Flexolith Overlay

WA-RD 107.1

Post-Construction Report
February 1987

Washington State Department of Transportation
Planning, Research and Public Transportation Division
in cooperation with the
United States Department of Transportation
Federal Highway Administration

Washington State Department of Transportation

Duane Berentson, Secretary
A.D. Andreas, Deputy Secretary
James P. Toohey, Assistant Secretary for Planning, Research and Public Transportation

Washington State Transportation Commission Research Committee
William O. Kamps, Chair
Richard Odabashian, Commissioner
Jerry Overton, Commissioner
Leo B. Sweeney, Commissioner

WSDOT Research Executive Committee
A.D. Andreas, Chair, Deputy Secretary for Transportation
E.W. Ferguson, Administrator, District 4
H. W. Parker, Assistant Secretary for Marine Transportation
Robert C. Schuster, Assistant Secretary for Highways
James P. Toohey, Assist. Sec. for Plan'g, Research & Public Transp.

WSDOT Research Technical Committees

Highway Operations and Development
Roland Cook, Chair, District 2 Administrator
John Aspaas, District 4 Project Engineer
William P. Carr, Associate Research Director
John Conrad, District 1 Operations Engineer
Rich Darnell, District 3 Maintenance & Operations Engineer
C. Stewart Gloyd, Bridge/Structures Engineer
Wayne Gruen, State Traffic Engineer
Stan Moon, Location/Design Engineer
Ed Schlect, Construction Engineer - Paving
Don Senn, District 2 Location/Construction Engineer
Dick Shroll, District 6 Maintenance Superintendent
Ken Thomas, Operations Engineer, Bellingham Public Works Department
George Tsiatis, Structural Engineer, WSU

Materials and Product Evaluation
Del Vandehey, Chair, State Construction Engineer
Keith W. Anderson, Research Specialist
Jim Buss, District 5 Assistant Construction Engineer
Newton Jackson, Pavement/Soils Engineer
Steve Kramer, Assistant Professor, Civil Engineering, UW
Bob Krier, Bridge Operations Engineer
Art Peters, Materials Engineer
Bob Spratt, District 2 Maintenance Engineer
John Strada, Construction Engineer - Grading

Planning and Multimodal
Don Tranum, Chair, District 6 Administrator
Ron Anderson, Manager, District 6 Management Services
Ken Casavant, Professor, Washington State University
King Cushman, Director, Pierce County Transit Development
John Doyle, Manager, Economics Branch
Kris Gupta, Manager, Transportation Data Office
Kern Jacobson, District 1 Public Transportation & Planning Engineer
Jerry Lenzi, Manager, Multi Modal Branch
Jim Slakey, Manager, Public Transportation
Stephen Smith, Service Planning Manager, Ferry System, Colman Dock

WSDOT Research Implementation Committee
Stan Moon, Chair, Location/Design Engineer
Jack E. Hanson, Assistant Location Engineer
Dennis Ingham, Highway Maintenance Engineer
Kern Jacobson, District 1 Public Transportation & Planning Engineer
Bob Krier, Bridge Operations Engineer
Art Peters, Materials Engineer
Ed Schlect, Construction Engineer
Gerald Smith, District 1, Assistant I-90 Construction Engineer
Bob Spratt, District 2 Maintenance Engineer

WSDOT Research Office
G. Scott Rutherford, Director
William P. Carr, Associate Director
Keith W. Anderson, Federal Program Manager
Julie Leverson, Database Coordinator
Ellen Loyer, Secretary
Carl Toney, Research Administrator
Cynthia Wallace, Clerk-Typist

WSDOT Research Liaisons

District 1 - Kern Jacobson, Public Transportation & Planning Engineer
District 2 - Don Senn, Location/Construction Engineer
District 3 - Bob George, Assistant Location Engineer
District 4 - Richard N. Coffman, Maintenance Engineer
District 5 - Robert MacNeil, Design Engineer
District 6 - Richard Larson, Design and Planning Engineer
WSDOT Library - Barbara Russo, Librarian

Transportation Research Council

Transportation Commission
Vaughn Hubbard, Chair
William J. Kamps*#
Richard Odabashian*
Jerry B. Overton
Albert D. Rosellini
Bernice Stern
Leo B. Sweeney*

* Research Committee # Research Committee Chair

Federal Highway Administration
Paul C. Gregson, Division Administrator

Private Sector
Milton "Bud" Egbers, President, Skagit Valley Trucking
Richard Ford, Managing Partner, Preston Thorgrimson, Ellis, Holman
William Francis, Vice President, Burlington Northern R.R.
Tom Gaetz, Project Manager, David Mowat & Company, Bellevue
Lawrence Houk, Vice President, Lockheed Shipbuilding
Charles H. Knight, President, Concrete Technology
H. Carl Munson, VP for Strategic Planning, Boeing Company, Seattle
Michael Murphy, President, Central Pre-Mix Concrete
Richard Norman, President, Associated Sand & Gravel, Everett
John Ostrowski, Public Works Director, Vancouver, WA
Richard S. Page, President, Washington Roundtable
James D. Ray, Senior Manager, IBM Company
Sudarshan Sathe, Director, Technical Services, Polycarb Inc., Cleveland, OH
Paul Turvill, General Manager, PACCAR, Mt.Vernon, WA
Alva Williams, Director, Public Works, Olympia

Universities

Gene L. Woodruff, Vice Provost for Research, UW
Neil M. Hawkins, Professor & Chair, Civil Engineering, UW
Robert V. Smith, Associate Provost for Research, WSU
Surinder K. Bhagat, Professor & Chair, Civil Engineering, WSU

Washington State Department of Transportation
Duane Berentson, Secretary

A.D. Andreas, Deputy Secretary
C.W. Beeman, District 5 Administrator
R.E. Bockstruck, District 1 Administrator
J.L. Clemen, Assistant Secretary for Management Services
R.C. Cook, District 2 Administrator
R.L. Daniels, Administrator, Public Affairs Office
J. Doyle, Manager, Economics
E.W. Ferguson, District 4 Administrator
W. H. Hamilton, Assistant Secretary for Aeronautics
W.I. Hordan, State Aid Engineer
H. W. Parker, Assistant Secretary, Marine Transportation
R.C. Schuster, Assistant Secretary for Highways
J.H. Slakey, Manager, Public Transportation Office
J.P. Toohey, Asst. Sectry for Plng, Res., and Pub. Transportation
M.D. Tranum, District 6 Administrator
D.J. Vandehey, State Construction Engineer
J.D. Zirkle, District 3 Administrator

Representative George Walk, Chair - Legisl. Transportation Committee

Federal Highway Administration
M. Eldon Green, Regional Administrator
Otis C. Haselton, Research and T2 Engineer
Ernest J. Valach, Director, Planning and Program Development

Division Office
Paul C. Gregson, Division Administrator
Barry Brecto, Programming and T2 Engineer
Charles W. Chappell, Division Transportation Planner

Washington State Transportation Center (UW & WSU)

G. Scott Rutherford, Director
Ken Casavant, Associate Director, WSU
Joe P. Mahoney, Associate Director, UW
Khossrow Babaei, Senior Research Engineer
Rhonda Brooks, Research Implementation Manager
Mark Hallenbeck, Senior Research Engineer
Ed McCormack, Research Engineer
Amy O'Brien, Coordinator
Bev Odegaard, Budget Analyst
Ron Porter, Word Processing Technician
Cy Ulberg, Senior Research Engineer
Duane Wright, Research Aid

TECHNICAL REPORT STANDARD TITLE PAGE

1. Report No. WA-RD 107.1	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle Flexolith Overlay		5. Report Date
		6. Performing Organization Code
7. Author(s) Keith W. Anderson		8. Performing Organization Report No.
9. Performing Organization Name and Address Washington State Department of Transportation Olympia, WA 98504		10. Work Unit No.
		11. Contract or Grant No. WA 84-02
12. Sponsoring Agency Name and Address Washington State Department of Transportation Olympia, WA 98504		13. Type of Report and Period Covered Post-Construction
		14. Sponsoring Agency Code

15. Supplementary Notes

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

16. Abstract

This report describes the installation and post-construction evaluation of a thin, lightweight epoxy concrete bridge deck overlay. This subject "Flexolith" epoxy concrete system was installed by Dural International Corporation on a bridge located on I-82 near Ellensburg, Washington.

The application of the overlay was unique in both the use of a special machine which mixed the epoxy components with the aggregates and the use of a vibratory screed to distribute and level the epoxy concrete to the desired depth. A small segment of the overlay, however, was placed using the more common broom and seed method of installation.

Post-construction testing showed that the overlay has adequate bond strength, extremely high friction resistance, and is performing adequately as a waterproof membrane. The only deficiencies noted were a nonuniform surface texture and profile. A recommendation was made to not allow the use of the vibratory screed method until improvements are made to insure that the final product will have a surface texture and profile equivalent to overlays placed with the broom and seed method.

17. Key Words Epoxy, concrete, lightweight, bridge decks, overlays	18. Distribution Statement

19. Security Classif. (of this report) Unclassified	20. Security Classif. (of this page) Unclassified	21. No. of Pages	22. Price

Form DOT F 1700.7 (8-69)
DOT FORM 341-004
6/72

FLEXOLITH OVERLAY

by

Keith W. Anderson
Research Specialist

Experiemental Feature WA 84-02

Post-Construction Report

Prepared for
Washington State Department of Transportation
and in cooperation with
U.S. Department of Transportation
Federal Highway Administration

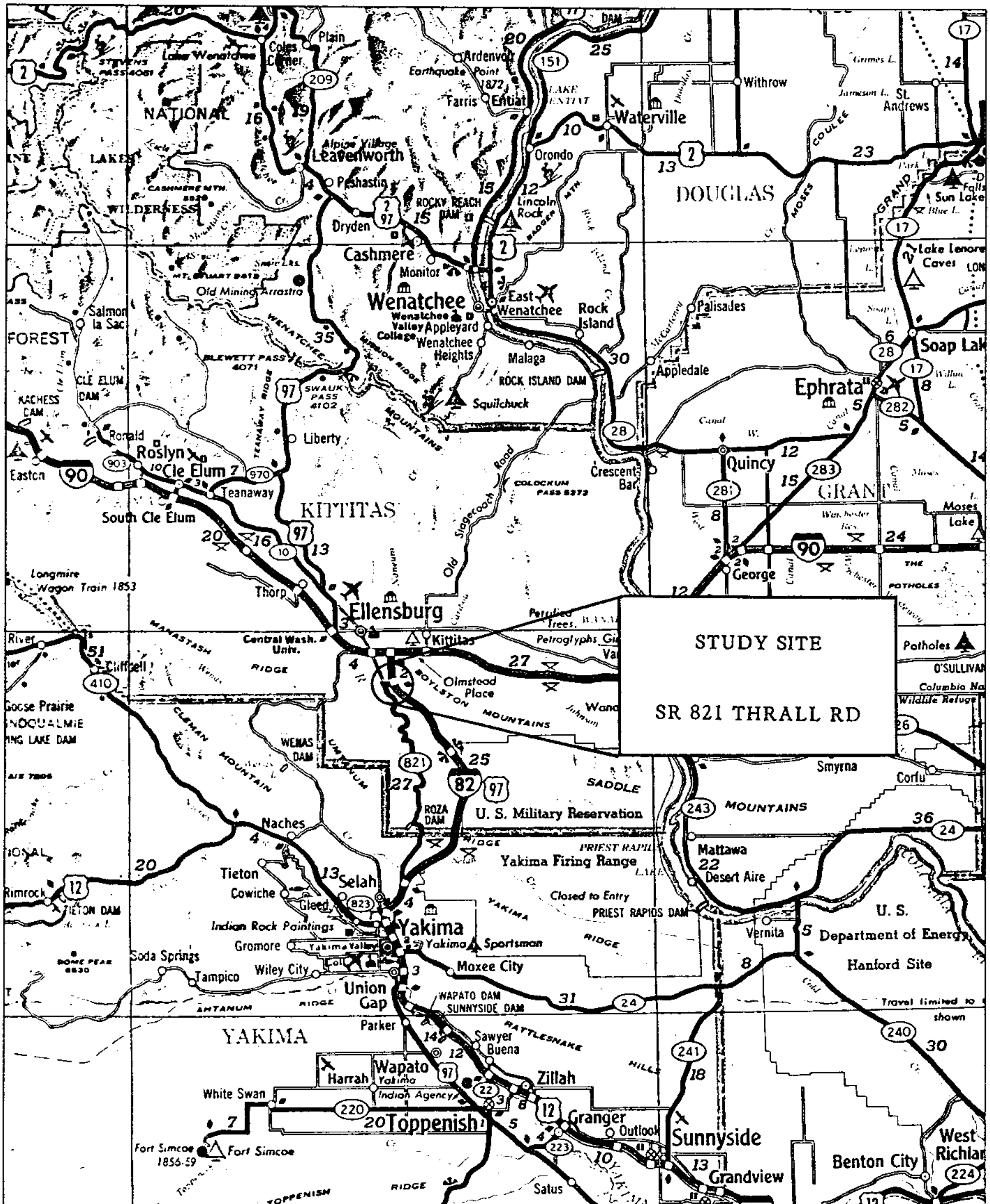
February, 1987

DISCLAIMER

TABLE OF CONTENTS

LIST OF TABLES

LIST OF APPENDEXES


STUDY SITE
SR 821 THRALL RD
DOUGLAS
KITTITAS
GRANT
YAKIMA
BENTON
YAKIMA INDIAN RESERVATION
Wenatchee
Ellensburg
Yakima
Cle Elum
Ephrata
Quincy
Sunnyside
Toppenish
Prosser
U. S. Military Reservation
Yakima Firing Range
U. S. Department of Energy
Hanford Site

CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

The following list of conclusions are based on the tests and observations made during the construction and post-construction evaluation of the overlay and may be subject to revision as the long term monitoring progresses.

1. The machine mixed/vibrator screed method produces a surface which is less uniform in texture and has more profile irregularities then the surface produced with the broom and seed method.
2. The machine mixed/vibrator screen method produces a pavement with greater water impermeability than the broom and seed method.
3. Both paving methods produce and overlay with adequate bond strength and extremely high surface friction resistance.

RECOMMENDATIONS

The following recommendation is made regarding the use of a vibrator screed for paving future epoxy concrete overlays.

- The vibrator screen method of paving should not be used for future epoxy concrete overlays until improvements are made to insure that a more uniform texture and smoother profile can be produced.

INTRODUCTION

This report covers the installation of an experimental thin, lightweight, epoxy concrete overlay on the Thrall Road Overcrossing bridge, 82/105, which is located on I-82 near Ellensburg (see Figure 1). This installation took place in the spring of 1985. It followed the successful installation of a similar system on the movable portion of the Chehalis River Bridge on SR-101 near Aberdeen in 1984. Future plans call for the installation of ten additional experimental installations of these new generation thin overlay systems in the 1986/87 construction seasons.

STUDY SITE

The subject bridge was a prestressed concrete girder structure built in 1970. The original design for the structure included an asphalt overlay, but due to problems with the concrete mix used in the deck pour, a 3 inch thick, reinforced concrete overlay was substituted. It was due to the added deadload of this 3 existing overlay, however, that a recommendation was made from the Bridge Office to use a lightweight overlay on this structure in place of Latex Modified Concrete. The companion structure in the northbound direction, which did not have the additional 3 inch overlay, was rehabilitated with a LMC overlay.

The deck is 357 feet long and varies in width from 60 feet at the north pavement seat to 53 feet at the south pavement seat (see Appendix A). It has a 2% grade from north to south and a 0.02 ft/ft cross slope either side of centerline which is 16 feet from the median side curb line. The bridge carries the two southbound lanes of traffic for I-82 plus the on-ramp traffic from SR-821. The ADT for the structure is 3900 vehicles with a 21 percent truck population.

CONSTRUCTION

The Flexolith overlay was applied by Polymer Construction Specialties Incorporated using epoxy supplied by Dural International Incorporated. Aggregate for the overlay was produced by Manufacturers Minerals Tukwila, WA from the Steilacoom gravel source. Dural International was a subcontractor to Sealant Systems Incorporated, the prime contractor for contract 2857 which included nine latex modified concrete deck overlays in addition to the overlay described in this report.

Construction of the overlay by Polymer Construction Specialties was proceeded by the repair of all delaminations in the deck by Sealant Systems. The application of the overlay involved five steps:

- Cleaning
- Mixing
- Screeding
- Floating and Troweling
- Aggregate Broadcasting

The first step was a complete cleaning of the deck surface using a Blastrac shotblaster machine. This machine uses steel shot which are propelled against the surface of the deck to remove any contaminates. A vacuum system picks up the steel shot and recycles it through the machine in a continuous operation. A magnetic broom was run across the cleaned portion of the deck to pick up any of the steel shot not removed by the vacuum system.

The epoxy binder and aggregate were mixed together in a continuous operation using a special unit normally found in factories which produce synthetic marble. This machine has two positive displacement pumps which deliver the correct proportion of each binder component from storage tanks to the mixing tube. The aggregate, which feeds from a manually supplied hopper, was mixed with the binder portion by two high speed augers inside the mixing tube. The resultant epoxy concrete was very liquid rich and contained very little entrapped air because of the enclosed nature of the mixing operation.

The epoxy concrete was deposited directly on the bridge deck surface in front of the vibrator screed. Laborers distribute the concrete across the width of the screed with shovels as the screed was pulled across the deck by hand. The vibratory screed was constructed from two rectangular aluminum members spaced 12 inches apart by cross members. Two gasoline engines mounted on the screed provided the power for the vibrators attached to the aluminum frame. The screed rode on 1/4 inch thick flat steel bars layed along each side of the lane to be paved and provided depth control for the overlay. The screed bars were leap frogged ahead as the paving progresses.

A longhandled bullfloat was used directly behind the screed to smooth out any longitudinal irregularities in the slurry. Hand trowels were used at each side of the paved lane to fill in and smooth the void created when the screed bars were moved.

The final operation was the broadcasting of aggregate onto the surface of the overlay. This aggregate, which was the same as that used in the slurry mixture, is used to provide the final high friction surface texture. It was broadcast by hand in an upward motion so that no displacement of the slurry resulted. Sufficient aggregate was broadcast until all wet spots disappeared. The excess aggregate was broomed up and removed from the deck prior to opening the bridge to traffic.

Paving was accomplished in four approximately 15 foot wide passes beginning with the driving lane, followed by the on-ramp lane, followed by the outsise shoulder. The passing lane and shoulder comprised the final pass. The actual paving operations were completed in eight working days (see Table 1), although the actual start to finish of the overlay took approximately two months due to material supply problems. (See PROBLEMS section).

PROBLEMS

Installation of the overlay was not accomplished without problems due to the weather and materials.

Weather

The weather during the first week of paving, Table 1, was cold and rainy. The low temperatures necessitated early morning prewarming of the drums of epoxy components and the insulation of the plastic storage tanks to keep the viscosity of the epoxy at a low enough level so that it could be pumped. This preheating of the epoxy generally delayed the beginning of paving until 11:00 a.m. which slowed the entire operation. Heavy rains forced an early shut down of the paving on the 24th and a complete shut out on the 25th. Rain on the 26th delayed the cleaning of the deck because the Blastrac will not work on a wet surface and resulted in no paving on that day. The weather did improve, after the first week and presented no problems for the remainder of the project.

Table 1: Summary of Weather Data

Day	Date	Rainfall	High	Low	Comments
Tuesday	4/23/85	Trace	55°F	32°F	Paved 90% of driving lane
Wednesday	4/24/85	0	52°F	29°F	Finished driving lane and 33% of on-ramp lane
Thursday	4/25/85	0.05"	51°F	26°F	Finished on-ramp lane (Highest Rainfall for April)
Friday	4/26/85	Trace	57°F	33°F	None

Saturday	4/27/85	0	49°F	29°F	None
Sunday	4/28/85	0	70°F	38°F	None
Monday	4/29/85	0	67°F	29°F	Paved outside shoulder
Tuesday	4/30/86	0	65°F	31°F	Paved 75% of passing lane and shoulder
Wednesday	6/26/85	0	85°F	46°F	Paved 1st coat remainder of passing lane and shoulder
Thursday	6/27/85	0	89°F	48°F	Paving 2nd and 3rd coats passing lane and shoulder, 1st coat on delamination removals
Friday	6/28/85	0	72°F	45°F	Paved 2nd and 3rd costs on delamination removals

Materials

The initial truckload of special crushed and washed Steilacoom aggregate arrived at the jobsite the day before paving was scheduled to begin. Gradation tests on the aggregate showed it to be out of specifications. The contractor was given the option of using the aggregate with a reduced payment in the deferance to delaying the operation until specification materials could be brought to the jobsite. The contractor elected to use the out of specification aggregate in order to avoid delaying the paving, (see Appendix B, Change Order 14).

The contractor also experienced problems with his supply of epoxy components. The contractor realized at the completion of the first two 15 foot passes that the quantities of epoxy he had at the jobsite were insufficient to complete the project. Additional quantities of the epoxy were air freighted from New York the weekend following the first week of paving. Unfortunately, their estimate of the additional quantities needed turned out to be low so that they ran out of epoxy with approximately 120 lineal feet of the last pass to be covered. The contractor was forced by other obligations for his equipment to pull off of the job and return about two months later to complete the paving. It should be noted at this point that the actual finished pavement measured between 3/8 and 1/2 inch in thickness which substantially exceeded the planned thickness of 1/4 inch. The contractor indicated that his quantity estimates were based on this 1/4 inch thickness accounting for the large overrun.

When the contractor returned to finish the remaining 120 feet of the passing lane and shoulder he chose to use the broom and seed application method. This method consisted of: (1) mixing the epoxy components in plastic 5 gallon buckets using an electric drill with paddle attachment; (2) pouring the binder onto the deck and spreading to a uniform thickness with long handled paint rollers; and (3) broadcasting aggregate onto the binder until all wet spots were covered. The same process was repeated until the desired thickness was attained, which in this case was three layers.

CONSTRUCTION DEFICIENCIES

The completed overlay was found to have some localized areas which did not meet the surface smoothness specification and some areas which indicated a delamination condition as determined by the chain drag test.

Surface Smoothness

The standard specifications prohibit irregularities in the completed surface which vary by more than 1/8 inch as measured with a 10 foot straight-edge. A penalty is assessed for each area of a single traffic lane 100 feet in length in which a deviation occurs. There were six such areas in the overlay and the contractor was assessed a penalty of $500.00 for each (see Appendix B). Those irregularities were all within the area paved with the vibratory screed which produced a very nonuniform surface texture and irregular profile. The small area paved using the broom and seed method, in contrast, had a very smooth profile and a uniform surface texture.

Delaminations

The finished portions of the overlay were checked for delaminations by the project inspection crew at the time the contractor returned to complete the job. A large delaminated area was found at the north end of the driving lane where initial paving began. Removal of the overlay in this area revealed that the epoxy binder was extremely flexible and apparently had the wrong proportions of the two binder components. This was probably caused by the difficulties encountered in pumping the epoxy due to the low temperatures on the first day of paving. Several other areas of delamination were also discovered principally at the southend of the driving lane. These particular delaminations generally occurred over one of the patched portions of the underlying deck. Samples of the overlay were removed in two of these areas to determine the origin of the delamination. The overlay was found to be well bonded to the surface of the patching material indicating that the actual delamination was at some depth in the patch itself. The contractor expressed confidence in the ability of the overlay to bridge over these delaminations so a decision was made to not remove the overlay to repair these spots. These areas were added to the monitoring program as a part of the evaluation of the long-term performance of the overlay.

TESTS AND OBSERVATIONS

Tests were run before and after construction to a Hain base line data for the long term monitoring of the overlay's performance.

Pre-Construction Testing

The pre-construction evaluation of the deck in April of 1983, indicated that it was in generally fair condition. A delamination survey detected only 40 square yards of delaminations. The chloride content valves ranged from 0.20 to 6.09 LB/CY with 11 of the 28 samples exceeding the 2.0 LB/CY threshold valve. Shrinkage cracks were noted in the northern half of the deck but core sampling revealed that these cracks were confined to just the 3 inch overlay.

Additional testing and sampling were performed in April of 1985 just prior to the construction of the overlay. The testing included half-cell readings to check corrosion activity in the rebar steel and additional chloride content sampling to assess any changes since 1983. The additional testing was confined to the passing lane of the deck which is the area chosen as the test section for the long term monitoring of the overlays performance.

The chloride content values are shown in Table 2 for both the 1983 and 1985 samplings. The results show an interesting distribution of high values concentrated mainly in the driving and passing lanes of the deck. A common belief concerning the concentration of chlorides is that the deicing salts will migrate to the lower or curb line areas of the decks due to gravity. These results do not support this belief. It appears that traffic is having some effect possibly through the pressure exerted by tires forcing the deicing salts into the deck or through the deterioration process which produces a more permeable deck surface.

Table 2. Chloride content results for Bridge 82/105 from April of 1983 and 1985.

Chloride Content in LB/YD^3			
Inside Shoulder	Passing Lane	Driving Lane	On Ramp And Outside Shoulder
.91	4.85	6.09	2.02
.32	4.04	2.97	1.82
	2.47	2.86	.75
	1.46	2.85	.46
	1.39	2.64	.45
	.37	2.58	.26
		2.05	
	.32	1.89	.20

Inside Shoulder	Passing Lane	Driving Lane	On Ramp And Outside Shoulder
	.25	1.82	
	*5.01	0.91	
	*3.68	0.66	
	*3.47		
	*2.30		
N=2 =1.23 x=0.62	n=12 = 29.61 x=2.47	n=11 = 27.32 x=2.48	n=7 =6.14 x=0.88
n>2.00=0	n>2.00=7	n>2.00=7	n>2.00=1

* 1985 samples

Half-cell potential readings were taken prior to construction to access possible corrosion activity in the deck. The valves ranged from a low of 113 millivolts to a high of 363 millivolts with a uniform distribution about a media valve of 225 millivolts. Individual valves are shown in Table 3. The readings indicate that only a minor amount of corrosion activity may be occurring in the deck.

Table 3. Half Cell Potential Readings

Station	Offset[b] 5'	10'	15'	Station	Offset 5'	10'	15'	Station	Offset 5'	10'	15'
0+00	298[c]	283	293	120+00	204	189	204	240+00	180	205	204
5+00	282	314	339	125+00	186	173	185	245+00	213	202	221
10+00	265	286	331	130+00	148	164	174	250+00	195	192	216
15+00	219	276	346	135+00	187	148	168	255+00	214	223	259
20+00	213	248	273	140+00	170	142	159	260+00	183	235	258
25+00	245	272	272	145+00	161	144	150	265+00	213	210	238
30+00	255	301	299	150+00	169	149	175	270+00	208	225	233
35+00	330	274	306	155+00	148	155	191	275+00	230	257	299
40+00	218	255	273	160+00	142	168	175	280+00	196	232	259
45+00	214	263	267	165+00	160	202	232	285+00	208	214	285
50+00	186	272	292	170+00	194	192	214	290+00	232	234	265
55+00	206	288	293	175+00	177	154	188	295+00	195	209	256
60+00	273	262	306	180+00	143	171	188	300+00	191	229	240
65+00	314	256	262	185+00	157	146	159	305+00	192	225	246
70+00	300	310	301	190+00	113	159	195	310+00	214	207	229
75+00	293	292	301	195+00	149	173	224	315+00	195	188	208
80+00	335	284	299	200+00	179	208	259	320+00	198	221	212

Station	Offset[b] 5'	10'	15'	Station	Offset 5'	10'	15'	Station	Offset 5'	10'	15'
85+00	247	304	300	205+00	162	221	268	325+00	207	226	230
90+00	270	217	217	210+00	201	191	201	330+00	203	244	269
95+00	230	207	200	215+00	154	193	202	335+00	199	204	221
100+00	276	237	240	220+00	213	197	212	340+00	183	235	247
105+00	286	282	266	225+00	255	233	208	345+00	231	238	315
110+00	267	232	241	230+00	190	202	202	350+00	248	363	
115+00	256	203	238	235+00	195	193	217				

a Stationing measured from north pavement seat of bridge.

b Offset measured from median side curb.

c Readings are in negative millivolts.

Post-Construction Testing

The finished overlay was evaluated for delaminations, waterproofing effectiveness, bond strength and friction resistance. This testing provided data to assess the contractors compliance with contract specifications as well as providing base line data for the long term monitoring of performance.

Delaminations

A chain drag survey detected 20 square yards of delamination in the completed overlay which is less than 1 percent of the total deck area. The majority of the delaminations occurred at the south end of the driving lane as noted in the PROBLEMS section.

Waterproofing Effectiveness

The electrical resistivity tests for waterproofing effectiveness were generally acceptable with only two readings below the must repair level of 100,000 ohms. Under normal acceptance procedures the contractor would be required to repair these two areas but due to the experimental nature of this overlay a decision was made to leave them as is to see if further deterioration would be measurable over time.

There was a notable difference in the resistivity valves between the machine mixed/vibrator screed paved area and the broom and seed paved area, (see Table 4). The machine mixed paving had valves which were predominately of infinite resistance whereas the broom and seed paving had valves in the 40,000 to 880,000 ohm range with only four readings of infinite resistance. The application contractor indicated that the lower valves for the broom and seed paving may have been caused by voids in the binder which he might have been prevented by the using less aggregate in the first layer. Less aggregate would have resulted in a more liquid rich mixture which would yield better wetting of the deck surface and less chance for these voids to develop.

Table 4. Electrical Resistivity Readings

Station	Offset		Station	Offset		Station	Offset	
	7'	12'		7'	12'		7'	12'
0.00	Inf[a]	Inf	120+00	Inf	Inf	240+00	500	500
5+00	Inf	Inf	125+00	Inf	Inf	245+00	280	245
10+00	Inf	Inf	130+00	Inf	Inf	250+00	90	500
15+00	Inf	Inf	135+00	Inf	Inf	255+00	600	360
20+00	Inf	Inf	140+00	Inf	Inf	260+00	300	320
25+00	Inf	Inf	145+00	Inf	Inf	265+00	40	340
30+00	Inf	Inf	150+00	Inf	Inf	270+00	400	230
35+00	Inf	Inf	155+00	Inf	Inf	275+00	Inf	Inf
40+00	Inf	Inf	160+00	Inf	Inf	280+00	400	400
45+00	Inf	Inf	165+00	Inf	Inf	285+00	320	330
50+00	Inf	Inf	170+00	Inf	Inf	290+00	360	470
55+00	Inf	Inf	175+00	Inf	Inf	295+00	360	600
60+00	Inf	Inf	180+00	Inf	Inf	300+00	150	360
65+00	Inf	Inf	185+00	Inf	Inf	305+00	220	550
70+00	Inf	Inf	190+00	170[b]	Inf	310+00	880	440
75+00	Inf	Inf	195+00	Inf	Inf	315+00	340	420
80+00	Inf	Inf	200+00	300	Inf	320+00	360	240
85+00	Inf	Inf	205+00	600	Inf	325+00	250	230
90+00	Inf	Inf	210+00	Inf	Inf	330+00	230	380
95+00	Inf	Inf	215+00	Inf	Inf	335+00	580	500
100+00	Inf	Inf	220+00[c]	280	160	340+00	Inf	500
105+00	Inf	Inf	225+00	170	400	345+00	Inf	460
110+00	Inf	Inf	230+00	600	780			
115+00	Inf	Inf	235+00	880	625			

a Inf = Infinite resistance = > 1,000,000 ohm/ft^2.

b Readings are in 1,000 ohm/ft^2, 170 = 170,000 ohm/ft^2.

c Beginning of broom and seed application method.

Bond Strength

Bond strength tests were performed at random locations again only in the passing lane of the bridge. Photographs and a desriptions of this procedure are found in Appendix D (see photos 21 thru 26). The results ranged from 239 to 501 psi with an average of 359, see Table 5. Failure plane location was predominately in the deck substrate material indicating that the bond strength exceed the tensile strength of the underlying deck. All tests met the contract specifications which called for a minimum of 350 psi or failure in the bridge deck Portland cement concrete.

Table 5. Bond Strength Test Results.

Location No.	Gauge Reading (lbs)	Bond Strength (psi)	Failure Plane Location
1	1200	382	95%PCC/5%Overlay
2	750	239	80%PCC/20%Overlay
3	1000	318	95%PCC/5%Overlay
4	1210	385	90%PCC/10%Overlay
5	1550	493	50%PCC/50%Overlay
6	1575	501	90%PCC/10%Overlay
7	850	271	90%PCC/10%Overlay
8	1370	436	80%PCC/20%Overlay
9	1350	430	95%PCC/5%Overlay
10	810	258	100%PCC
11	775	247	95%PCC/5%Overlay
12	1100	350	100%PCC

Average Bond Strength: 359 psi

Range in Bond Strength: 239 to 501 psi

Average Failure Plane Location: 88%PCC/12%Overlay

Friction Resistance

Friction resistance measurements were made with a locked-wheel skid trailer meeting

ASTM E-274 standards. The valves ranged from 68 to 81 with an average of 75 (see Table 6) which exceeded the contract specificant of a minimum of 50 for all tests. Cormal valves for new ACP pavements are 45 to 55 and for new PCC pavements are 35 to 45.

Table 6. Friction number (FN) valves for Flexolith overlay.

Passing Lane		Driving Lane	
LWP* (FN)	RWP (FN)	LWP (FN)	RWP (FN)
72	73	72	___
81	82	68	___
71	74	70	___
81	84	68	___

Average Friction Number(FN): 75

Range of FN's: 68 to 81

All tests performed at 40 MPH with ASTM Lock-Wheel Friction Tester on July 17, 1985.

* LWP = Left Wheel Path
RWP = Right Wheel Path

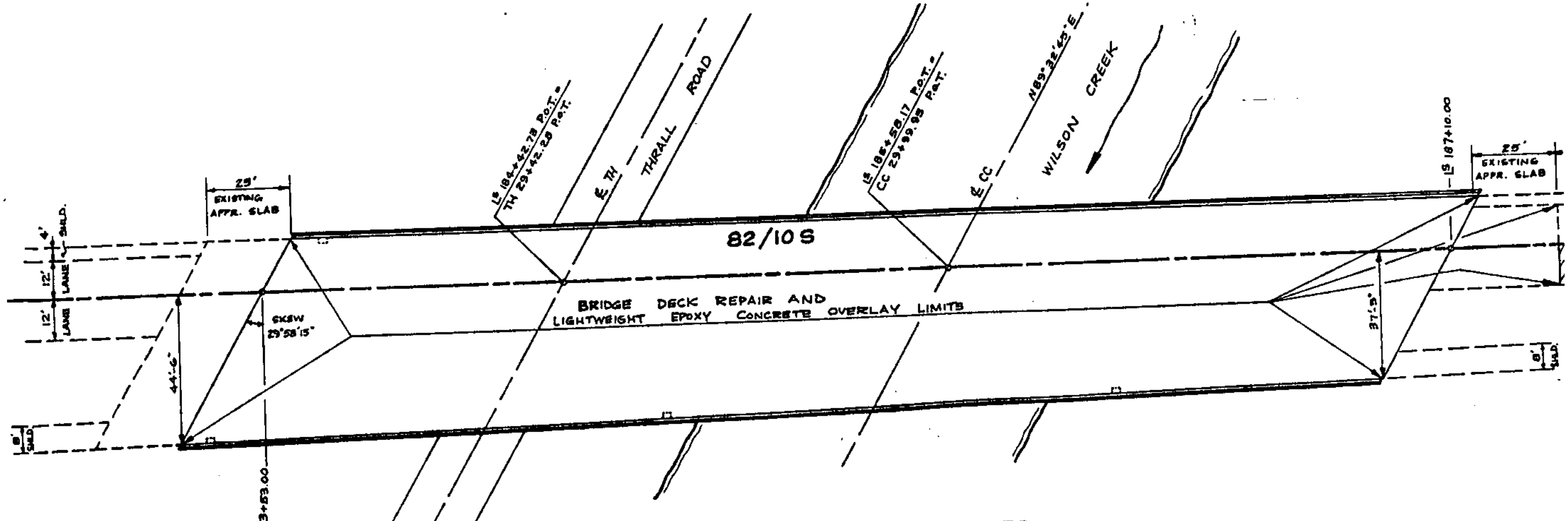
LONG-TERM MONITORING PLAN

The evaluation schedule included in the work plan for these experimental features (See Appendix C) calls for friction resistance and electrical resistivity testing on a periodic basis over a ten year period. This plan will be supplemented with bond strength tests, half-cell potential surveys, and chloride content sampling as deemed necessary by the researcher. These latter tests result in removal of portions of the overlay either as a result of the test as in the bond strength test or as a requirement for being able to perform the test as is the case with the half-cell test and the chloride content sampling. Prudent judgment will be used to determine when and to what extent these tests will be performed. The evaluation schedule does not show delamination detection, but it will be added to monitor the delaminations not only in the passing lane but also in the remainder of the deck.

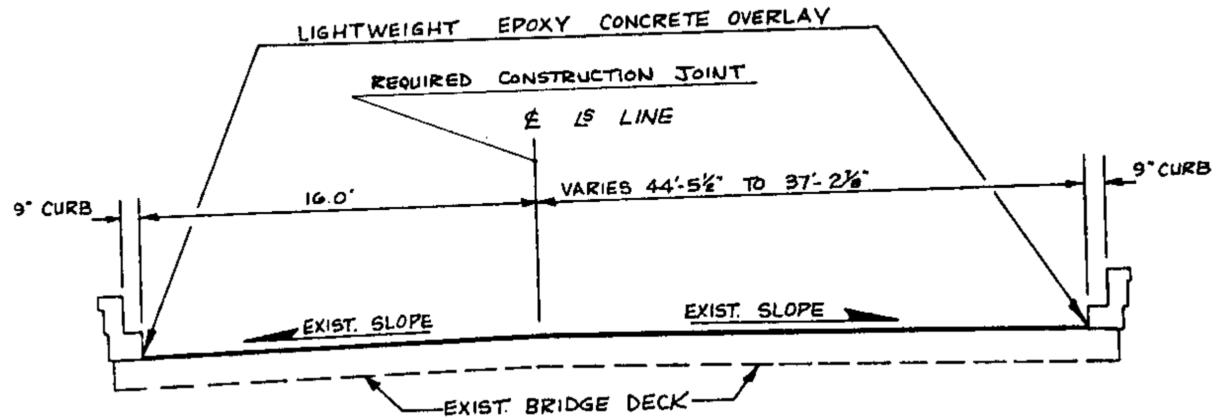
K44/012

APPENDIX A

CONTRACT PLANS AND SPECIFICATIONS



THRALL OVERCROSSING BRIDGES



BRIDGE DECK SECTION
STA. LS 183+53.00 TO STA. LS 187+10.00 82/10S (THRALL OVERCROSSING)

Part 6 Payment

6.01

A. Payment for this item of work, excluding the work required for further deck preparation and the subsequent filling of the prepared areas, will be made at the unit contract price per square yard for "Latex Modified Concrete Overlay", which price shall be full compensation for all material, labor, tools and equipment necessary to complete the work specified in accordance with the plans, these special provisions and the standard specifications.

B. Payment for the work required for further deck preparation and the subsequent filling of the prepared areas will be made by force account in accordance with section 1-09.6 of the standard specifications. For the purpose of providing a common proposal for all bidders, and for that reason only, the State has estimated the cost of the item "Further Deck Preparation" and has arbitrarily entered the amount in the bid proposal to become a part of the total bid by the Contractor.

LIGHTWEIGHT EPOXY CONCRETE OVERLAY

This item of work shall consist of furnishing and placing a waterproof overlay on the deck of Bridge No. 82/10S and the south Bridge approach slabs of Bridge 82/10N as shown on the layout sheet.

The following items shall be included in this item of work:

1. Preparing and cleaning the concrete by methods described in this specification.

2. Applying the overlay in accordance with the manufacturer's recommendations and instructions and as described in this specification.

The Contractor shall have the manufacturer of the overlay product, or the manufacturer's licensee, install the product in accordance with the manufacturer's specifications and these special provisions.

This special provision shall be a guideline to be used in the application of the specified product. Any anticipated deviations or recommendation by the manufacturer shall be introduced by him at the preconstruction conference and shall be approved by the Engineer. The manufacturer shall be responsible for preparation, including type of equipment, mixing of the overlay components, type of application, method of application and finish.

Quality Assurances

The Contractor shall prepare and submit the design mix for the epoxy concrete, including samples of all components for each lot, to the Washington State Department of Transportation Materials Laboratory for testing and obtain approval prior to ordering any and all materials for application of the overlay.

Submittals

The Contractor shall submit each of the following to the Engineer for approval:

1. The design mix report for the epoxy concrete.

2. Certification that key personnel to be used in the application of the overlay material have experience in the application of this type of material on a concrete bridge deck.

Delivery and Storage of Materials

1. All materials shall be delivered in their original containers bearing the manufacturer's label, specifying date of manufacturing, batch number, trade name brand, quantity and mixing ratio.

2. Sufficient material to perform the entire overlay application shall be in storage at the site prior to any field preparation, so that there shall be no delay in procuring the materials for each day's application.

3. The material shall be stored so as not to be damaged from the elements and to insure the preservation of their quality and fitness for the work. The storage space shall be kept clean and dry, shall contain a thermometer, and the temperatures of the storage space shall not fall below or rise above that recommended by the manufacturer. Every precaution shall be taken tc avoid contact with flame.

4. Stored materials, even though accepted before storage, shall be inspected by the manufacturer prior to their use in the work, and shall meet the requirement of the contract at the time of use.

5. Any material which is rejected become of failure to meet the required tests or that has been damaged so as to cause rejections, shall be immediately replaced at no additional cost to the State.

Materials

The epoxy concrete overlay shall be composed of the following three components:

1. Epoxy resin base
2. Epoxy resin base hardener
3. Aggregate

The epoxy resin base and hardener shall be composed of a two-component, 100 percent solids, thermosetting, moisture-insensitive, flexible, high-elongation compound. The compound shall be FLEXOLITH, manufactured by Dural International Corporation, 95 Brook Avenue, Deer Park, New York 11729.

The aggregate shall be from Site B1 at Steilacocm, Washington and shall be crushed, thoroughly washed and kiln dried. The aggregate shall meet the following:

	Percent by Weight
Retained on U.S. NO. 6	0
Retained on U.S. No. 8	0-1
Retained on U.S. No. 10	65-90
Retained on U.S. No. 20	10-35
Passing U.S. No. 20	0-3

<u>Equipment For Deck Preparation</u>

All equipment for cleaning the surface and mixing and applying the overlay shall be in strict accordance with the manufacturer's requirements and approved by the Engineer prior to commencement of any work.

Prior to placing the epoxy concrete overlay, the surface shall be cleaned to remove contaminants. The concrete and steel surfaces shall be clean, free of dust, and dry for proper bonding of the epoxy concrete.

Automatic shot blast cleaning, using Wheelarrator-Fry's Blastrac Unit, instead of sandblasting may be used for this purpose. The unit shall be equipped with its own dust collector and shall recycle the abrasives.

The unit shall be composed of a blasting unit and a vacuum unit, both self-propelled. All contaminate shall be picked up and stored in the vacuum unit.

<u>Deck Preparation</u>

Using the equipment, material, technique and procedures established by the applicator for surface preparation, the bridge deck and approach slabs shall have the surfaces prepared by removing all material which may act as a bond breaker between the surface and the overlay.

Those areas of roadway deck not accessible for cleaning by the Blastrac unit shall be blast cleaned using conventional methods, subject to prior approval of the Engineer.

If the conventional blast cleaning is required then precautions shall be taken to assure that no dust or debris leaves the roadway deck and that all traffic is protected from rebound and dust. Appropriate shielding shall be provided as required at no additional cost of the State and shall be approved by the Engineer.

<u>Mixing Concrete</u>

The base and hardener shall be combined according to the manufacturer's instructions in an approved mixer with blades which wipe the inside of the mixer clean. Add two and one-half parts by volume of aggregate for every one part by volume of mixed epoxy to obtain the slurry. Mix thoroughly and apply immediately. Aggregate ratio may be varied to compensate for temperature fluctuations (± one-half part by volume for proper consistency).

<u>Placing Concrete</u>

The Contractor shall provide suitable coverings, such as heavy duty drop cloths, to protect all exposed areas not to be overlayed with epoxy concrete, whether his own or work of others, such as curbs, sidewalks, railings, parapets, etc. Any damage or defacement resulting from this application shall be cleaned or repaired, at the Contractor's expense, to the satisfaction of the Engineer.

Concrete surfaces shall be coated with epoxy concrete slurry after the cleaning is completed to prevent contamination of the cleaned surface. If, in the opinion of the Engineer, the surface has become soiled or contaminated prior to the application of the slurry, it shall be cleaned again to the satisfaction of the Engineer, at no additional cost to the State.

Apply epoxy concrete slurry by screed or trowel at the rate recommended by the manufacturer. Screed strips shall be used to provide a thickness of 1/4 inch. Immediately after placing epoxy concrete slurry, broadcast aggregate to the wet slurry at the rate of two pounds per square foot or until no wet spots appear. Sweep loose, excess aggregate from top of deck after epoxy concrete has cured and before opening to traffic.

Under no circumstances will any epoxy concrete be allowed to run into drains and expansion joints. It may be necessary to use an epoxy concrete with epoxy to aggregate ratio of 1:3 by volume in order to eliminate any runoff. In no event will ratios greater than 1:3.5 by volume be permitted. Feather edging to the outside will <u>not</u> be permitted.

Overlay Thickness

The overlay surface shall be checked at random by the Engineer during the application of the overlay before the initial set occurs. The surface shall be tested by means of an approved straight-edge not less than 10 feet long. The straight-edge shall be laid in contact with the surface in successive positions parallel to and transverse to the center line of the deck. Before the overlay hardens, any irregularities greater than 1/8 inch in 10 feet shall be promptly corrected in a manner approved by the Engineer.

Thickness of the overlay shall be determined prior to its initial set by using a measuring device provided by the manufacturer that can penetrate the overlay to determine the final thickness. Additional coats shall be required, at no additional cost to the State, if the minimum thickness is not achieved, as determined by the Engineer.

Repair of Surface Defects

The repair method for surface defects of the overlay shall be identical to the original application of the overlay.

Epoxy mortar repairs to concrete shall consist of the preparation of epoxy mortar composed of one part by volume of mixed epoxy components A and B, and three parts by volume of aggregate, as approved by the Engineer.

Curing

Allow the epoxy concrete overlay to cure sufficiently before subjecting it to loads of traffic or any nature that may damage the overlay. Cure time depends upon the ambient and deck temperatures.

Actual degrees of cure and suitability for traffic on the actual epoxy concrete overlay shall be determined by the manfuacturer and be acceptable by the Engineer. The manufacturer shall determine, prior to bid, that its system will cure in sufficient time to satisfy the requirements for vehicular operations.

Measurement

The quantity to be paid for will be the number of square yards of epoxy concrete overlay on the bridge, having the required thickness measured in place, in the completed work, as approved by the Engineer.

Payment

The unit contract price per square yard for "Lightweight Epoxy Concrete Overlay", shall be full compensation for providing all labor, materials and equipment necessary to complete the work as specified.

TESTING LIGHTWEIGHT EPOXY CONCRETE OVERLAY

Evaluating Waterproofing Effectiveness

After completion of the epoxy concrete overlay, an evaluation of the waterproofing effectiveness of the system will be made in accordance with WSDOT Test Method No. 413A. The acceptance standards for the epoxy concrete shall be 70 percent readings above 250,000 ohms and no single reading below 100,000 ohms. Those areas requiring repair or replacement to meet acceptance standards shall be corrected as directed by the Engineer and at the Contractor's expense.

The testing will be conducted by State forces.

Evaluating Friction Resistance

The epoxy concrete overlay will be tested with a locked wheel friction tester in accordance with ASTM E 274. The friction number shall be a minimum of 50 (SN) for all tests. Those areas requiring repair to meet the acceptance standard shall be corrected as directed by the Engineer and at the Contractor's expense.

The testing will be conducted by State forces.

Evaluating Bond Strength

The epoxy concrete overlay will be tested for bond strength to the bridge deck surface by the Engineer. The bond strength will be a minimum of 350 psi or failure in the bridge deck Portland cement concrete. Those areas requiring repair to meet the acceptance standards shall be corrected as directed by the Engineer and at the Contractor's expense.

The testing will be conducted by State forces.

APPROACH SLAB JOINT MODIFICATION

As detailed and where shown in the plans, the expansion joints at both ends of the existing approach slabs shall be extended thru the latex modified concrete overlay. The Contractor shall have the option to furnish and install poured rubber joint sealer in lieu of 1/2" premolded joint filler. The method of forming the joint without use of the 1/2" joint filler must be approved by the engineer.

The unit contract price per linear foot for "Approach Slab Joint Modification" shall be full pay for furnishing all labor, tools, materials and equipment necessary to complete the work as specified.

EXISTING TRANSFLEX EXPANSION JOINTS

At Bridge 90/154 S and 90/154 N (Yakima River) the Contractor shall remove the existng transflex expansion joints prior to removing

APPENDIX B

CONTRACT RECORDS

PS&E JOB NO: 84E179
CONTRACT NO: 002857
WORK ORDER#: 0L7556

* * * BID TABULATION * * *

BIDS OPENED ON JANUARY 23, 1985 AT TEN AM
AWARDED ON FEBRUARY 08, 1985

HWY: SR 82 AND SR 90
TITLE: BRIDGE DECK REPAIRS

PROJECT: IR -82- 1(61) IR-82-1(61) IR-90-2(148)
LENGTH: 0 MILES
COUNTY(S): KITTITAS

ITEM NO.	ITEM DESCRIPTION / EST. QUANTITY	UNIT MEAS	ENGR'S. EST. PRICE PER UNIT/ TOTAL AMOUNT	LOW BIDDER: BUTLER-SEALANT COMPANY, 11525 E. MARGINAL WAY SOU, SEATTLE WA 98168 — PRICE PER UNIT/ TOTAL AMOUNT	2ND BIDDER: DAVID A. MOWAT COMPANY, P.O. BOX 1201, BELLEVUE WA 98009 — PRICE PER UNIT/ TOTAL AMOUNT	3RD BIDDER: HAMILTON CONSTRUCTION CO., P.O. BOX 659, SPRINGFIELD OR 97477 — PRICE PER UNIT/ TOTAL AMOUNT
13	BRIDGE DECK REPAIR 205.00	C.F.	120.00 24,600.00	90.00 18,450.00	125.00 25,625.00	90.00 18,450.00
14	BRIDGE DECK SCARIFYING 11,266.00	S.Y.	5.00 56,330.00	7.20 81,115.20	8.50 95,761.00	4.50 50,697.00
15	FURTHER DECK PREPARATION 58,275.00	EST.	58,275.00	58,275.00	58,275.00	58,275.00
16	LATEX MODIFIED CONCRETE OVERLAY 21,284.00	C.F.	20.00 425,680.00	6.00 127,704.00	6.00 127,704.00	9.25 196,877.00
17	LIGHTWEIGHT EPOXY CONCRETE OVERLAY 2,425.00	S.Y.	110.00 266,750.00	82.00 198,850.00	76.00 184,300.00	76.00 184,300.00
18	FINISHING AND CURING LATEX MODIFIED CONCRETE OVERLAY 11,824.00	S.Y.	5.00 59,120.00	7.00 82,768.00	18.00 212,832.00	13.50 159,624.00
19	APPROACH SLAB JOINT MODIFICATION 716.00	L.F.	7.50 5,370.00	3.00 2,148.00	2.00 1,432.00	8.00 5,728.00
20	REMOVING AND RESETTING EXPANSION JOINT 120.00	L.F.	50.00 6,000.00	20.00 2,400.00	18.00 2,160.00	35.00 4,200.00
21	CONCRETE OVERLAY INSET 560.00	S.Y.	5.00 2,800.00	8.00 4,480.00	8.00 4,480.00	15.00 8,400.00
	LIQUID ASPHALT					
22	ANTI-STRIPPING ADDITIVE 130.00	EST.	130.00	130.00	130.00	130.00
	CEMENT CONCRETE PAVEMENT					
23	CEMENT CONCRETE PAVEMENT 3 DAY 0.75 FT. SECTION 325.00	S.Y.	40.00 13,000.00	65.00 21,125.00	14.00 4,550.00	35.00 11,375.00
24	SPECIAL CONCRETE CLASS A FOR BRIDGE APPROACH SLAB 106.00	C.Y.	150.00 15,900.00	250.00 26,500.00	140.00 14,840.00	100.00 10,600.00
25	EPOXY-COATED STEEL REINF. BAR FOR CEMENT CONC. PAVEMENT 21,200.00	LB.	.70 14,840.00	.83 17,596.00	.50 10,600.00	.40 8,480.00
26	EPOXY-COATED TIE BAR 127.00	EACH	2.50 317.50	5.00 635.00	3.00 381.00	7.00 889.00

* * * BID TABULATION * * *

BIDS OPENED ON JANUARY 23, 1985 AT TEN AM
AWARDED ON FEBRUARY 08, 1985

PS&E JOB NO: 84E179
CONTRACT NO: 002857
WORK ORDER#: OL7556

HWY: SR 82 AND SR 90
TITLE: BRIDGE DECK REPAIRS

PROJECT: IR -82- 1(61) IR-82-1(61) IR-90-2(148)
LENGTH: 0 MILES
COUNTY(S): KITTITAS

ITEM NO.	ITEM DESCRIPTION / EST. QUANTITY	UNIT MEAS	ENGR'S EST PRICE PER UNIT/ TOTAL AMOUNT	LOW BIDDER: BUTLER-SEALANT COMPANY, 11525 E. MARGINAL WAY SOU, SEATTLE WA 98168 — PRICE PER UNIT/ TOTAL AMOUNT	2ND BIDDER: DAVID A. MOWAT COMPANY, P.O. BOX 1201, BELLEVUE WA 98009 — PRICE PER UNIT/ TOTAL AMOUNT	3RD BIDDER: HAMILTON CONSTRUCTION CO., P.O. BOX 659, SPRINGFIELD OR 97477 — PRICE PER UNIT/ TOTAL AMOUNT
13	BRIDGE DECK REPAIR 205.00	C.F.	120.00 / 24,600.00	90.00 / 18,450.00	125.00 / 25,625.00	90.00 / 18,450.00
14	BRIDGE DECK SCARIFYING 11,266.00	S.Y.	5.00 / 56,330.00	7.20 / 81,115.20	8.50 / 95,761.00	4.50 / 50,697.00
15	FURTHER DECK PREPARATION 58,275.00	EST.	58,275.00	58,275.00	58,275.00	58,275.00
16	LATEX MODIFIED CONCRETE OVERLAY 21,284.00	C.F.	20.00 / 425,680.00	6.00 / 127,704.00	6.00 / 127,704.00	9.25 / 196,877.00
17	LIGHTWEIGHT EPOXY CONCRETE OVERLAY 2,425.00	S.Y.	110.00 / 266,750.00	82.00 / 198,850.00	76.00 / 184,300.00	76.00 / 184,300.00
18	FINISHING AND CURING LATEX MODIFIED CONCRETE OVERLAY 11,824.00	S.Y.	5.00 / 59,120.00	7.00 / 82,768.00	18.00 / 212,832.00	13.50 / 159,624.00
19	APPROACH SLAB JOINT MODIFICATION 716.00	L.F.	7.50 / 5,370.00	3.00 / 2,148.00	2.00 / 1,432.00	8.00 / 5,728.00
20	REMOVING AND RESETTING EXPANSION JOINT 120.00	L.F.	50.00 / 6,000.00	20.00 / 2,400.00	18.00 / 2,160.00	35.00 / 4,200.00
21	CONCRETE OVERLAY INSET 560.00	S.Y.	5.00 / 2,800.00	8.00 / 4,480.00	8.00 / 4,480.00	15.00 / 8,400.00
	LIQUID ASPHALT					
22	ANTI-STRIPPING ADDITIVE 130.00	EST.	130.00	130.00	130.00	130.00
	CEMENT CONCRETE PAVEMENT					
23	CEMENT CONCRETE PAVEMENT 3 DAY 0.75 FT. SECTION 325.00	S.Y.	40.00 / 13,000.00	65.00 / 21,125.00	14.00 / 4,550.00	35.00 / 11,375.00
24	SPECIAL CONCRETE CLASS A FOR BRIDGE APPROACH SLAB 106.00	C.Y.	150.00 / 15,900.00	250.00 / 26,500.00	140.00 / 14,840.00	100.00 / 10,600.00
25	EPOXY-COATED STEEL REINF. BAR FOR CEMENT CONC. PAVEMENT 21,200.00	LB.	.70 / 14,840.00	.83 / 17,596.00	.50 / 10,600.00	.40 / 8,480.00
26	EPOXY-COATED TIE BAR 127.00	EACH	2.50 / 317.50	5.00 / 635.00	3.00 / 381.00	7.00 / 889.00

WASHINGTON STATE
DEPARTMENT OF TRANSPORTATION

REQUEST FOR . OVAL OF MATERIAL SOURCES

45305

SEE REVERSE FOR INSTRUCTIONS

Date April 1, 1985

Contr. No. 2857 F.A. No. IR-82-1(61) City/County or S.R. No. 82 and 90

Section BRIDGE DECK REPAIRS

Item No.	DESCRIPTION OF MATERIAL	SOURCES OF SUPPLY: Local Supplier	SOURCES OF SUPPLY: Manufacturer's Brand or Pit No.	Approval Action
7	Epoxy Mortar Binder	Dural International	Flexolith	✓
	Aggregate	Manufacturer's Mineral Company	Pit No.: B-1	✓

Dept. of Trans
District 5
REC'D APR 8 '85
PROJ ENGR
ASST
LOC
FIELD
OFFICE

Contractor: Butler-Sealant Company

Submitted by: [signature]

I, [signature] Project Engineer, have reviewed all items above for conformance to contract specifications and requirements and (X) recommend approval as these items conform thereto ( ) do not concur (Attach comments).

ANY ITEMS FOR WHICH APPROVAL IS BEING SOUGHT AS EQUIVALENT TO A SPECIFIED MATERIAL OR PRODUCT HAVE BEEN CIRCLED. ITEMS FULFILLING A SPECIFICATION OTHER THAN THE APPLICABLE STANDARD SPECIFICATIONS AS AMENDED HAVE BEEN UNDERLINED.

DEPARTMENT OF TRANSPORTATION MATERIALS LABORATORY USE ONLY

Sources of supply for all items checked (✓) in approval column are approved for use on the above improvement provided the materials delivered comply with all specifications.

Action on items indicated by number in the approval column is identified per the following code:

- Source Approved. Approval for Change of Source must be secured from the Headquarters Materials Engineer per Chapter 3-1.7 of the Construction Manual.
- Approval withheld; submit samples for preliminary evaluation.
- Approval withheld; submit brand name, name of manufacturer, or treating plant.
- Approval withheld; suibmit Transportation Department pit number (if known) and legal description.
- Approval withheld; please submit catalog cuts and/or shop drawings.
- Approval withheld;
- Source Approved: Acceptance of Materials for project use is to be conditional upon certification of either 100 percent American manufacture or identification of foreign manufacture and materials cost within the permissible limits for the project (See Special Provisions).

APR 12 1985
MATERIALS

X Dist. Admin. 5 Reviewed by CB

X Matls Engr. 5 Phone No. 8 2343183

Engr. Couture

Insp Office X

Project Engineer will submit control samples of materials as covered in Construction Manual, Chapter 9.

Materials Engineer

Date 4/24/85 By [signature]

WASHINGTON STATE
DEPARTMENT OF TRANSPORTATION

REQUEST FOR APPROVAL OF MATERIAL SOURCES

45287

SEE REVERSE FOR INSTRUCTIONS

Date March 22, 1985

...t. No. 2857 F.A. No. IR-82-1(61) & IR-90-2(148) City/County or S.R. No. 82 and 90

...ction Bridge Deck Repair Kittitas County

Bid Item No.	DESCRIPTION OF MATERIAL	SOURCES OF SUPPLY: Local Supplier	SOURCES OF SUPPLY: Manufacturer's Brand or Pit No.	Approval Action *
..3	Grout	C.R. Watts	Set 45	✓
	or			
..,15	Calcium Aluminate Cement	Pioneer Const. Materials	Lone Star LaFarge 'Fondu'	✓
	Aggregates	Ellensburg Cement	Pit No. S64	✓
	Air Entrainment	Great Western Chemical	Azcon AES101	✓

Dept. of Trans District 5 REC'D MAR 27 '85 PROJ ENGR / ASST ... / OFFICE EN... / LOC ENGR / FIELD ... / OFFICE ASST

Contractor: BUTLER-SEALANT COMPANY Submitted by: [signature]

I, [signature] Project Engineer, have reviewed all items above for conformance to contract specifications and requirements and (X) recommend approval as these items conform thereto ( ) do not concur (Attach comments).

ANY ITEMS FOR WHICH APPROVAL IS BEING SOUGHT AS EQUIVALENT TO A SPECIFIED MATERIAL OR PRODUCT HAVE BEEN CIRCLED. ITEMS FULFILLING A SPECIFICATION OTHER THAN THE APPLICABLE STANDARD SPECIFICATIONS AS AMENDED HAVE BEEN UNDERLINED.

DEPARTMENT OF TRANSPORTATION MATERIALS LABORATORY USE ONLY

Sources of supply for all items checked (✓) in approval column are approved for use on the above improvement provided the materials delivered comply with all specifications.

...tion on items indicated by number in the approval column is identified per the following code:

Source Approved. Approval for Change of Source must be secured from the Headquarters Materials Engineer per Chapter 3-1.7 of the Construction Manual.
Approval withheld; submit samples for preliminary evaluation.
Approval withheld; submit brand name, name of manufacturer, or treating plant.
Approval withheld; submit Transportation Department pit number (if known) and legal description.
Approval withheld; please submit catalog cuts and/or shop drawings.
Approval withheld;
Source Approved: Acceptance of Materials for project use is to be conditional upon certification of either 100 percent American manufacture or identification of foreign manufacture and materials cost within the permissible limits for the project (See Special Provisions).

APR 10 1985 ... MATERIALS

File X Dist. Admin. S Reviewed by [signature] Project Engineer will submit control samples of materials
... X Matls Engr S Phone No. 234 2183 as covered in Construction Manual, Chapter 9.
... Contrac
... Shop Office X

Materials Engineer

Date 4/17/85 By [signature]

FORM 350-071 ... 6/82 ... 574-

DISTRIBUTION: WHITE—Headquarter's Materials Lab; CANARY—Contractor; PINK—District Administrator; GOLDENROD—Project Engineer

ORIGINAL

Sheet 1 of 2

Date 9-5-85

WASHINGTON STATE
DEPARTMENT OF TRANSPORTATION

CHANGE ORDER

OCT 31 '85

NOV 25 1985

Change Order Number 14

[ ] Ordered by Engineer under terms of Section 1-04.4 of the Standard Specifications

[ ] Change proposed by Contractor

Endorsed by: Butler - Sealant
Contractor Firm Name

Signature: [signature] Date: 10/29/85

Title: V. Pres.

Consent given by Surety: (when required)

By: ______ Attorney-in-fact ______ Date

Contract No. 2857

To: Butler - Sealant
11525 E. Marginal Way South
Seattle, WA 98168

Sign Route: SR 82 & 90

Federal Aid No: IR-82-1(61) & IR-90-2(148)

Project Title: Bridge Deck Repairs

DESCRIPTION OF WORK

You are ordered to perform the following described work upon receipt of an approved copy of this change order:

A price adjustment shall be granted to the State by the Contractor for placing Lightweight Epoxy Concrete Overlay containing aggregate which did not meet the Gradation Specification. The price adjustment is based on 58.3% of the invoice cost of the aggregate shipped on 4-22-85 and 19.2% of the invoice cost of the aggregate shipped on 4-25-85 and 4-30-85.

A new lump sum item, "Non-Spec Epoxy Overlay - Credit" in the amount of -$1,559.72 shall convey the credit to the State.

All work, materials and measurement to be in accordance with the provisions of the Standard Specifications and Special Provisions for the type of construction involved.

[ ] DISTRICT APPROVAL REQUIRED / [X] HEADQUARTERS APPROVAL REQUIRED	ORIGINAL CONTRACT AMOUNT	CURRENT CONTRACT AMOUNT	ESTIMATED NET CHANGE THIS ORDER	ESTIMATED CONTRACT TOTAL AFTER CHANGE
	$1,036,878.20	$1,204,119.20	$ -1,559.72	$ 1,202,559.48

DISTRICT USE

APPROVAL RECOMMENDED: [signature] 11/4/85
Project Engineer — Date

[ ] APPROVAL RECOMMENDED [ ] APPROVED

District Administrator: C.W. Beeman

By: Thomas E. Lyon Date 11-22-85

HEADQUARTER'S USE

APPROVED: [signature] 11.25.85
for Highway Construction Engineer — Date

[signature]

FORM 421-003

ORIGINAL

NOV 15 '85

SHEET 1 OF 2

DATE 10-31-85

WASHINGTON STATE
DEPARTMENT OF TRANSPORTATION

CHANGE ORDER

DEC 4 1985

CHANGE ORDER NUMBER 16

[X] ORDERED BY ENGINEER UNDER TERMS OF SECTION 1-04.4 OF THE STANDARD SPECIFICATIONS

[ ] CHANGE PROPOSED BY CONTRACTOR

CONTRACT NO. 2857

TO Butler - Sealant
11525 E. Marginal Way South
Seattle, WA 98168

ENDORSED BY: Butler - Sealant
Contractor Firm Name

[signature] 11/8/85
Signature Date

TITLE V. Pres.

Consent given by Surety: (When required)

BY: ____________ ____________
Attorney-in-fact Date

SIGN ROUTE SR 82 & 90
FEDERAL AID NO. IR-82-1(61) & IR-90-2(148)
PROJECT TITLE Bridge Deck Repairs

DESCRIPTION OF WORK

YOU ARE ORDERED TO PERFORM THE FOLLOWING DESCRIBED WORK UPON RECEIPT OF AN APPROVED COPY OF THIS CHANGE ORDER:

A price adjustment shall be granted to the State by the Contractor for placing Lightweight Epoxy Concrete Overlay which failed to meet the surface smoothness specifications which prohibit irregularities in the completed surface which vary by more than 1/8 inch as measured with a 10 foot straight-edge.

For each single traffic lane 100 feet in length in which such deviations occur a penalty of $500.00 shall be assessed. Six (6) such areas exist. Therefore, the total penalty equals 6 x $500.00 = $3,000.00.

A new lump sum item "Epoxy Overlay Smoothness - Credit" shall convey this $3,000.00 credit to the State.

ALL WORK, MATERIALS AND MEASUREMENTS TO BE IN ACCORDANCE WITH THE PROVISIONS OF THE STANDARD SPECIFICATIONS AND SPECIAL PROVISIONS FOR THE TYPE OF CONSTRUCTION INVOLVED.

	ORIGINAL CONTRACT AMOUNT	CURRENT CONTRACT AMOUNT	ESTIMATED NET CHANGE THIS ORDER	ESTIMATED CONTRACT TOTAL AFTER CHANGE
[ ] DISTRICT APPROVAL REQUIRED [ ] HEADQUARTERS APPROVAL REQUIRED	$ 1,036,878.20	$1,212,659.48	$ -3,000.00	$1,209,659.48

DISTRICT USE

APPROVAL RECOMMENDED
[signature] 11/18/85
Project Engineer Date

[ ] APPROVAL RECOMMENDED [ ] APPROVED:
DISTRICT ADMINISTRATOR C. W. Beeman
BY: James Burns DATE: 11-27-85

HEADQUARTER'S USE

APPROVED:
[signature] 12.4.85
For Highway Construction Engineer Date

FORM 421 003
REVISED 9/79

APPENDIX C

EXPERIMENTAL FEATURE WORK PLAN

RESEARCH PROPOSAL

September 5, 1984

FLEXOLITH OVERLAY

PROPOSED TO

WASHINGTON STATE DEPARTMENT OF TRANSPORTATION

by

A. J. PETERS, MATERIALS ENGINEERS

K. W. ANDERSON, RESEARCH SPECIALIST

DEPARTMENT OF TRANSPORTATION

Work Plan

for

Experimental Project

"Flexolith Overlay"

OBJECTIVE

To place an experimental installation of Flexolith epoxy overlay on a bridge on I-82 between Ellensburg and Yakima. The existing bridge is showing some delaminations and has chloride contents between 0.20 and 6.09 lbs/yd^3 with 11 out of the 28 samples over the 2.00 lbs/yd^3 threshold limit. The epoxy overlay was selected because no additional dead load could be tolerated on the bridge which has a reinforced, three inch PCC overlay placed during construction of the bridge. The overlay will serve as a waterproofing membrane and as a skid resistance driving surface.

DESCRIPTION

The subject bridge is 82/10S, SR-821 OC-Thrall Road, located about 4 miles south of Ellensburg on I-82. The deck is 53 ft wide and 357 ft long for a total of 18,921 sq ft or approximately 2,100 sq yds.

This project will consist of the repair of all delaminated deck areas with epoxy mortar and the application of the two layer epoxy-aggregate overlay. The epoxy mortar patching compound and the epoxy-aggregate overlay will be FLEXOLITH, manufactured by Dural International located in Deer Park, New York. FLEXOLITH was chosen over other light-weight overlay systems on the basis of its successful application in other states, principally, New York, and on the desired goal of trying all of the most promising systems of this type. Two other light-weight membrane overlay systems METABOND and FLEX-O-GRID were installed this past construction season on bridges in the State.

MEASUREMENTS AND OBSERVATIONS

The subject bridge will be carefully surveyed prior to construction to provide base line data for future monitoring. Half-cell corrosion potential testing and rebar depth measurements will be performed to supplement the chloride content and delamination information already gathered for the bridge. A permanent ground wire connection to the rebar system will be established for future monitoring purposes.

The application of the FLEXOLITH overlay will be closely monitored and documented during construction. Electrical resistivity measurements to test for waterproofing effectiveness will be conducted immediately following construction and at the intervals outlined in Appendix A for the remainder of the ten year study period. Friction resistance measurements will be taken immediately following overlay placement and at one month intervals for the first six months of the study and at year intervals for the remainder of the study period. Visual observations, which will include a photographic record of any problems that occur, will be conducted at the same time as the electrical resistivity testing.

The principle investigator for this project will be the Materials Engineer and his staff with assistance from the District 5 Project Engineer assigned to the construction contract.

REPORTS

A short post-construction report covering methods, equipment, materials and preliminary measurements and observations will be published within 90 days of the completion of the overlay. Letter reports and Form 1461's will be issued at one-year intervals and a final report will be prepared within 90 days of the end of the ten year study period.

EQUIPMENT

Cox and Sons Friction Tester

Half-Cell Test Apparatus

Resistivity Test Apparatus

Rebar Depth Meter

Concrete Coring Machine

Vehicles

35mm Camera

ESTIMATE OF COST

The testing and analysis costs are tabulated in Appendix A. The funds for pre-construction and post-construction testing will be provided as part of the construction funding for this contract. The remainder of the required funds will be underwritten by the Headquarters Materials Laboratory.

DELIVERABLES

1. Post-Construction Report
2. Ten Letter Reports (1 Each Year)
3. Ten Form 1461's (1 Each Year)
4. Final Report

APPENDIX A

FLEXOLITH TESTING AND ANALYSIS COSTS

Responsible Unit	Work Item	Pre-Construction	Post-Construction	Year 1	2	3	4	5	6	7	8	9	10	Totals
HQ Mats. Lab	Friction Testing (x hrs) @ $100/hr		(8 hrs) $800	(48 hrs) $4800	(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	$ 7,095
HQ Mats. Lab	Electrical Resistivity (x hrs) @ $108/hr		(14 hrs) 1512	(14 hrs) 1512	(14 hrs) 1663	(14 hrs) 1829		(14 hrs) 2213		(14 hrs) 2677			(14 hrs) 3564	14,97
HQ Mats. Lab	Half-Cell Testing (x hrs) @ $108/hr	(8 hrs) $864												864
HQ Mats. Lab	Rebar Depth (x hrs) @ $108/hr	(8 hrs) $864												864
HQ Mats. Lab	Visual Observation (x hrs) @ $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 Mats. Lab	Analysis & Report Writing (x hrs) @ $27.50/hr		(40 hrs) 1100	(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	(16 hrs) 1036	4,349
	TOTALS	$1728	$3628	$6748	$2253	$2478	$280	$2998	$338	$3627	$409	$451	$5347	$30,28

TOTAL CONTRACT FUNDING $5356

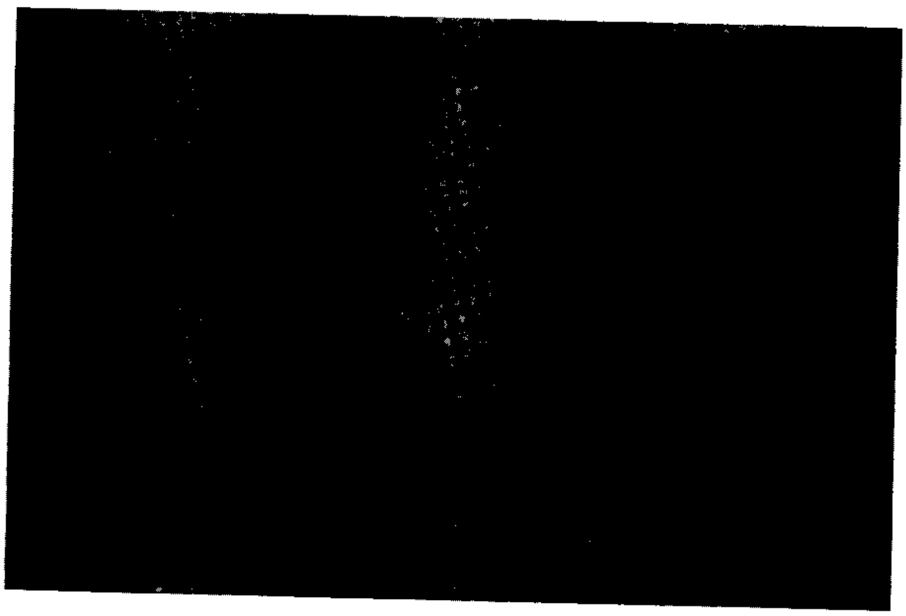
TOTAL H.Q. MATS LAB FUNDING * -5,35 / $24,92

* PS0361 Experimental Projects Evaluation

APPENDIX D

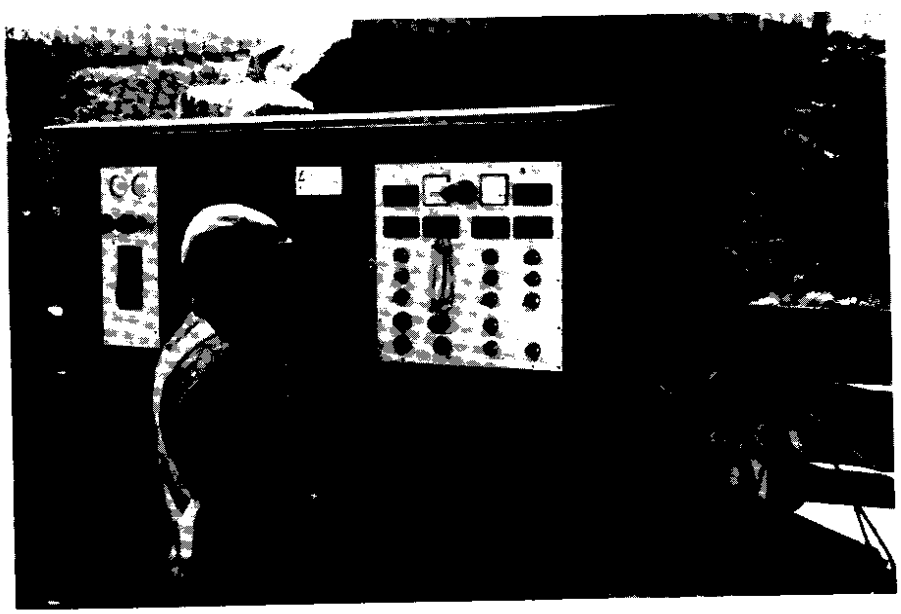
PHOTOGRAPHS

Bridge 82/105 looking north prior to overlay application. Outlined areas are delaminations.



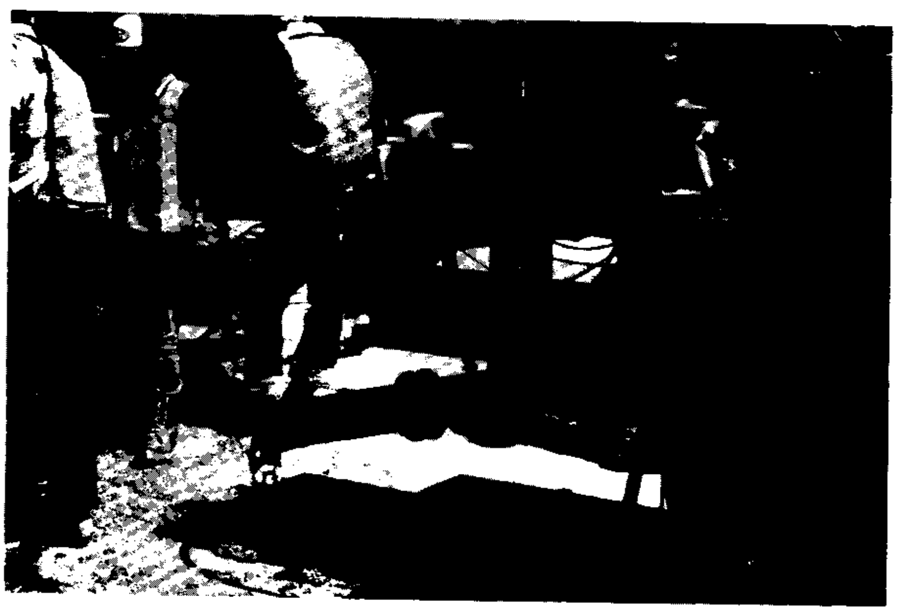
Close up view of shrinkage cracks located in the northern half of the deck.

Insulated storage tanks for epoxy binder components.

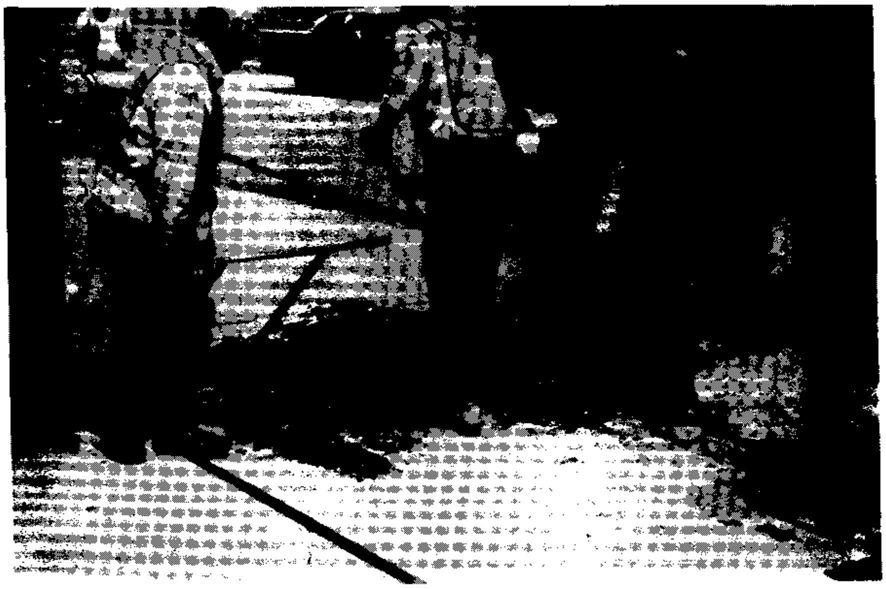


Control panel of special mixing machine.

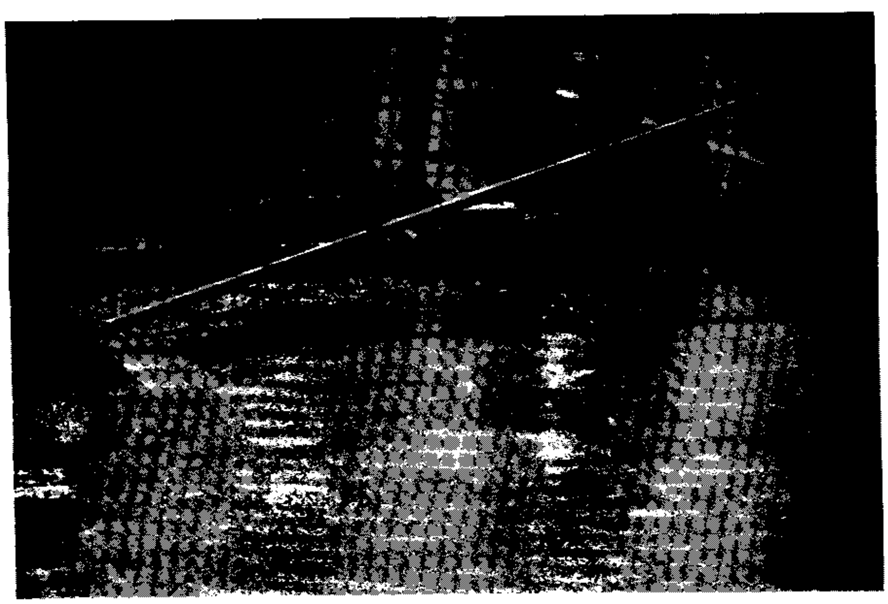
Manual loading of aggregate into the mixing machine.



Discharge of epoxy slurry from the mixing machine. High speed augers are located in the lower section of the discharge tube.



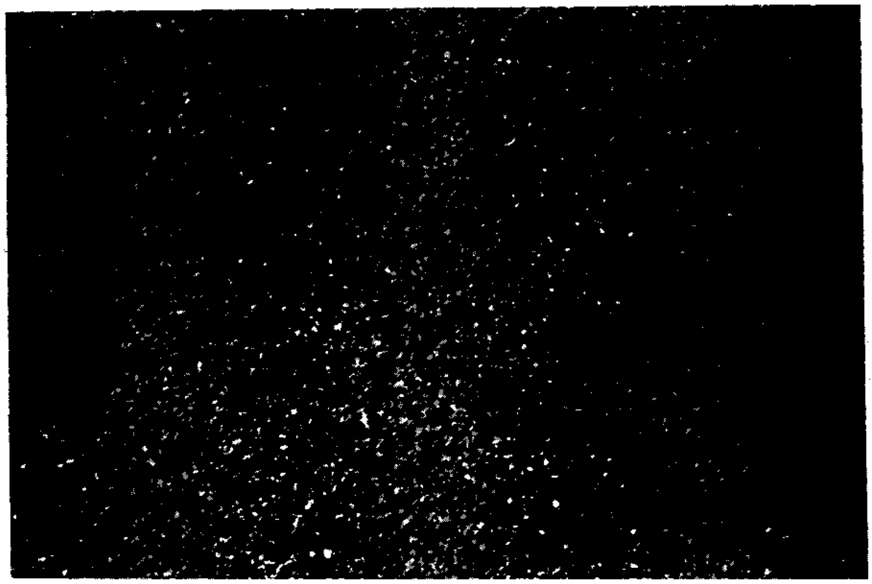
Distribution of slurry mixture in front of screed. Note screed bars on deck and handle for pulling screed.



Bullfloat being used to smooth longitudinal striations behind screed. Note gasoline engines mounted on screed which provide power for vibrators.

Hand troweling to finish edge joint and fill gaps left when screed bars are removed.

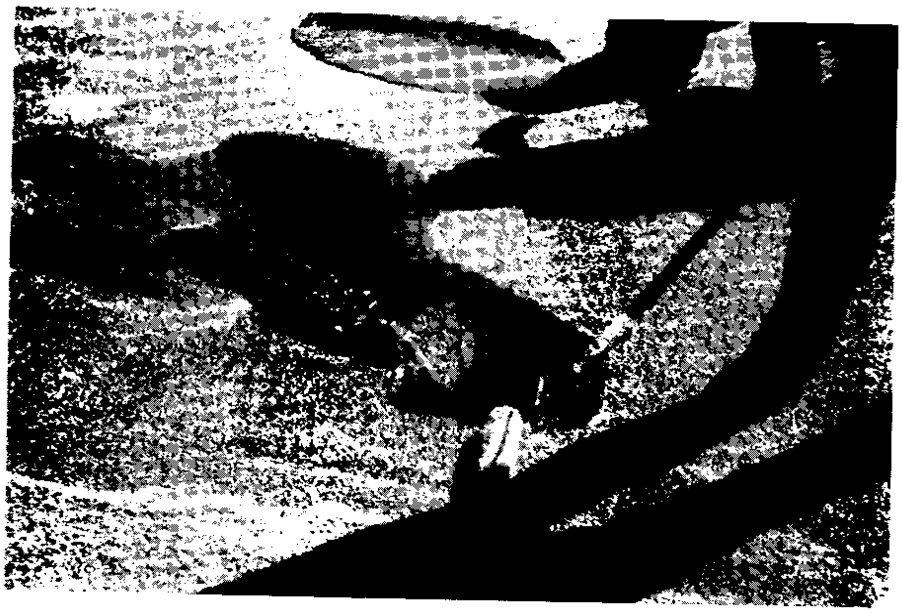
Broadcasting aggregate to provide final non-skid wearing surface.



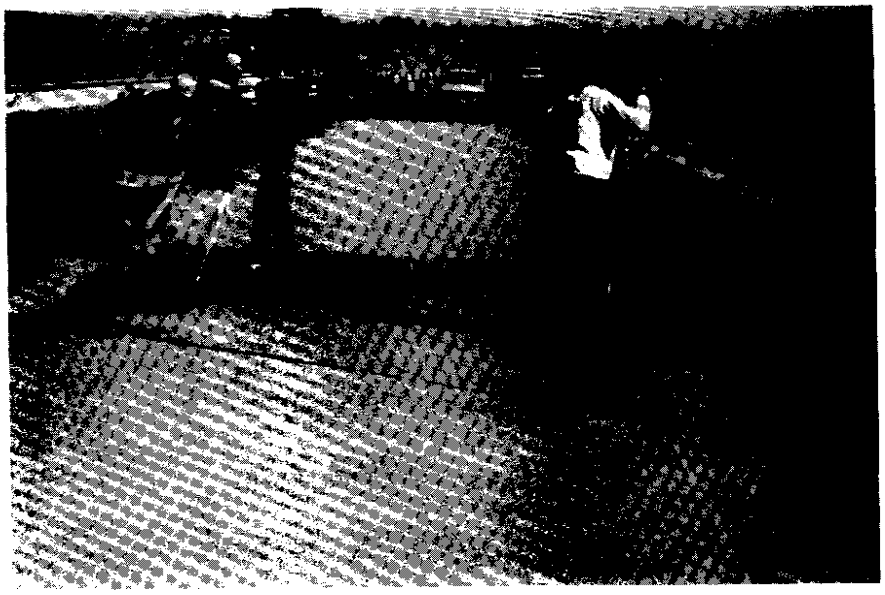
Finished surface texture of overlay.

View looking south at area in passing lane which was overlayed using the broom and seed method.

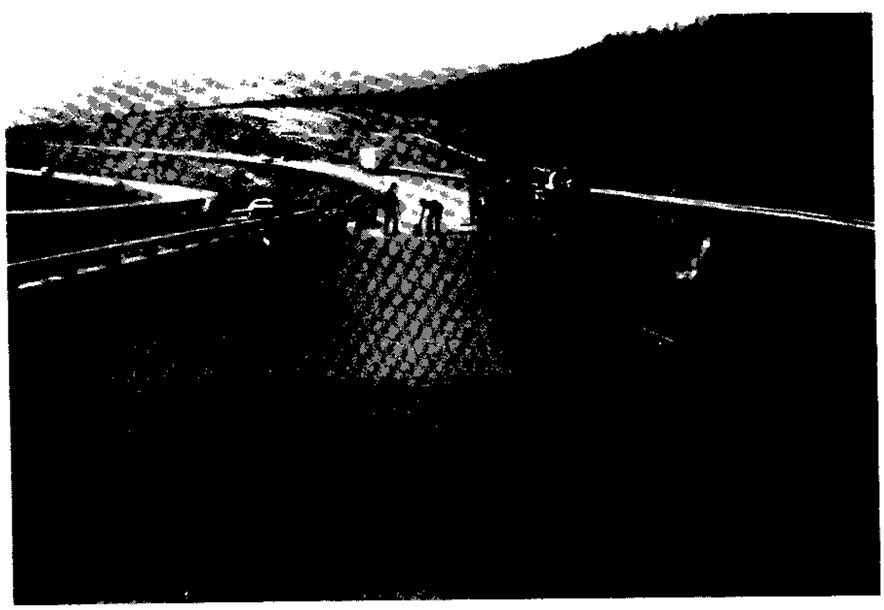
Hand mixing of epoxy binder for broom and seed method.



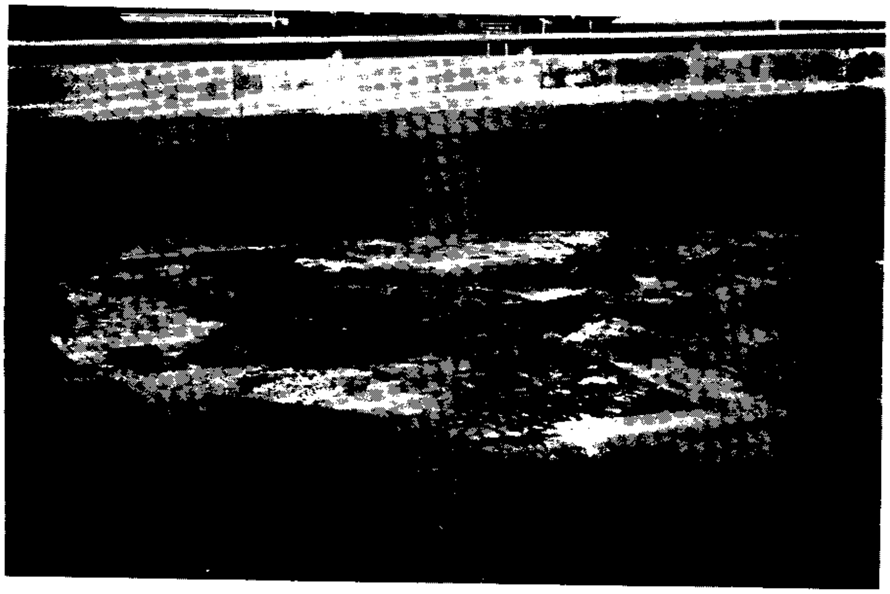
Spreading of the epoxy binder using long handled paint rollers. This is the second layer of three layers applied to the south end of the passing lane.



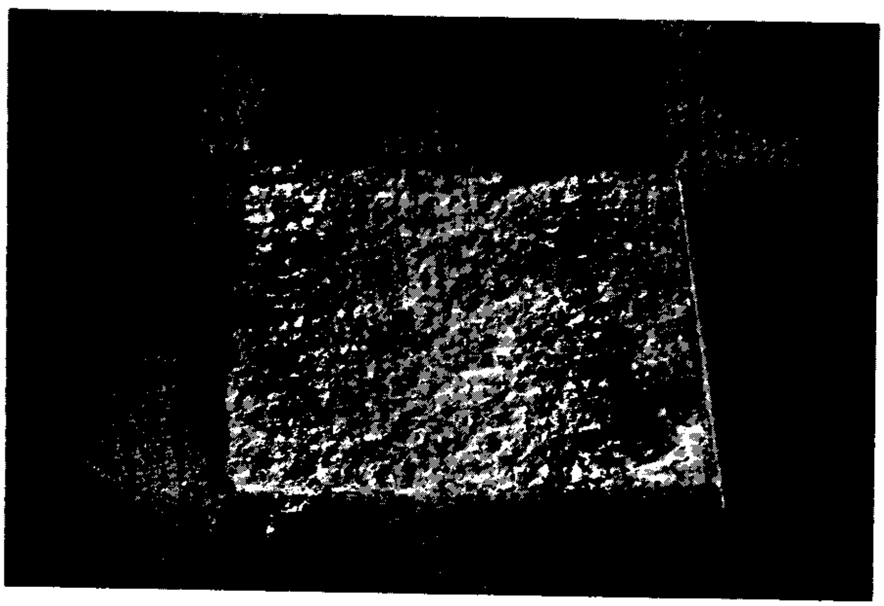
Use of squeegee to distribute epoxy binder. Aggregate is being broadcast onto the binder directly behind roller and squeegee operation.



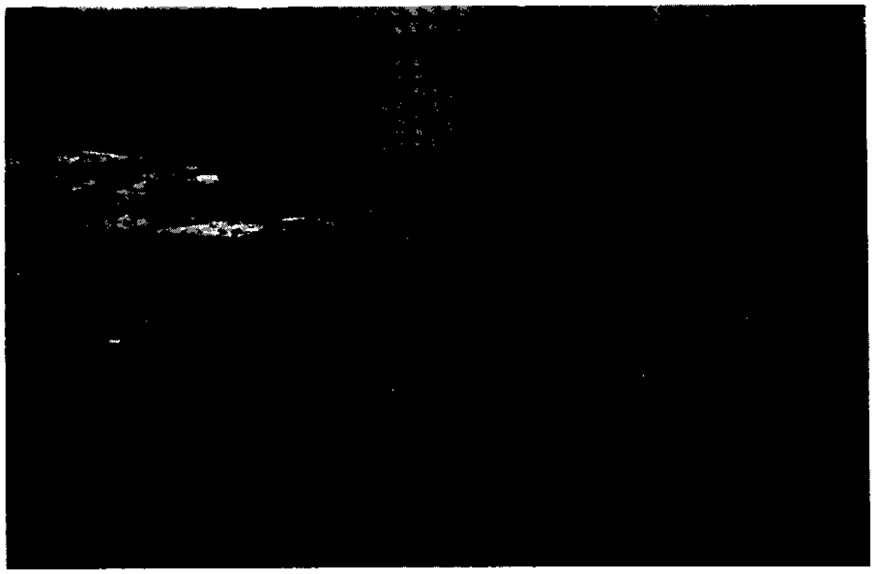
View looking south showing area overlayed using the broom and seed method. Note different appearance of two methods of application.



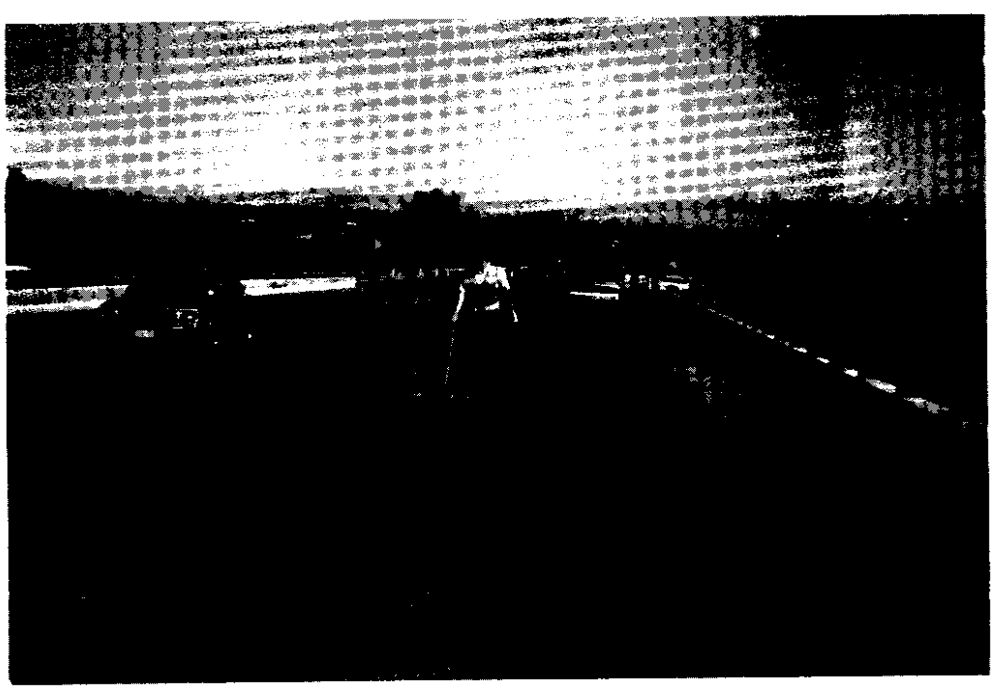
Large delaminated area at north end of driving lane.



One of small delaminated areas removed to inspect bond between overlay and patching material in deck.



The areas outlined exceed the smoothness specification of 1/8 inch.



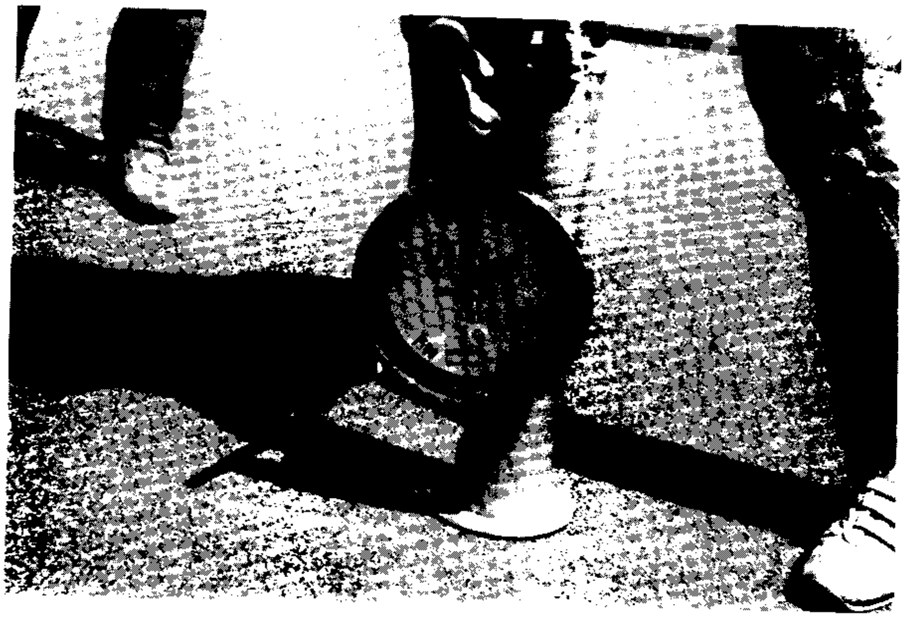
Chain drag apparatus used to detect delaminations.

Coring overlay for pull-off bond test using 2 inch diameter diamond bit.

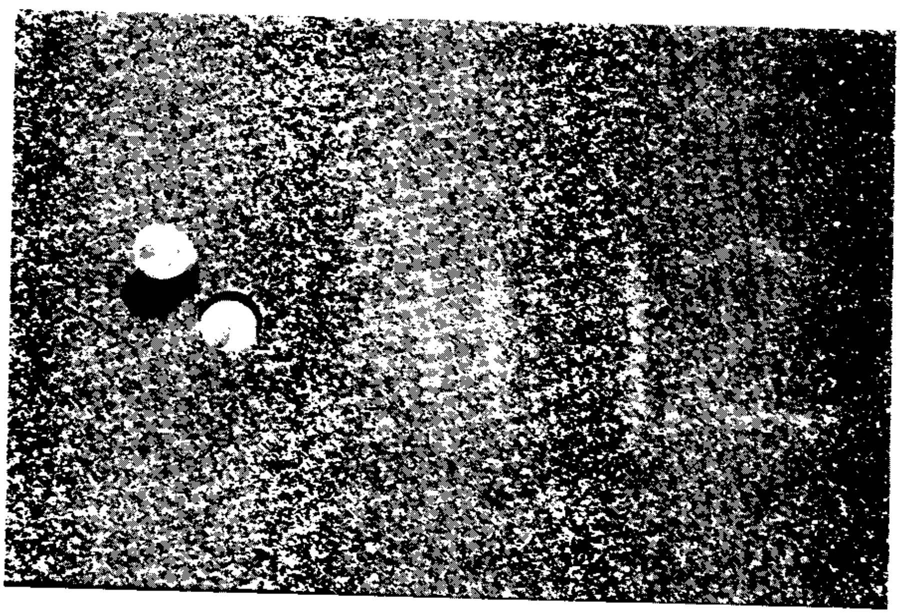
Core island ready for pipe cap and epoxy glue.

Application of epoxy to core island.

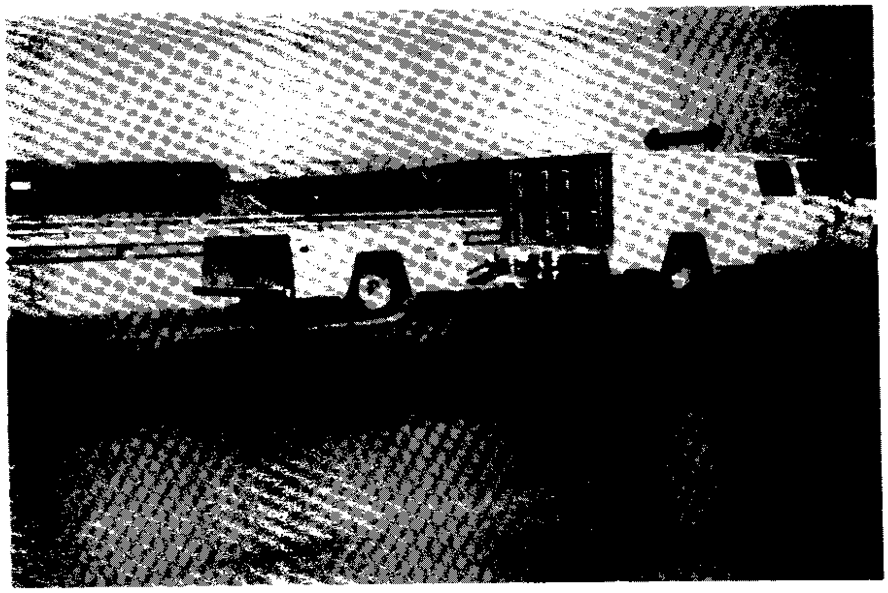
Setting pipe cap.



Bond strength pulling mechanism with dynamometer.



Typical bond test core showing failure plane in deck substrate (note large aggregate).



Friction testing of Flexolith overlay with Cox and Sons CS9000 skid tester.