Thin Overlay South 154th Street Overcrossing 5/523E

WA-RD 243.1

Post Construction Report
October 1991

Washington State Department of Transportation
Program Development Division
Bridge and Structures

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

The Washington State Department of Transportation is conducting experimental field evaluations of selected polymer concrete thin (1/4 inch) overlays. The polymer concrete material is manufactured by private industry firms and installed on selected bridge decks under standard WSDOT construction contracts. Approximately 24 bridges will be involved in the experiment; eight of these are included in federal participating construction projects as experimental features.

A polymer concrete thin overlay, The Conkryl Paviour Broadcast System (methyl methacrylate), was applied to the deck of the South 154th Street Overcrossing, Bridge No. 5/523E, under Contract No. 3354, SR 405 Tukwila to South Renton HOV Lanes. This bridge is a prestressed girder bridge located on mainline I-5 at the intersection with I-405 in Seattle, Washington.

17. KEY WORDS
Thin overlay, polymer concrete, bridge deck repairs

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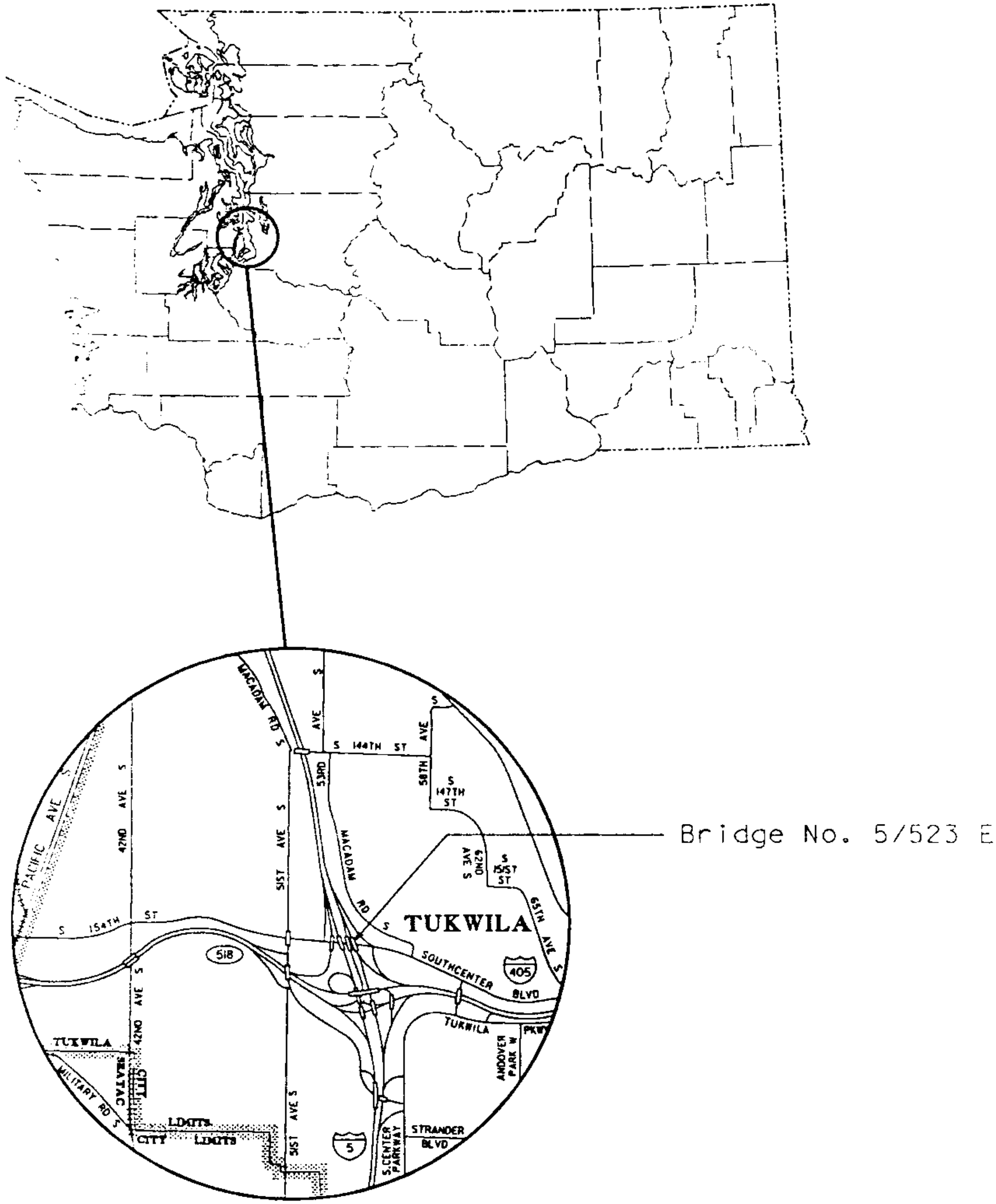
VICINITY MAP



PROJECT SITE

INTRODUCTION

This is the seventh bridge in a series of eight federal participating bridge deck overlay projects using thin polymer concretes. Each deck in the series will be constructed using a different commercially available polymer concrete system, with work performed under a standard WSDOT contract. Each deck will be monitored over a ten-year period to evaluate the long-term performance. A description of the total experimental project design can be found in Appendix A.

STUDY SITE

The polymer concrete thin overlay was applied to the deck of the South 154th Street Overcrossing 5/523E, under Contract No. 3354 SR 405 Tukwila to South Renton HOV Lanes. This bridge is on mainline I-5, at the intersection with I-405 in Seattle, Washington. The bridge is 90' 5-1/2" wide and 97' 8-5/8" long. Pre-construction testing found that 18 percent of the chloride samples had values greater than 2.0 lbs. per cubic yard. There were no delaminations found and the half-cell readings were mostly positive values. Four percent of the deck had rebar cover of less than one inch and rutting measurements average 1/8 inch in the wheel paths. The overall condition of the deck was considered good.

INSTALLATION PROCEDURE

The Conkryl Paviour Broadcast System (methyl methacrylate) thin polymer concrete overlay was installed during August 1988. The product was supplied by Conkryl Canada, Inc., and applied by the Charles Watts Company. The product was applied one lane at a time, each evening. The bridge is 6 (12 foot) lanes wide, with an 8 foot shoulder on the outside and a 10' 5-1/2" shoulder on the median side.

Operations began at 10:10 pm, with removal of deck surface contaminants by means of shotblasting, followed by air cleaning to remove any remaining loose material or shot. Edging for the product was controlled with duct tape placed on the deck and over expansion joints. (This was removed after Steilacoom aggregrate was applied, but before final cure.) Between 11:20 pm and 11:45 pm, a coat of Conkryl Primer #112 was applied to the prepared surface using an ordinary paint roller, followed with a light coat of a white silica grit for a bonding surface. The primer will not cure properly if the concrete surface is not dry.

After priming, the entire sequence of overlay placement must be completed. If operations are suspended, the sequence must begin again with shotblasting the surface.

Proper proportions of Conkryl Paviour Liquid, Conkryl Hardener, and Conkryl Paviour Powder were mixed in a galvanized wash tub with a heavy duty drill and a mixing paddle. The mixture was trowelled and rolled on the deck with a porcupine roller, to a thickness of five millimeters, or about 1/4 inch. This mixture is self-leveling. The Steilacoom aggregate was broadcast on the entire surface of the uncured overlay mix approximately two minutes after rolling. It is very important to obtain complete coverage with the Steilacoom aggregate, but it should not be applied too heavily too quickly. Allowing the aggregate to freefall straight down into the mix gave the best penetration. Broadcasting was done by hand. At 2 am, the application of mix and aggregate was complete and cured sufficiently to allow removal of excess aggregate with a hand broom, which was completed by 2:45 am.

Conkryl Sealer #112 was applied with rollers between 3:00 am and 3:25 am. No aggregate was applied to the sealer, since the special provisions did not require it. At 3:40 am cores were taken to check thickness and bonding, and by 4:30 am traffic control was removed and the lane opened to traffic.

CONSTRUCTION PROBLEMS

There were no construction problems associated with the installation of this product. The Charles Watts Company crew had complete control of the operation and work progressed with no delays.

ACCEPTANCE TESTING

The post-construction test results are shown in detail in Appendix C.

Specifications required a minimum of 300 psi for the average bond strength, or failure in the bridge deck Portland cement concrete. Only one of the six bond strength tests broke in the polymer, and this was at a strength of 173 psi. The remaining tests all broke in the deck concrete.

Friction tests conducted in September 1988 ranged from 37 to 45, with an average of 41. Contract specifications required a minimum of 45. The field values were accepted anyway.

Contract specifications required 70 percent of resistivity test readings to be above 250,000 ohms, with no single reading less than 100,000 ohms. All readings met the minimum criteria.

CONCLUSIONS AND RECOMMENDATIONS

State inspectors were impressed with the product. The actual application time was about the same as a latex modified concrete overlay, but the curing time of only a few minutes was very impressive. Visual inspection after the winter showed no signs of wear, and the overlay seemed to produce less road spray in heavy rains than the original deck. This product could easily be applied by state forces, with acquisition of suitable surface preparation equipment.

APPENDIX A

TOTAL EXPERIMENTAL PROJECT DESIGN

TOTAL EXPERIMENTAL PROJECT DESIGN

General Background

Over time, the top few inches of a concrete structure can become contaminated with salt from a saltwater marine environment or deicing agents used during the winter months. This condition destroys the passivity of the reinforcing steel and provides a favorable environment for the development of corrosive anode-cathode relationships on the surfaces of the reinforcing steel. The salt and moisture in the concrete serve as the electrolyte. A reinforcing bar will corrode at the anodes, with the rust expanding and cracking the concrete. Delaminations and spalls occur in the deck with resulting deterioration.

Latex modified concrete (LMC), low slump dense concrete (LSDC), and asphalt concrete with waterproofing membranes are the most common systems being used for bridge deck overlays to restore deteriorated decks and to help prevent further penetration of chloride into the deck concrete. These systems add extra weight to bridges. In addition, the latex modified and low slump concrete overlays require careful quality control during construction and, generally, 48 to 96 hours of cure time before traffic can be restored to the structure.

In recent years, polymer concrete (PC) in the form of 1/4 inch thin bridge deck overlays has shown promise of providing a long-lasting, maintenance-free deck protection system. It is impervious to the penetration of salt, can be constructed with relative ease and with relatively simple construction equipment, allows traffic to be restored within 1 to 12 hours, and provides good skid resistance. No scarifying is necessary during construction; therefore, there is less potential for debonding and damage to rebars. These polymer concretes have a cross-linked polymer that replaces Portland cement as a binder in the concrete mix. Epoxy resins are commonly used in polymer concretes, but much attention has also been focused on the use of vinyl monomers, such as polyester-styrene, methyl methacrylate, high molecular weight methacrylate, furane derivative, and styrene. Since the polymer constitutes the continuous phase, behavior of the PC is determined by the specific polymer used.

Purpose

The purpose of the experimental project is to gain knowledge about field installation techniques and procedures and to assess the performance and effectiveness of the PC thin overlays over time.

General Project Description

WSDOT has elected to use PC overlays on 8 federal aid and 16 state-funded bridges that needed deck rehabilitation and protection. The normal delamination and spall repairs have been followed by the application of thin (usually 1/4 inch) PC overlays. These PC overlays were done under usual WSDOT contracts. A number of different PC systems have been used on the bridges. Contract documents specify the type of overlay system for each bridge. A total of approximately 130,000 sq. ft. of bridge deck is involved in the FHWA experimental feature project portion of this study.

Installation of the PC overlay for the bridge deck has been in compliance with the manufacturer's recommendations. Contract documents require that a supplier's field representative be present during installation of the system. Complete records of field observations, testing, and subsequent monitoring is maintained for each installation, with emphasis on the cause and resolution of problems during any phase of the project. The district field office provides an end of construction report on each installation.

Annual inspections and testing of the experimental feature projects will be made over a ten-year period. The WSDOT Materials Laboratory will be responsible for all field testing and reporting on all field activities. See Appendix B for scheduled testing and reporting.

<u>Control Section</u>

The final performance evaluation report for each thin overlay application will include a comparison of the installation techniques and procedures with those for latex modified and low slump concrete overlays. The effectiveness of the permeability for deck protection and length of service life will be compared to the LMC and LSDC overlays in similar environments and service conditions.

The current "Bridge Deck Program Development" includes research for "Evaluation of Concrete Overlays for Bridge Applications." The data collected and analyzed in that research will be utilized, to the fullest extent possible, as the basis for comparative evaluation of the overlays in this experimental feature project.

Tests

Annual inspections and testing of each federal aid bridge will be made over a ten-year period. The testing will include: 1) friction measurements for skid resistance of the overlay surface; 2) half-cell for corrosion activity; 3) chloride content for intrusion of corrosive chloride ions; 4) pachometer for rebar depth; 5) pull-off for bond strength; and 6) visual inspection for detection of surface deterioration, such as cracks, spalls, or delaminations. These tests will be performed according to the schedule in Appendix B.

Reporting

A post-construction report will be issued after completion of the construction project. Annual Form 1461 reports summarizing the performance of the overlay will be submitted to FHWA through the WSDOT Research Office. The testing results for each year will be reported to the Research Office with a brief report summarizing any observations or conclusions that can be made at that point. A final report will be issued at the end of the evaluation period. This report will contain the observations, test results, and conclusions from the study, along with any appropriate photographs.

APPENDIX B

PROJECT LIST AND TEST PLAN

Experimental Bridge Deck Thin Overlay Projects

	Federal Aid Projects	District	Deck Area (Sq. Ft.)	Deck Rating	Install Date	Contract Number	System Type	Dollars Per Square Yard
403/7	Grays R. Rosburg	4	5,360	7	8/86	3090	Degussa	35
12/915	Snake R. Clarkston	5	56,940	4	6/86	3107	Flexogrid	40
82/114S	Yakima R.	5	11,370	3	7/87	3131	Concressive 2020	77
82/115S	Naches R.	5	11,370	4	7/87	3131	Concressive 3070	77
900/12W	SR 5 OC	1	13,950	5	11/86	3189	Flexolith	60
900/13W	SR 5 OC	1	13,950	4	6/87	3189	Sika Pronto 19	55
5/316	Custer Way UC	3	6,190	4	1990	3361	EPI/Flex III	62.60
5/523E	S. 154th St. OC	1	7,300	6	8/88	3354	Conkryl	100
	Non Federal Aid Projects							
167/102	Third Ave. SW OC	3	7,216	7	8/87	3078	Flexogrid	43
167/104	Ellingston Rd. OC	3	7,172	7	8/87	3078	Flexogrid	43
167/106	First Ave. N. OC	3	6,424	7	8/87	3078	Flexogrid	43
161/10	SR 512 OC	3	11,120	7	6/86	3100	EPI/Flex III	40
167/21	Milwaukee Ave. OC	3	6,864	7	8/87	3183	Degussa	43
512/40	SR 167 OC	3	12,806	7	8/87	3183	Degussa	43
529/20W	Steamboat SL	1	20,472	5	10/87	XE 2625	Flexogrid	40
529/20E	Steamboat SL	1	21,840	3	10/87	XE 2625	Flexogrid	40
104/5.2	Hood Canal E 1/2	3	101,388	4	7/88	3316	Flexogrid	32
82/10S	Thrall Rd. O-Xing	5	18,992	5	4/85	2857	Flexolith	82
101/115	Chehalis River Br.	3	14,508	6	8/84	2643	Flexogrid	65
101/514	Mottman Road O-Xing	3	6,640	7	8/85	2945	Degussa	45
16/120	Olympic Inter UC	3	6,417	7	7/88	3336	Degussa	42
99/530	Duwamish R. (Bascule) (Wheel Paths)	1	17,028	6	8/88	3432	Flexogrid	Unk.
520/8	Evergreen Point (Drawspan) (Wheel Paths)	1	20,070	6	8/88	3432	Flexogrid	Unk.
97/2	BN RR OC	4	5,876	3	6/89	3530	Degussa	55

THIN OVERLAY EXPERIMENTAL PROJECT
TESTING AND ANALYSIS COSTS PER AVERAGE 13,000 FT.^{2} BRIDGE

Responsible Unit	Work Item	Pre-Construct.	Post-Construct.	Year* 1	2	3	4	5	6	7	8	9	10	Totals
HQ ML	Friction Testing (x hrs) at $100/hr		(1 hr) $ 100	(1 hr) $ 100	(1 hr) $ 110	(1 hr) $ 121	(1 hr) $ 133	(1 hr) $ 146	(1 hr) $ 161	(1 hr) $ 177	(1 hr) $195	(1 hr) $ 215	(1 hr) $ 237	$1,695
HQ ML	Electrical *** Resistivity (x hrs) at $108/hr		(6 hrs) $ 648	(6 hrs) $ 648	(6 hrs) $ 713	(6 hrs) $ 784		(6 hrs) $ 948		(6 hrs) $1,147			(6 hrs) $1,527	$6,415
HQ ML	Half-Cell Testing (x hrs) at $108/hr	(8 hrs) $ 864				(1 hr) $ 131				(1 hr) $ 192			(1 hr) $ 255	$1,442
HQ ML	Chloride Testing (x hrs) at $108/hr	(2 hrs) $ 216				(1 hr) $ 131				(1 hr) $ 192			(1 hr) $ 255	$ 794
HQ ML	Rebar Depth (x hrs) at $108/hr	(2 hrs) $ 216												$ 216
HQ ML	Bond Testing (x hrs) at $108/hr		(2 hrs) $ 216	(2 hrs) $ 216		(2 hrs) $ 262							(2 hrs) $ 510	$1,204
HQ ML	Visual Observation (x hrs) at $108/hr		(2 hrs) $ 216	(2 hrs) $ 216	(2 hrs) $ 238	(2 hrs) $ 262		(2 hrs) $ 317		(2 hrs) $ 384			(2 hrs) $ 510	$2,143
**HQ Br. Branch & ML	Analysis & Report Writing (x hrs) at $27.50/hr		(40 hrs) $1,100	(8 hrs) $ 220	(8 hrs) $ 242	(8 hrs) $ 266	(4 hrs) $ 147	(8 hrs) $ 322	(4 hrs) $ 177	(8 hrs) $ 389	(4 hrs) $ 214	(4 hrs) $236	(40 hrs) $2,590	$5,903
	TOTALS	$1,296	$2,280	$1,400	$1,303	$1,957	$ 280	$1,733	$ 338	$2,481	$ 409	$ 451	$5,884	$19,812
	TOTAL CONTRACT FUNDING		$3,576											- 3,576
													TOTAL EXPERIMENTAL PROJECT FUNDING	$16,236

* 10% Annual Inflation Rate Assumed.

** Field data reporting will be by Materials Lab (ML). Analysis of data and final report by Bridge Branch.

*** Deleted per agreement with FHWA.

APPENDIX C

TEST RESULTS

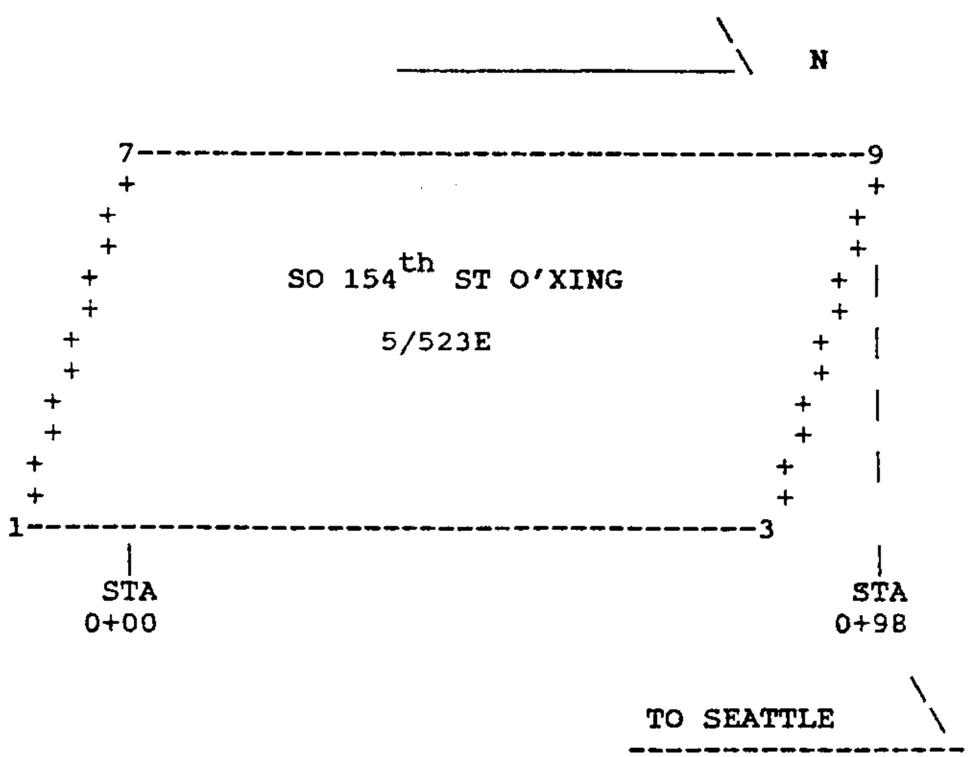
SO 154th ST O'XING
5/523E
CONTRACT 3354

TESTING REQUIREMENTS

	Post Const 1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
FRICTION	9/88	7/89	6/90	4/91	x	x	x	x	x	x	x
RESISTIVITY	x	7/89									
BOND	x	7/89		x				x			x
HALF-CELL				x				x			x
CHLORIDE				x				x			x

x = To Be Tested
CONKRYL
FEDERAL

Bridge
Orientation



BOND TEST RESULTS
SO 154th ST O'XING 5/523E

Year	Station	Offset*	Depth	Load	PSI	Comments
1989	0+05	15		1600	269	100% Break in conc.
	0+02	25		1025	173	100% Break in polymer
	0+29	25		1100	185	40% Break in conc.
	0+44	15		375	63	DITTO
	0+63	25		1275	215	80% Break in conc.
	0+75	15		400	67	25% Break in conc.

*NOTE: Offset is feet right of left curb ahead on station

FRICTION TEST RESULTS
SO 154th ST O'XING 5/523E

DATE	DIR	FN	AVE	RANGE
9/88	N1	45		
	N1	43		
	N2	41		
	N2	40		
	N3	37		
	N3	39		
	N4	41		
	N4	44	41	37-45
7/89	N1	42		
	N1	45		
	N2	39		
	N2	31		
	N3	28		
	N3	27		
	N4	46		
	N4	39	37	27-46
6/90	N1	44		
		42		
	N2	40		
		36		
	N3	34		
		26		
	N4	48		
		33	38	26-48
4/91	N1	27		
		28		
	N2	25		
		33		
	N3	25		
		33		
	N4	36		
		44	31	25-44

FFFFFFFFFFFFFFFFFFFFFFFFFFFFFFF

DATE	DIR	FN	AVE	RANGE

FFFFFFFFFFFFFFFFFFFFFFFFFFFFFFF

ELECTRICAL RESISTIVITY TEST RESULTS
SO 154th ST O'XING 5/523E

JULY, 1989

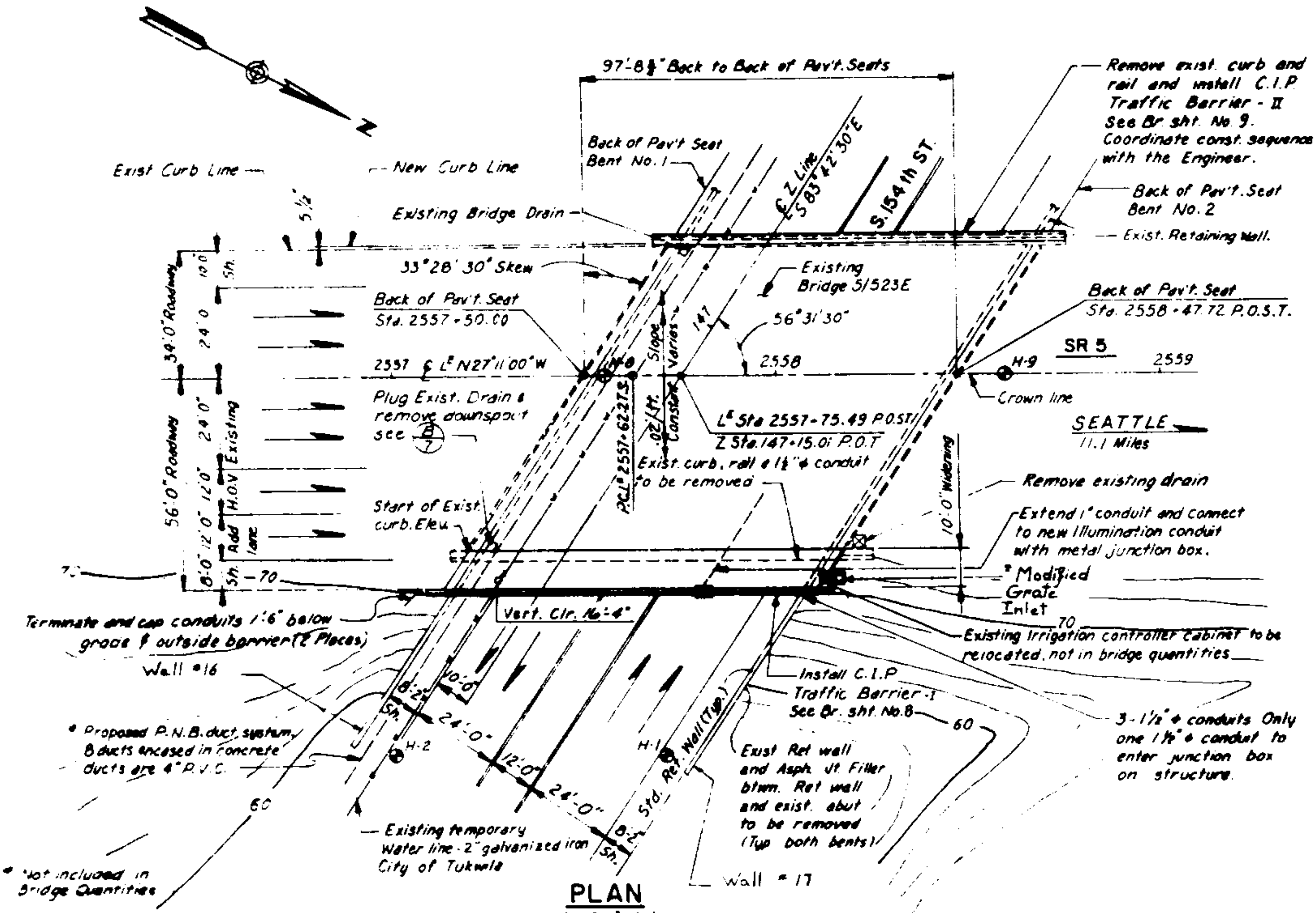
	5	10	15	20	25	30	~~	~~
							x	x
STA 0+00			&	&	200K	&	x	x
0+05	&	&	110K	&	250K	&	x	x
0+10	&	&	&	&	270K	&	x	x
0+15	&	140K	&	&	400K	&	x	x
0+20	&	&	&	&	500K	&	x	x
0+25	&	&	&	&	500K	&	x	x
0+30	&	&	&	&	500K	&	x	x
0+35	&	&	&	&	500K	&	x	x
0+40	&	&	500K	&	500K	&	x	x
0+45	&	&	500K	&	500K	&	x	x
0+50	&	&	&	500K	500K	&	x	x
0+55	&	2M	&	2M	1M	&	x	x
0+60	&	&	&	&	1M	500K	x	x
0+65	&	&	2M	2M	1M	2M	x	x
0+70	&	&	1M	2M	&	&	x	x
0+75	&	2M	500K	&	&	x	x	x
0+80	2M	2M	1M	2M	x	x	x	x
0+85	2M	2M	2M	x	x	x	x	x
0+90	2M	x	x	x	x	x	x	x
0+95	x	x	x	x				
0+98								

& = Infinite Resistance

Offset is feet right of left curb ahead on station

APPENDIX D

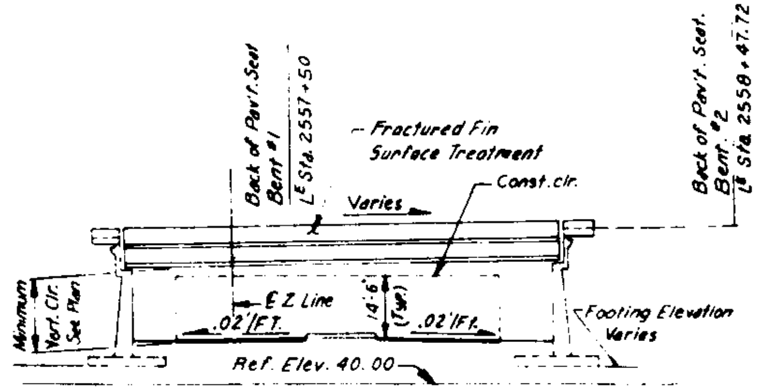
GENERAL LAYOUT



PLAN

SCALE: 1" = 20'

Bearing of Bents 1 and 2 is S83°42'30"E



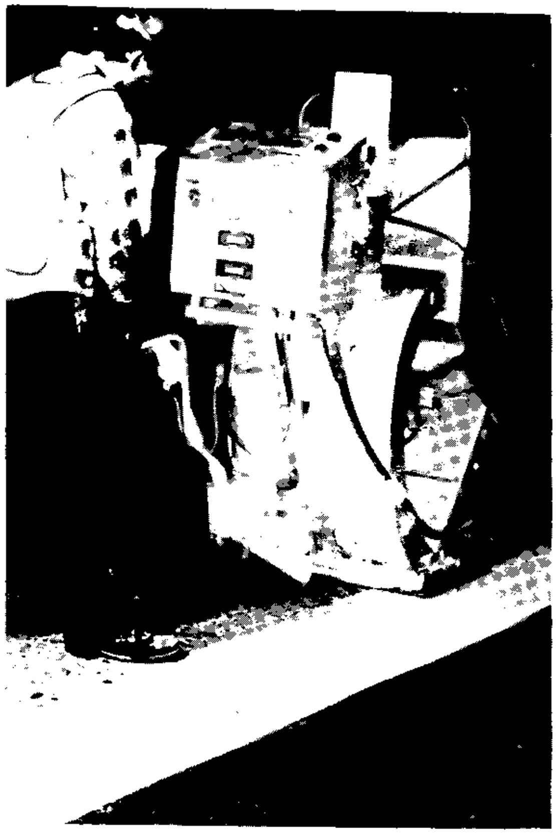
ELEVATION

SCALE 1" = 20'

Retaining Walls not shown

APPENDIX E

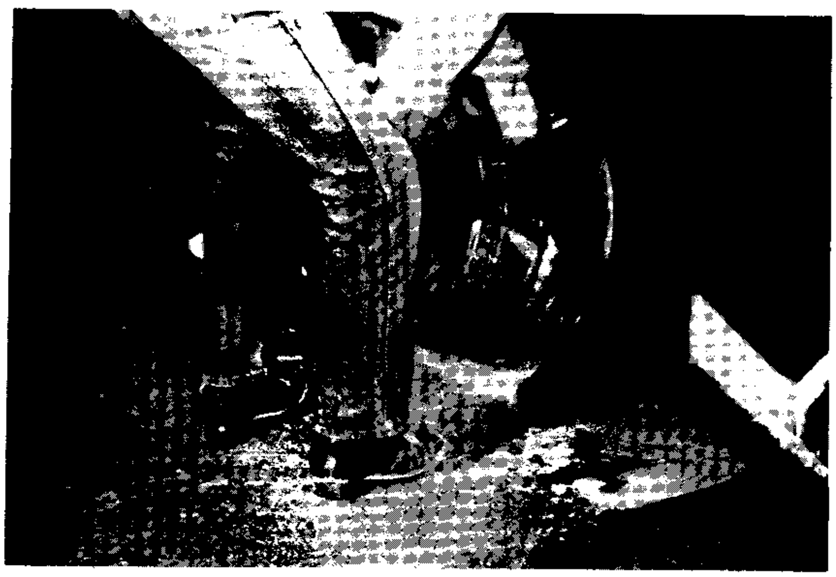
PROJECT PHOTOGRAPHS



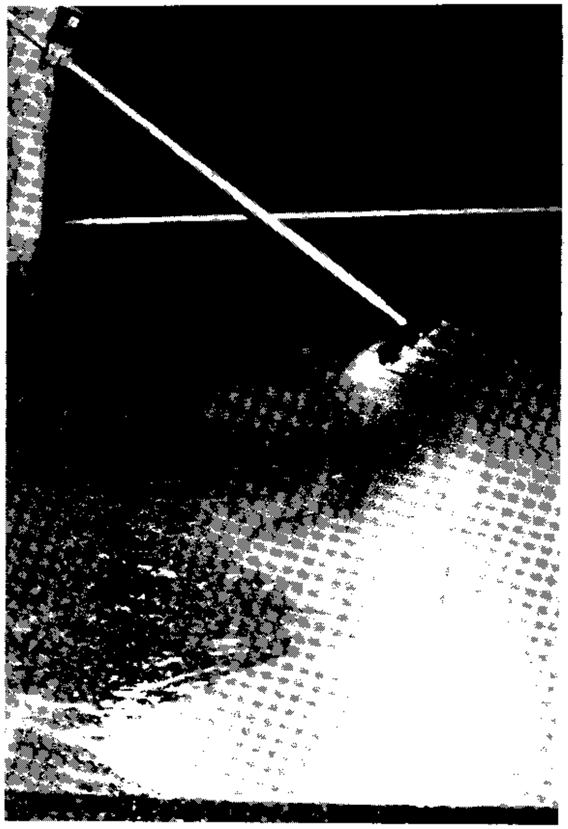
Cleaning deck with shotblaster.

Applying primer with roller.

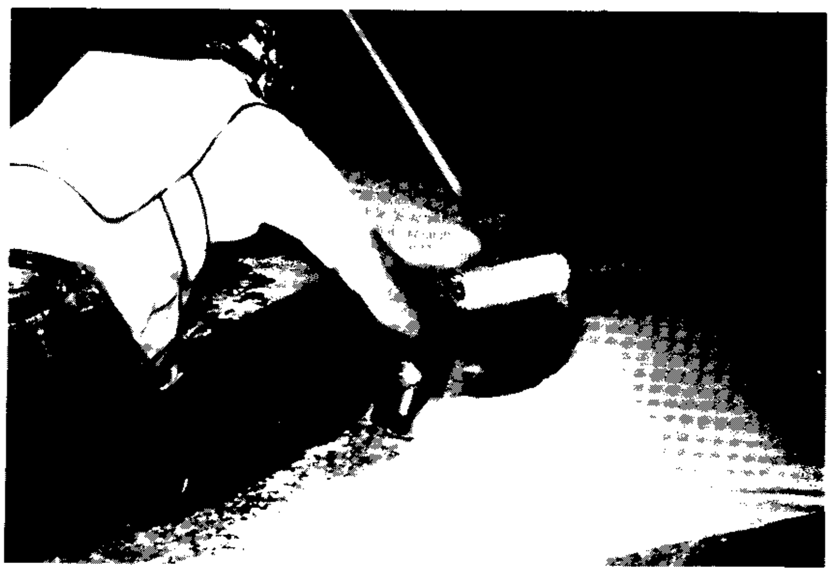
Mixing operation.



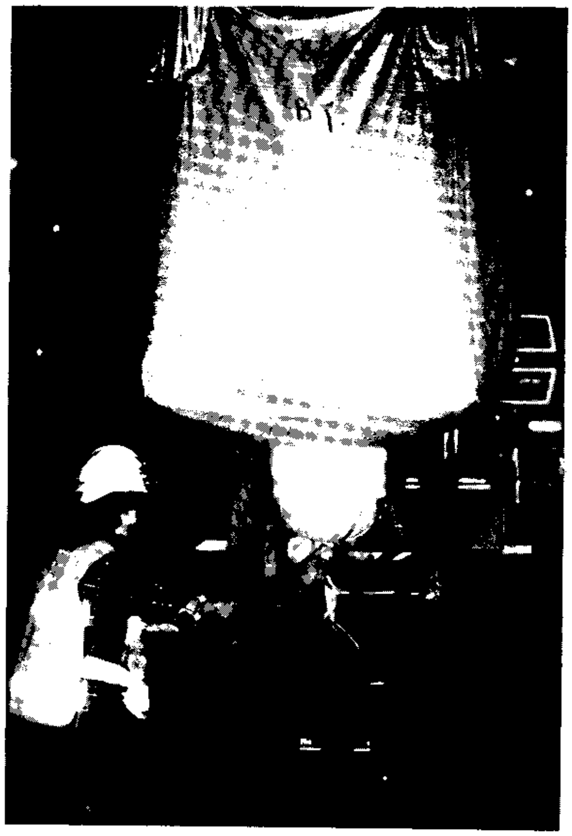
Placing MMA on deck with galvanized tub.



Spreading MMA by tined squeegee.



Spreading MMA by hand trowel and tined roller.



Dispensing aggregate to wheelbarrow.

Spreading aggregate by hand from a hand shovel.