Bridge No. 513/32

SR 5 Overcrossing NE 145th Street

High Early Strength Latex Modified Concrete Overlay

WA-RD 248.1

Post Construction and Annual Reports
January 1992

Washington State Department of Transportation
in cooperation with the
United States Department of Transportation
Federal Highway Administration

WASHINGTON STATE DEPARTMENT OF TRANSPORTATION

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15. SUPPLEMENTARY NOTES

The study was conducted in cooperation with the U. S. Department of Transportation, Federal Highway Administration.

16. ABSTRACT

Latex modified concrete overlays normally require 48 hours of cure time before traffic can be restored to the structure. It is desirable to minimize the disruption to traffic. High early strength latex modified concrete, as demonstrated by this project, can reduce the cure time.

A 1-1/2 inch overlay of high early strength latex modified concrete was placed on SR 5 Overcrossing NE 145th Street, Bridge No. 513/32, in October 1989. The existing concrete box girder bridge has a deck area of 14,442 sq. ft. The overlay concrete contained Type III cement; the latex was supplied by Dow Chemical USA.

The use of high early strength latex modified concrete can reduce traffic closure time by approximately 24 hours compared to a normal latex modified concrete. The actual bridge closure time will be dependent on the timing of other project activities related to expansion joint repairs or modifications, striping, and off-structure work.

17. KEY WORDS	18. DISTRIBUTION STATEMENT
Bridge deck overlay, concrete additives, bridge deck repairs, latex modified concrete	

19. SECURITY CLASSIF. (of this report)	20. SECURITY CLASSIF. (of this page)	21. NO. OF PAGES	22. PRICE
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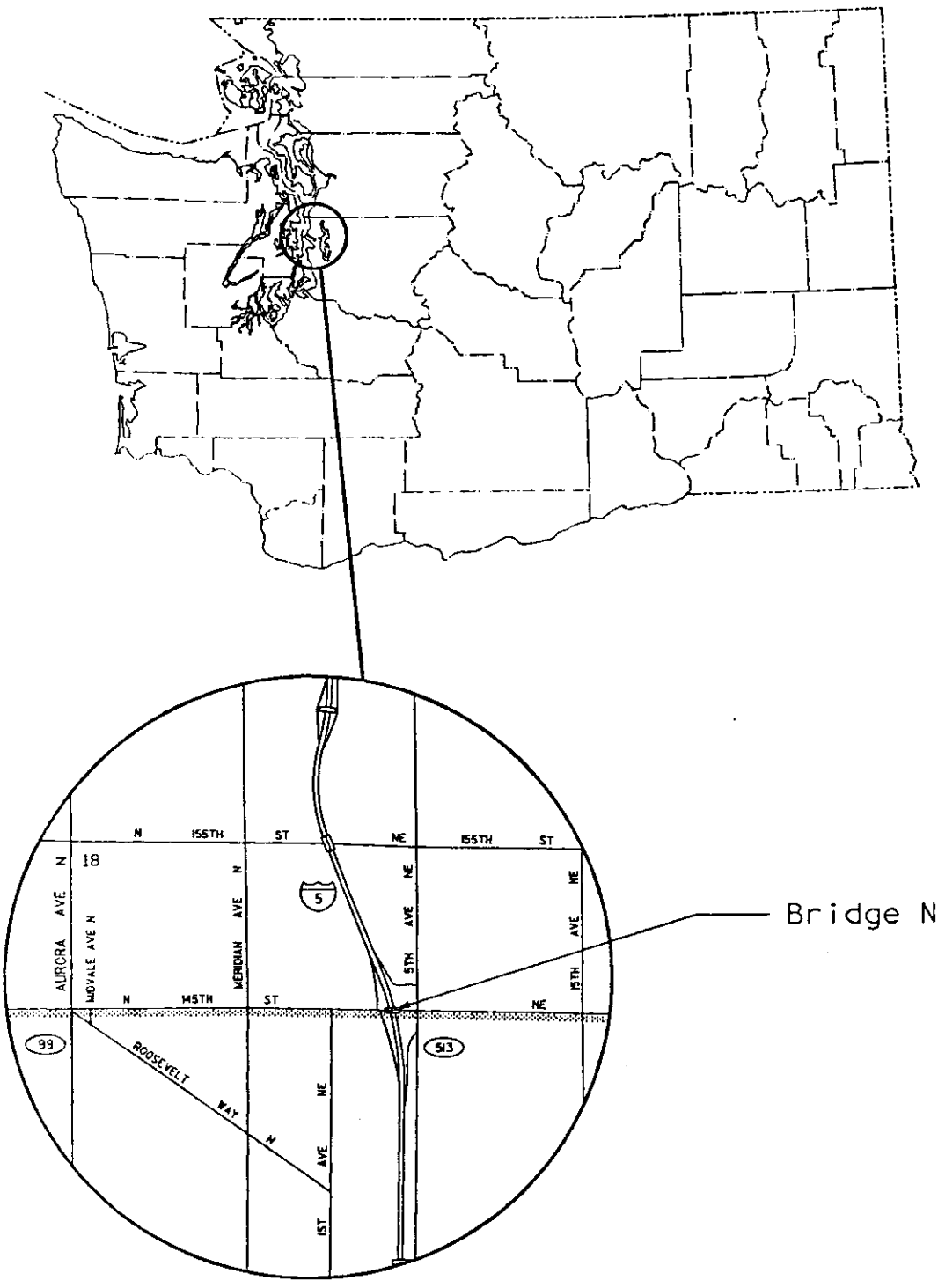
VICINITY MAP



PROJECT SITE

INTRODUCTION

The deterioration of concrete bridge decks is a major problem on the state's highways. This deterioration is primarily due to chlorides from deicing salts penetrating into the deck and causing corrosion of the reinforcing steel. Latex modified concrete (LMC) and asphalt concrete with a waterproof membrane (AC/membrane) overlays are presently being used as the primary systems to prevent intrusion of additional chlorides and moisture on existing bridge decks. LMC, which is more durable than AC/membrane systems, is used on bridge decks with high traffic volumes, high levels of chloride contamination, and on decks requiring significant rehabilitation.

Latex modified concrete overlays normally require 48 hours of cure time before traffic can be restored to the structure. It is desirable to minimize the disruption to traffic. High early strength latex modified concrete should reduce the cure time significantly, thus reducing downtime to traffic.

STUDY SITE

The bridge chosen for the test application carries SR-513 traffic over I-5. It is located approximately six miles north of downtown Seattle, in District 1. The bridge is 249 feet long and 58 feet wide, with a total deck area of 14,441 square feet. The bridge is configured for two lanes of traffic in each direction, separated by a center turn lane. The general layout of the bridge is shown in Appendix C.

The condition of the deck concrete was tested prior to the overlay. Chloride content testing indicated that 52 percent of the samples contained more than 2 lbs./cu. yd. of chlorides at the level of the top mat of reinforcing steel. A chain-drag survey found that 1.3 percent of the deck was delaminated.

INSTALLATION PROCEDURES

The overlay was constructed by Eagle Crest Construction (sub-contractor) under Contract 3643, NE 145th Street I/C. The construction sequence proceeded as follows:

1. Deck scarifying to a depth of 1/4 inch.
2. Cleaning with compressed air.
3. Setting rails.
4. Dry running of paving machine.
5. Paving and filling patches monolithically.
6. Application of curing blankets.

The north side of the bridge was paved first, followed by the south side.

The night of October 6, 1989, the entire bridge was closed to traffic for the north side paving. Scarifying started at 9:45 p.m. and concluded at 5:30 a.m. the next day, October 7, for a total of approximately 8 hours. Calibration of the LMC mixing trucks was completed by 1 p.m. on the following day, October 8. A dry run of the finishing machine was completed by 11:30 a.m. on that same day. Paving began on October 8, at 1:30 in the morning, and was completed by 9:30 that same morning. Patches were poured

monolithically with the deck pour. Curing of the overlay lasted from the end of paving at 9:30 a.m. on the 9th to 8:00 a.m. on the 10th, for a total of 22-1/2 hours. Per specifications, curing of the concrete with burlap and polyethylene cover could be discontinued when the compressive strength of the concrete reached 2,000 psi. The compressive strength of cylinders cured under the same conditions was 2,250 psi at 8 a.m. on the 10th.

Placement of the overlay on tthe south side was completed in less overall time. Scarification began at 8 a.m. on the 10th and was completed by 6 a.m. the following day. The overlay was started at 10:10 a.m. on the 11th and completed by 5:00 p.m. the same day. Cure time ran through 3:30 p.m. on October 12, for a total of 22-1/2 hours. A 2000 psi compressive strength was reached at the end of this cure period.

Striping of the deck and opening to traffic was completed by 3:45 p.m. on October 13, when the overlay compressive strength reached 2,500 psi or greater. The total time from start to finish was 6 days and 19 hours for the entire deck. Construction sequence photos are included in Appendix D.

CONSTRUCTION PROBLEMS

The completed overlay has no cracks and seems to be of very high quality. The only problems encountered during construction were related to the expansion joints at the bridge ends. A change order had to be issued to replace these joints, which were found to be in worse condition than originally thought. The work on the expansion joints lengthened the

overall time to complete the project, which negatively impacted the advantages of the reduced cure time on the overlay.

MATERIALS SPECIFICATIONS

The specifications for the high early strength concrete mix were as follows:

Cement (Type III)	846 pounds
Fine Aggregate	1,550 pounds
Coarse Aggregate	1,020 pounds
Latex	220 pounds
Maximum Water/Cement Ratio	0.33
Air Content of Plastic Mix	5% ± 1%

The concrete shall have a slump of 6 inches ± 1 inch, unless it is being placed on a deck with a gradient in excess of 6 percent, in which case the slump shall be limited to 3 inches ± 1 inch.

Mix proportions were achieved by a calibrated mobile mixer truck.

TEST RESULTS

The testing schedule, shown in Appendix A, involves visual inspection only, due to difficulties in gaining access to this high traffic volume site. Friction testing will be done

on an unscheduled basis. The initial friction numbers collected in the spring of 1990 are tabulated in Appendix B. They range from 29 to 40, with an average of 36.

Post-construction and periodic visual inspections will qualitatively evaluate the following characteristics of the experimental deck:

- Wear in wheel paths.
- Degree of surface deterioration (cracking, spalling, scaling).
- Delaminations (when visible).
- Surface roughness.

The results of the 1990 and 1991 annual visual inspections indicate the overlay is in excellent condition.

Periodic visual inspections will be performed over an eight-year period. If it is deemed necessary, the visual inspection may be supplemented by field testing, such as:

- Delamination detection.
- Half-cell tests for corrosion activity.
- Chloride content at the rebar level.
- Bond strength.
- Skid Resistance.
- Degree of surface deterioration (cracking, spalling, scaling).
- Wheel rut measurements.

CONCLUSIONS AND RECOMMENDATIONS

Per WSDOT specifications, normal LMC overlays require a 48 hour curing period before traffic can be restored. The south side lane pour of this high early strength latex modified concrete project was actually opened to traffic within approximately 46-1/2 hours. While the cure time for high early strength latex modified concrete is approximately 24 hours less than standard LMC, this did not result in a more timely traffic opening. The time required for striping, work at expansion joints, and off-structure work can reduce any benefit from a more rapid curing overlay. Using a rapid curing concrete overlay on this project did not result in any signficant time savings.

The special provisions of this project would have allowed traffic to be restored when the concrete reached a strength of 2,500 psi. This appears to be possible within a 24 hour cure period for the high early strength latex modified concrete. The maximum potential time savings appears to be only 24 hours over a normal LMC pour. The total project time was 6 days, 19 hours. Using the high early strength latex modified concrete, the maximum possible total project percent time savings over a normal LMC project would have been 13 percent. This amount of time savings is considered small. The use of high early strength latex modified concrete could reduce traffic closure time by one day, depending on the timing of other on- and off-structure work.

APPENDIX A

TEST PLAN

EXPERIMENTAL PROJECT
HIGH-EARLY STRENGTH LATEX MODIFIED CONCRETE FOR BRIDGE DECK OVERLAY
INSPECTION AND ANALYSIS COSTS
(Total Costs for One Bridge)

Responsible Unit	Work Item	Pre-Construction	Post Construction	YEAR[1] 1	2	4	6	8	Totals
HQBB	Visual Inspection	(1 hr) $ 28	(1 hr) $ 28	(1 hr) $ 29	(1 hr) $ 31	(1 hr) $ 34	(1 hr) $ 36	(1 hr) $ 39	$ 225
HQBB	Travel Time	(4 hrs) $ 112	(4 hrs) $ 112	4 hrs) $ 118	(4 hrs) $ 123	(4 hrs) $ 134	(4 hrs) $ 146	(4 hrs) $ 157	$ 902
HQBB	Analysis and Reporting		(60 hrs) $1,680	(4 hrs) $ 118	(4 hrs) $ 123	(4 hrs) $ 134	(4 hrs) $ 146	(20 hrs) $ 784	$2,985
	TOTALS	$ 140	$1,820	$ 265	$ 277	$ 302	$ 328	$ 980	$4,112
TOTAL CONTRACT FUNDING			$1,960						$1,960
								TOTAL EXPERIMENTAL FEATURE FUNDING	$2,152

[1]Five percent annual inflation rate assumed.

APPENDIX B

TEST RESULTS

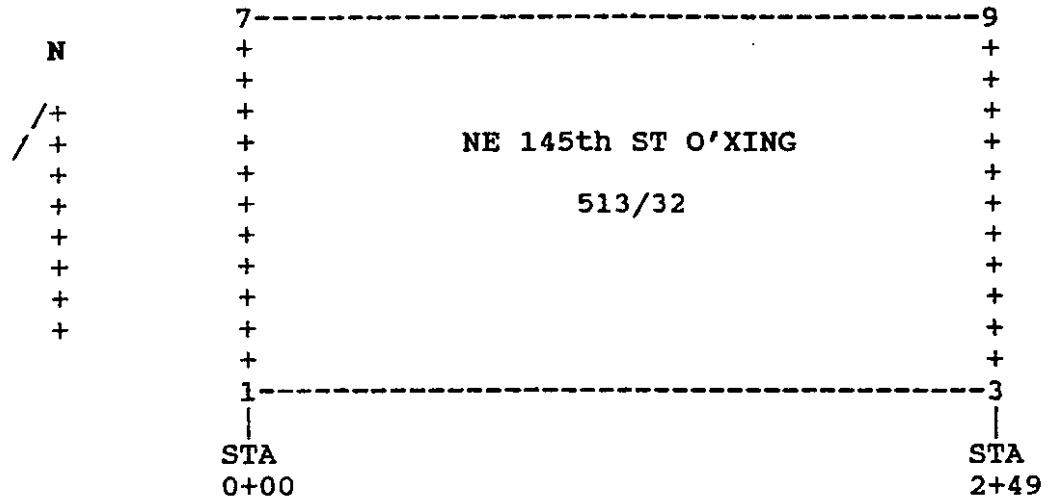
HIGH-EARLY LATEX MODIFIED CONCRETE OVERLAY
NE 145th ST O'XING
513/32
CONTRACT 3643

TESTING REQUIREMENTS

	Post Const 1989	1990	1991	1993	1995	1997
FRICTION	x	5/90	4/91	x	x	x
DELAMINATION	x					
BOND	x					
HALF-CELL						
CHLORIDE						
PERMIABILITY (Cores)	x					
AIR CONTENT (Cores)	x					

x = To Be Tested

Bridge
Orientation



FRICTION TEST RESULTS
NE 145th ST O'XING 513/32

DATE	DIR	FN	AVE	RANGE
5/90		35		
		40		
		39		
		29		
		39		
		34		
		38		
		36	36	29-40
4/91		35		
		38		
		38		
		42		
		38		
		43		
		41		
		44	40	35-44

FFFFFFFFFFFFFFFFFFFFFFFFFFFFFF

DATE	DIR	FN	AVE	RANGE

FFFFFFFFFFFFFFFFFFFFFFFFFFFFFF

FIELD REVIEW - BRIDGE DECK PROGRAM

Date: 7/12/90 Weather: Partly Cloudy 70°

Br. No. 513 / 32 ADT / Lanes: _____

Br. Name: SR 5 OC NE 145th St

Experimental Feature: 24 hr LMC
(Product Name / Type)

- ☐ 1/4" O'LAY
- ☐ 3/4" O'LAY
- ☐ MMC O'LAY
- ☒ (24 hr LMC) LSDC O'LAY
- ☐ EXPER. EXP. JNT.

COMMENTS: (Use backside if required)

Wear in Wheel paths: (note loss of aggregate , "shiney" areas or worn thru)
None noticeable, grooves still in good condition

Extent of spalls: (note any repairs made) None

Extent of cracking: ("Pattern" , "Transverse"; sketch optional)
None

Condition at Expansion Joints: A few cracks in the (Polymer) concrete headers next to the compression seals

Chain Drag Used? Y / (N) Debonding noted: _____

Foreign Material noted (Asphalt / Tar / Concrete / Oil spills):
None

"Curling" or separation at curb lines: None

Other: None

Remedial action recommendation: None

Recommended for reinspection: 1992 Inspector: OLW

FIELD REVIEW – BRIDGE DECK PROGRAM

Date: 11/19/91 Weather: Cloudy, raining 51°

Br. No. 513 / 32 ADT / Lanes: _____

Br. Name: SR5 Overcrossing NE 145th St.

Experimental Feature: 24 hr. LMC
(Product Name / Type)

- ☐ 1/4" O'LAY
- ☐ 3/4" O'LAY
- ☐ MMC O'LAY
- ☒ (24 hr) LMC/LSDC O'LAY
- ☐ EXPER. EXP. JNT.

COMMENTS: (Use backside if required)

Wear in Wheel paths: (note loss of aggregate , "shiney" areas or worn thru)

Tining is wearing in some spots

Extent of spalls: (note any repairs made) none

Extent of cracking: ("Pattern" , "Transverse"; sketch optional)

None

Condition at Expansion Joints: Some cracks in the header concrete next to the compression seals.

Chain Drag Used? Y / (N) Debonding noted: _____

Foreign Material noted (Asphalt / Tar / Concrete / Oil spills):

Some tar on deck in spots

"Curling" or separation at curb lines: None

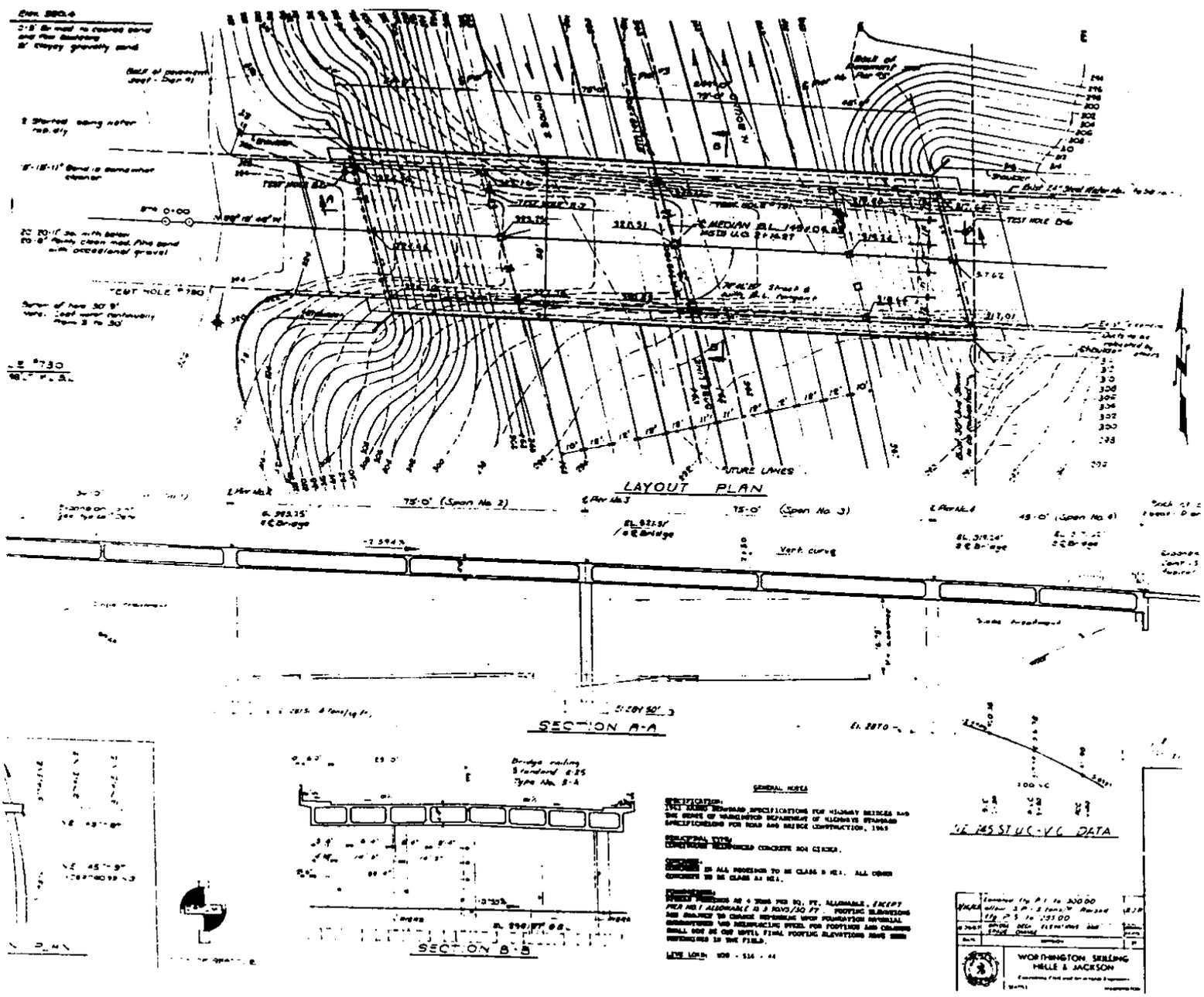
Other: North drain plugged

Remedial action recommendation: None

Recommended for reinspection: One Year Inspector: THR

APPENDIX C

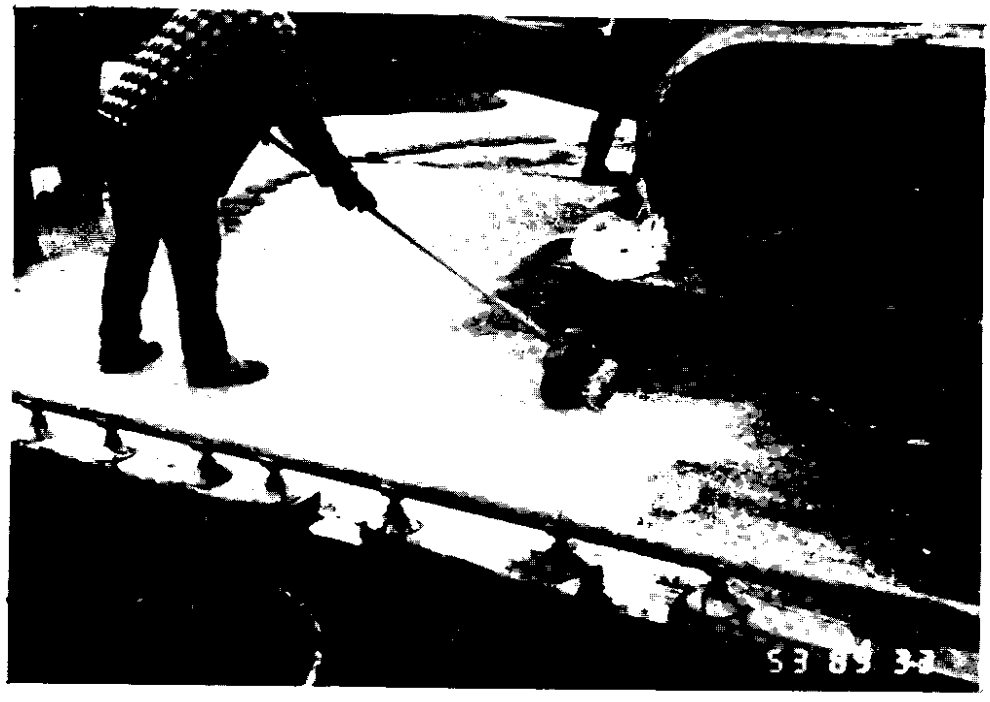
GENERAL LAYOUT


LAYOUT PLAN
SECTION A-A
SECTION B-B
WORTHINGTON SKILLING
HELLE & JACKSON

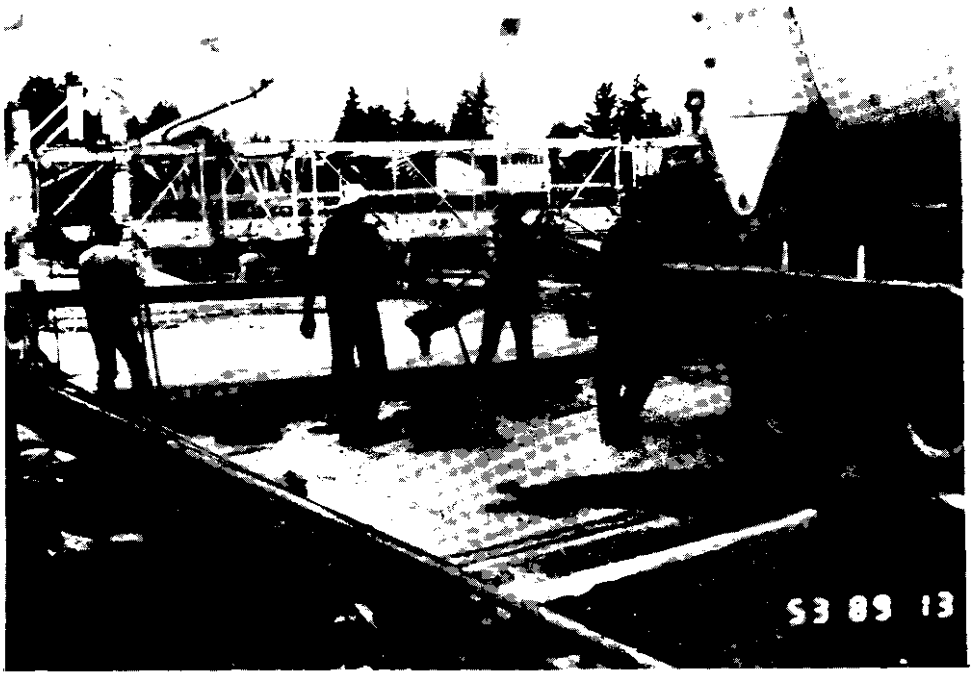
APPENDIX D

PROJECT PHOTOGRAPHS

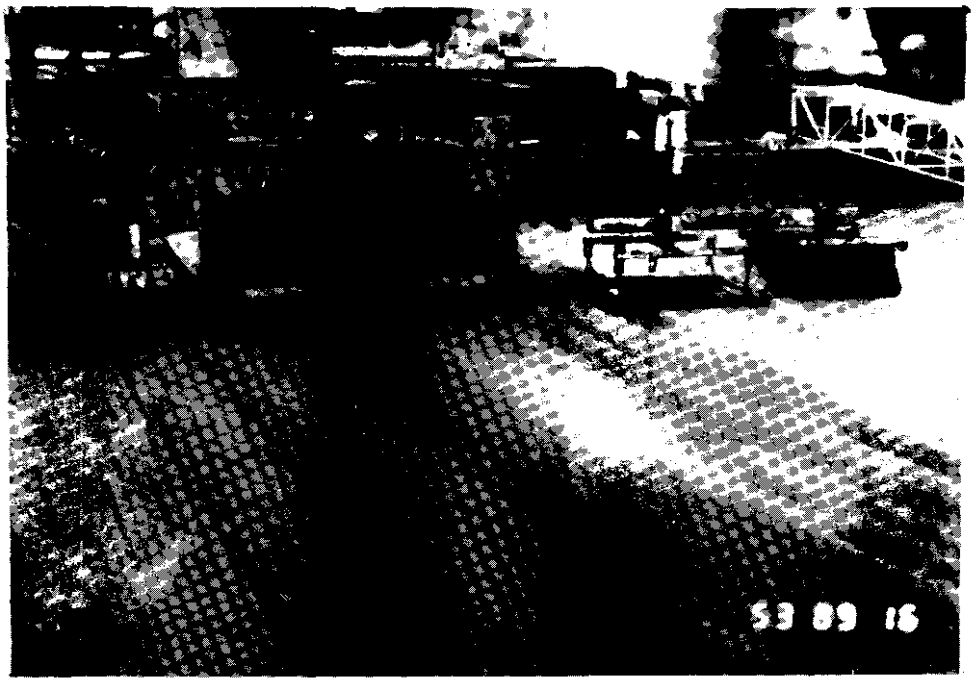
Mobile Mixer at Job Site



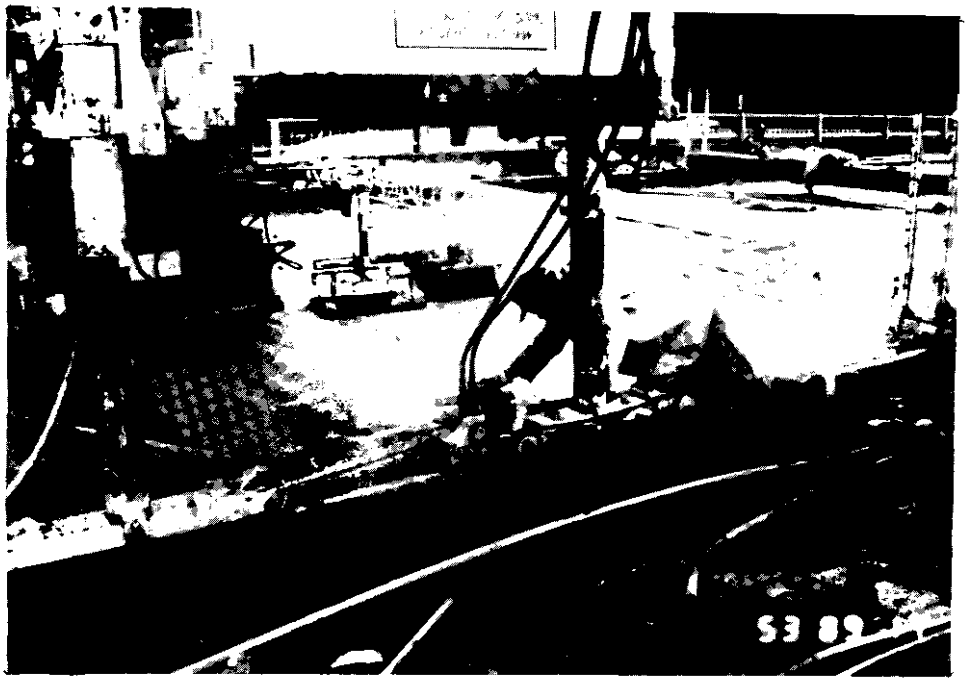
Brushing Slurry Bond Coat Into Deck Surface



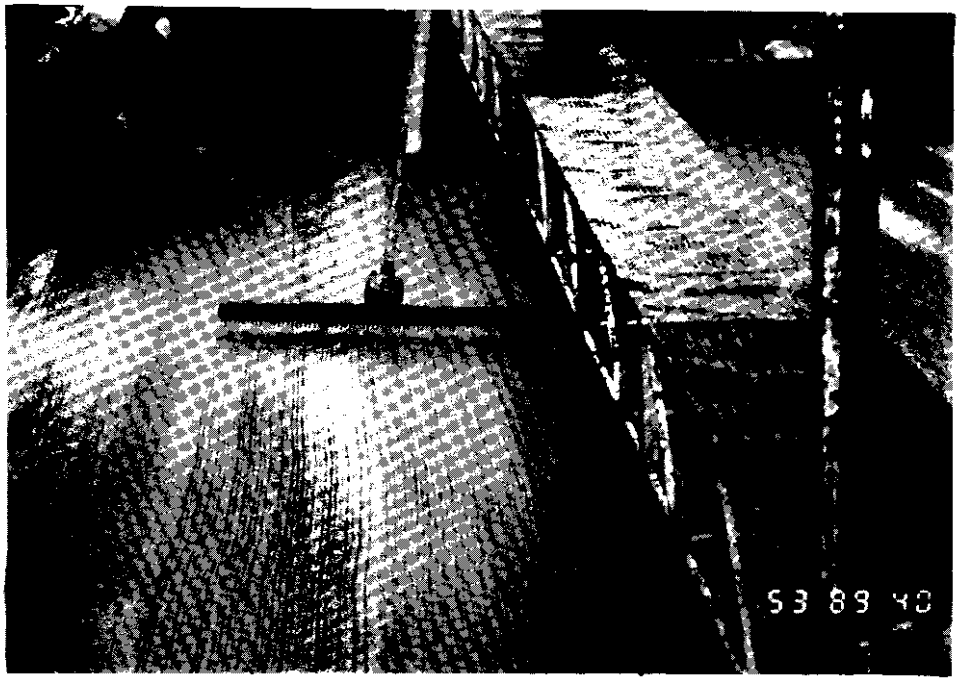
Depositing Concrete on Deck



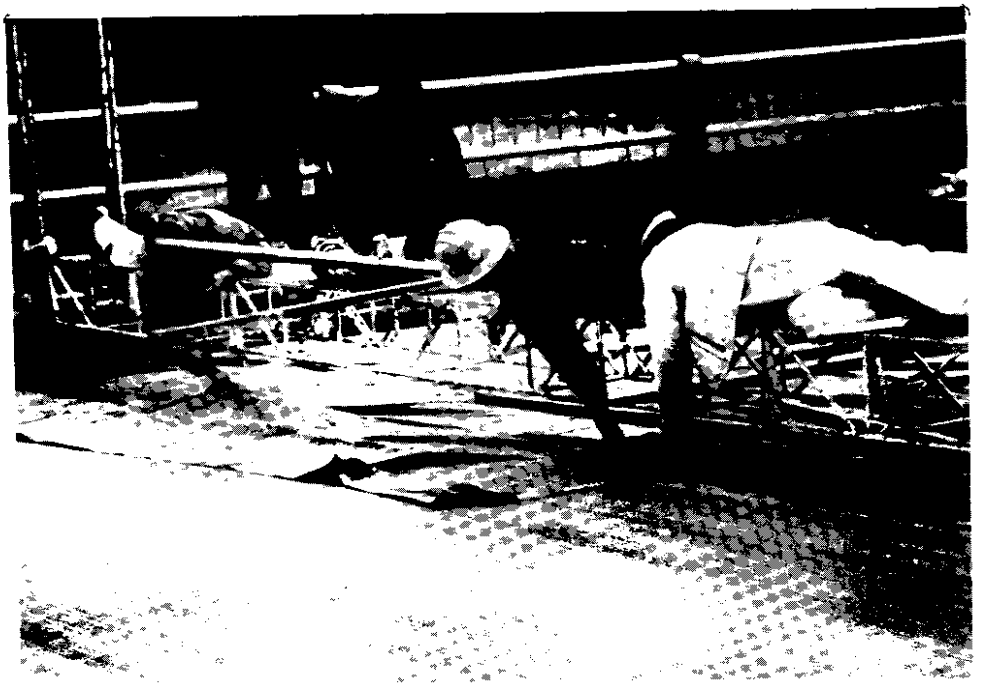
Finishing Machine



Hand Finishing at Edges

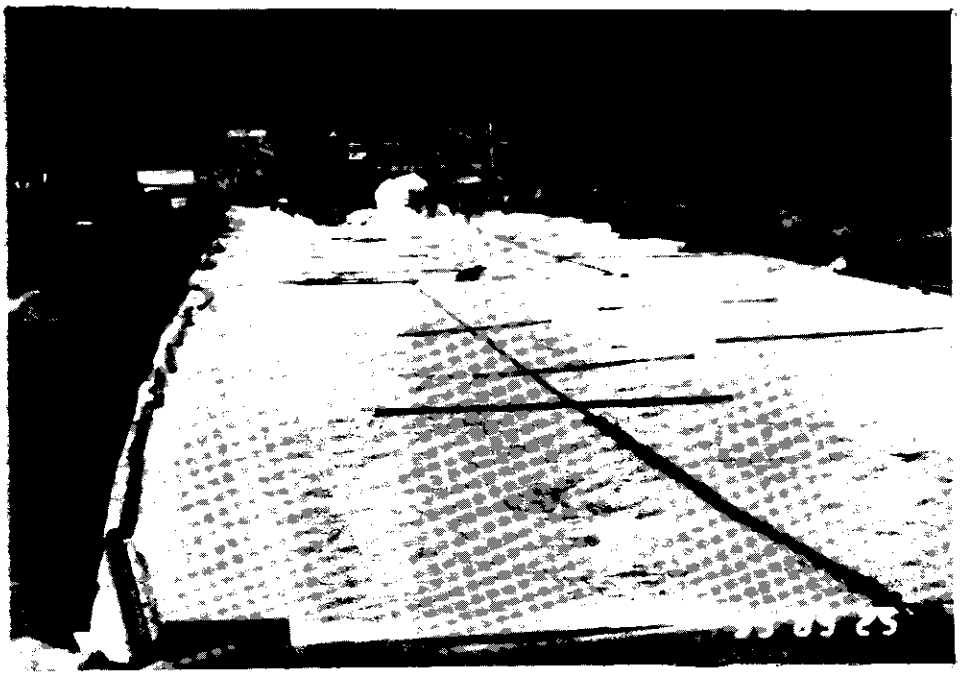


Tining Roadway Surface with Rake

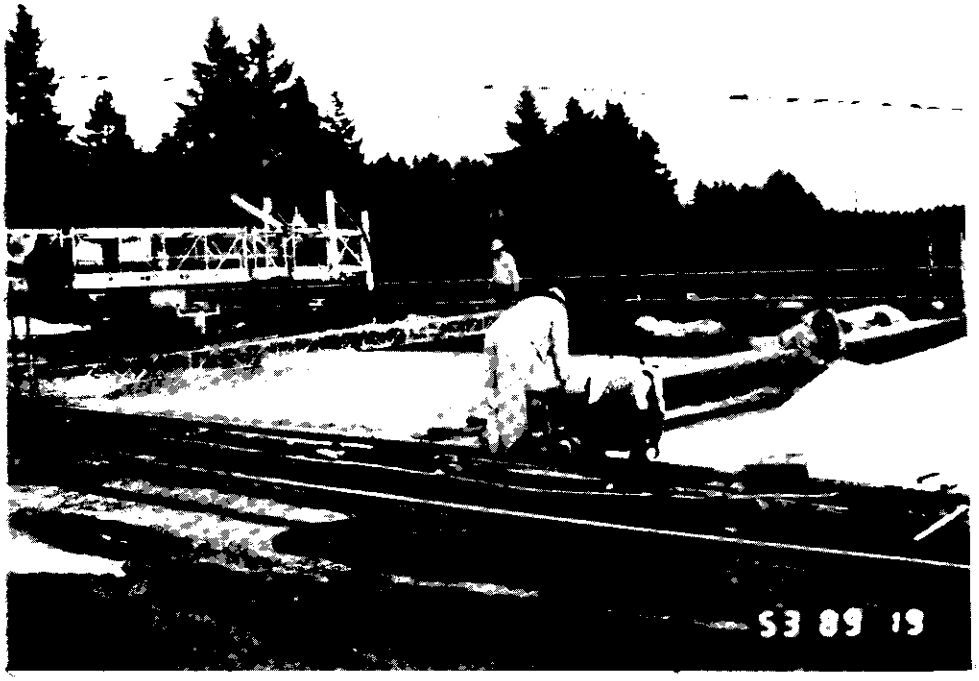


Placing Wet Burlap for Curing

Keeping Burlap Moist with Fog Sprayed Water



Placing Plastic Over Wet Burlap



Roadway Covered with Plastic for Curing