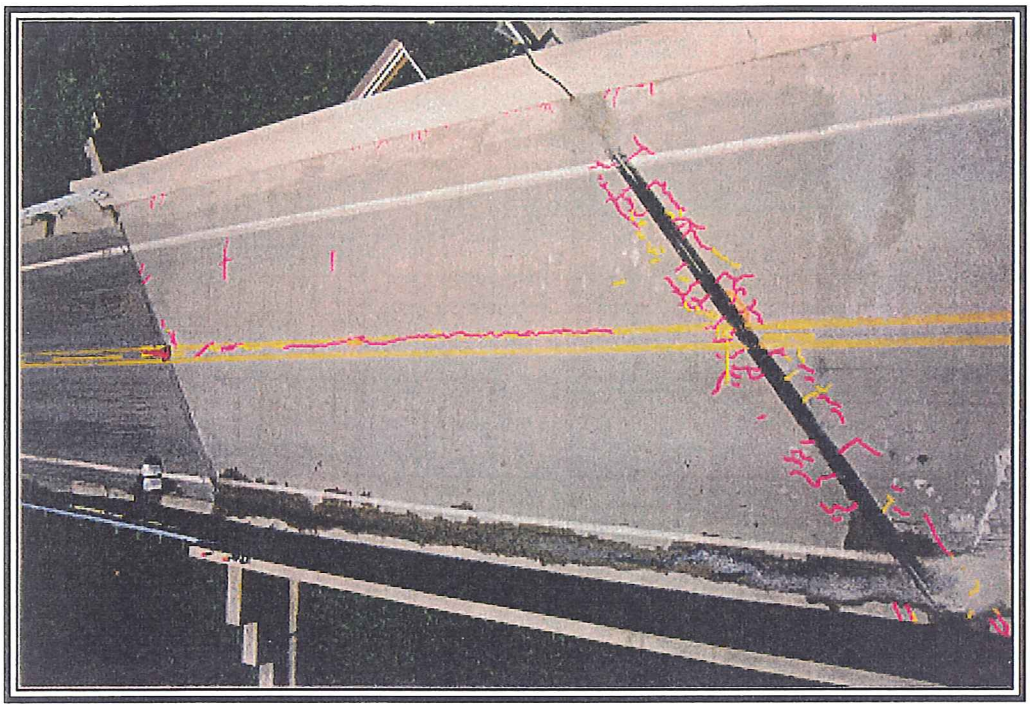


Figure 20 - S06 of 73131 - Span 2
Standard Overlay

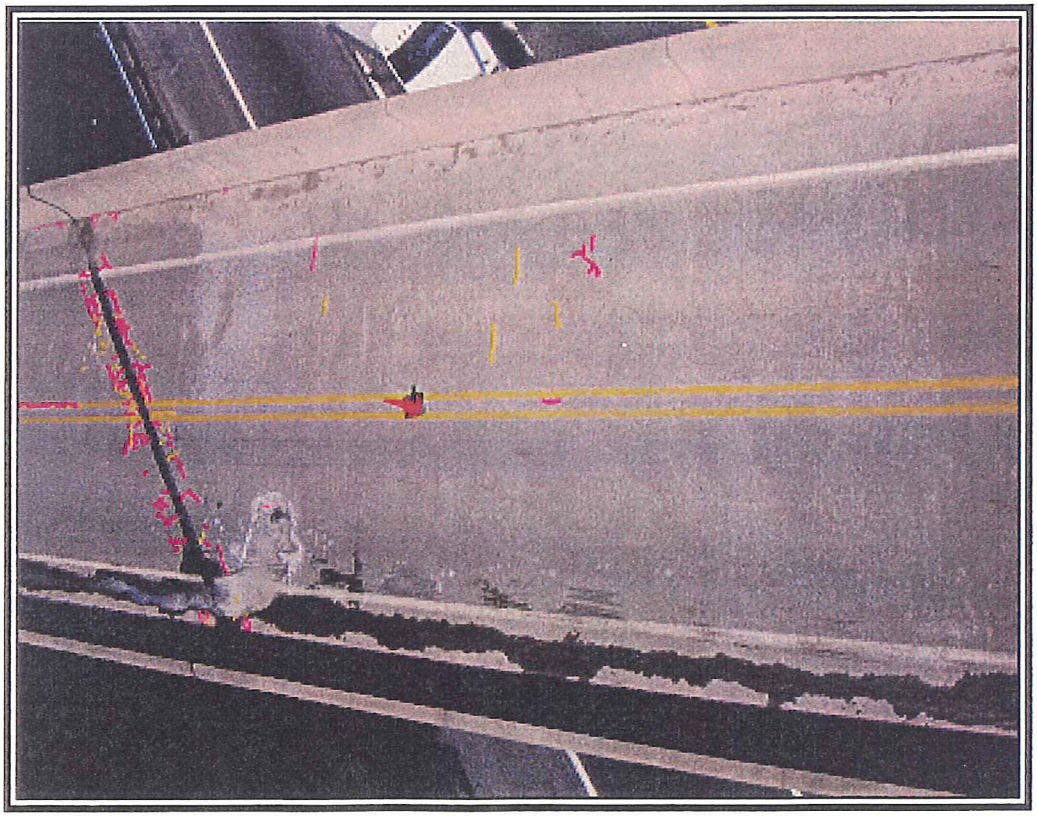


Figure 21 - S06 of 73131 - Pier 2
Standard Overlay

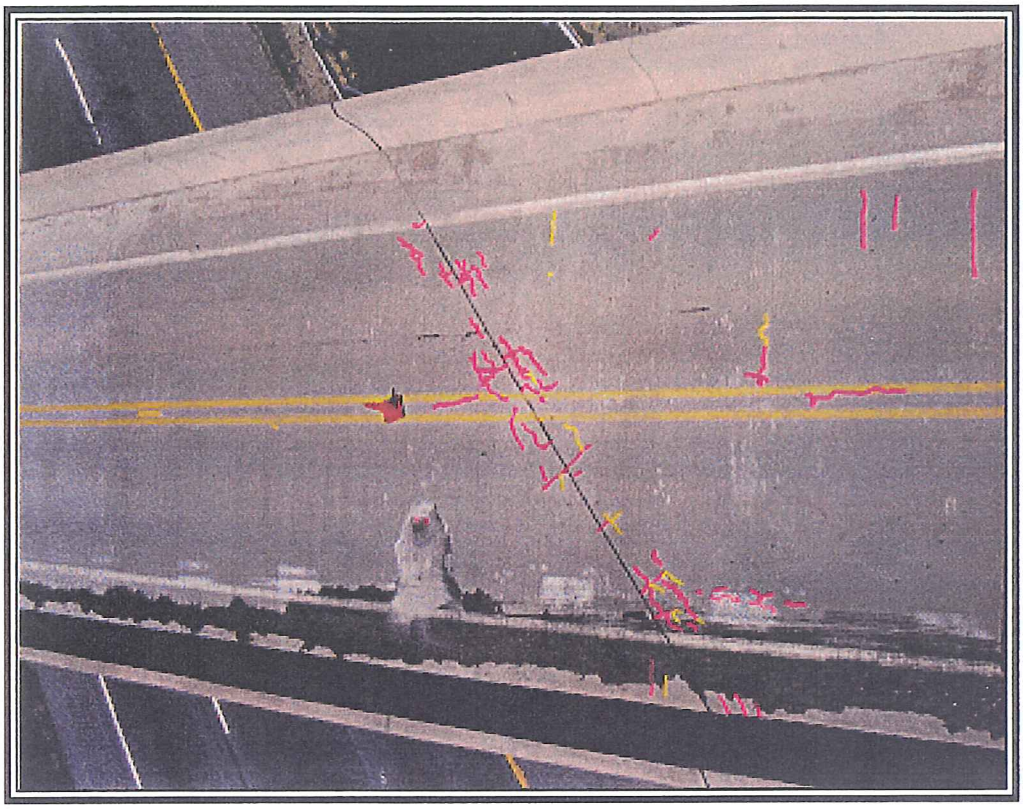


Figure 22 - S06 of 73131 - Span 3
Standard Overlay

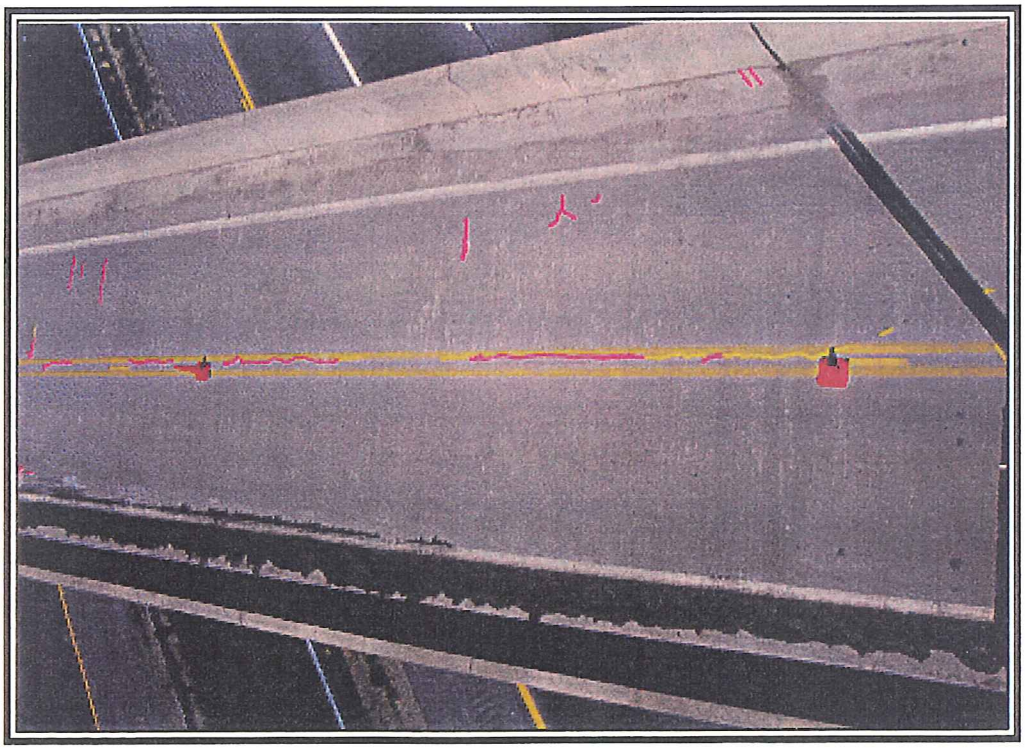


Figure 23 - S06 of 73131 - Span 4
Standard Overlay

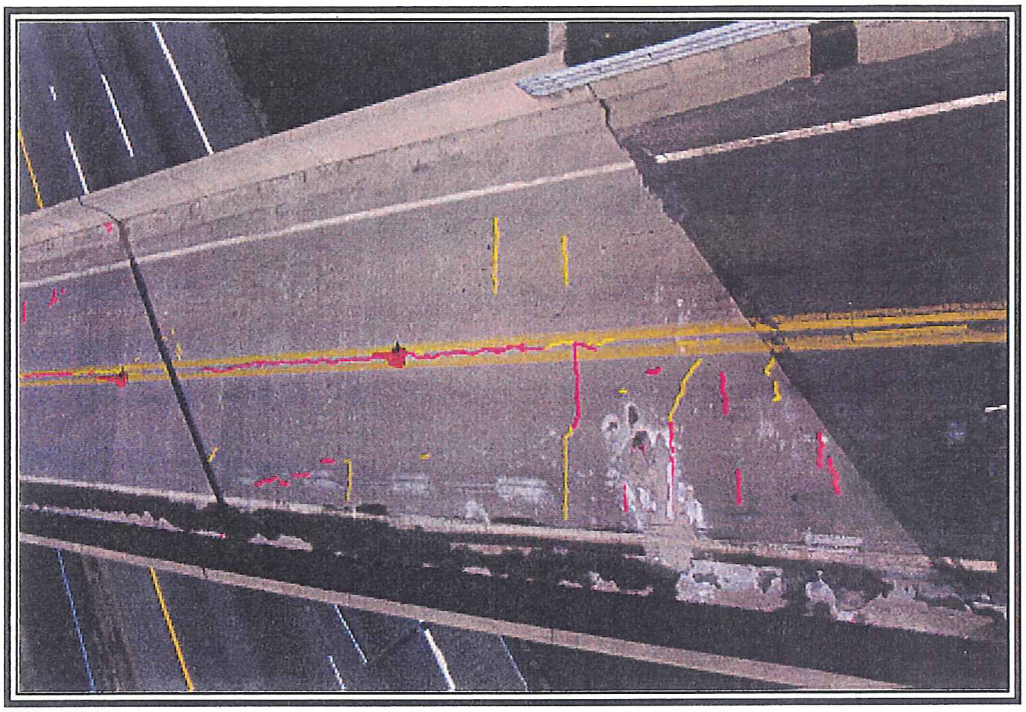
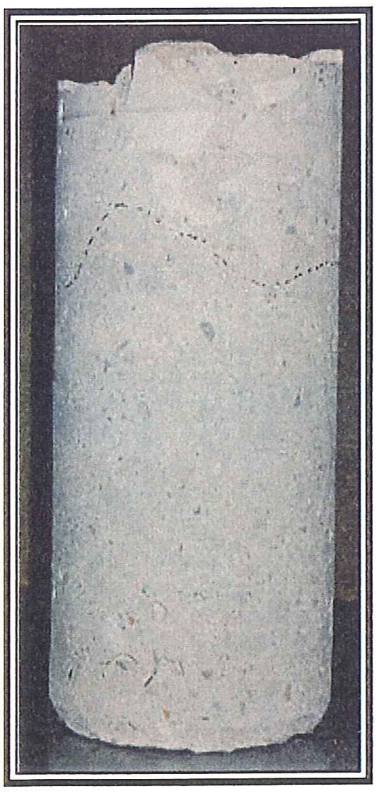


Figure 24 - Standard Overlay
Curtis Road

Figure 25- Deep Overlay
Townline Road

Figure 26- Deep Overlay
Busch Road



APPENDIX A

SHEAR TEST REPORTS

Testing and Research Section
Secondary Governmental Complex
P.O. Box 30049
Lansing, Michigan 48909

Job Number	Information Only
Control Section Identity	S04 of 73171
Laboratory No.	MR98-4C thru 6C
Date	August 11, 1998

REPORT OF TEST

Report on sample of	Bridge Deck Concrete (4 Inch Diameter Cores)		
Date sampled	June, 1998	Date received	June, 1998
Source of material	Busch Road/I-75		
Sampled from	Existing Bridge Deck	Quantity represented	3 Cores
Submitted by	Bryon Beck, Eng. Tech		
Intended use	Shear Strength Testing	Specification	

TEST RESULTS

Laboratory No.	Core No.	Station	Loc. Relative to Right Edge of Pavement, ft.	Shear Plane Inches (mm) from Top of Core	Shear Strength, psi (KPa)
MR98-4C	1B	NA	NA	5.5 (140)	630 (4340)
MR98-5C	2B	NA	NA	4.1 (104)	445 (3070)
MR98-6C	3B	NA	NA	4.5 (114)	630 (4340)

REMARKS: Tested for Information

cc: Materials Investigations - Elias David
Structures Unit - Bryon Beck

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Testing and Research Section
Secondary Governmental Complex
P.O. Box 30049
Lansing, Michigan 48909

Job Number	Information Only
Control Section Identity	S06 of 73171
Laboratory No.	MR98-7C thru 9C
Date	August 11, 1998

REPORT OF TEST

Report on sample of	Bridge Deck Concrete (4 Inch Diameter Cores)		
Date sampled	June, 1998	Date received	June, 1998
Source of material	Curtis Road/I-75		
Sampled from	Existing Bridge Deck	Quantity represented	3 Cores
Submitted by	Bryon Beck, Eng. Tech		
Intended use	Shear Strength Testing	Specification	

TEST RESULTS

Laboratory No.	Core No.	Station	Loc. Relative to Right Edge of Pavement, ft.	Shear Plane Inches (mm) from Top of Core	Shear Strength, psi (KPa)
MR98-7C	1C	NA	NA	4.5 (114)	670 (4620)
MR98-8C	2C*	NA	NA	0 (0)	
MR98-9C	3C*	NA	NA	0 (0)	

REMARKS: Tested for Information. *Cores were too short for testing.

cc: Materials Investigations - Elias David
Structures Unit - Bryon Beck