Bridge No. 5/725 Alger Road Undercrossing
Bridge No. 5/803 Samish Inn Undercrossing
Bridge No. 5/807 South Bellingham Undercrossing

Microsilica Modified Concrete Overlay

WA-RD 245.1

Post Construction and Annual Reports
December 1991

Washington State Department of Transportation

WASHINGTON STATE DEPARTMENT OF TRANSPORTATION

TECHNICAL REPORT STANDARD TITLE PAGE

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

16. ABSTRACT

This project overlayed three existing bridges on SR 5 in Skagit and Whatcom Counties with microsilica modified concrete. The bridges involved were 5/725 Alger Road Undercrossing; 5/803 Samish Inn Undercrossing; and 5/807 South Bellingham Undercrossing.

The minimum overlay thickness was 1-1/2 inches. Superplasticizer was added to the mix. The concrete was mixed in a conventional batch plant, with the technical representative from the microsilica supplier providing assistance. The microsilica modified concrete overlay was finished and cured as prescribed by WSDOT's specification for LMC overlays.

The finished decks exhibited an abnormal number of shrinkage cracks, which had to be sealed. Problems with excessive slump are believed to be the cause of this cracking.

17. KEY WORDS	18. DISTRIBUTION STATEMENT
Bridge deck overlay, concrete additives, bridge deck repairs, microsilica concrete, silica fume	

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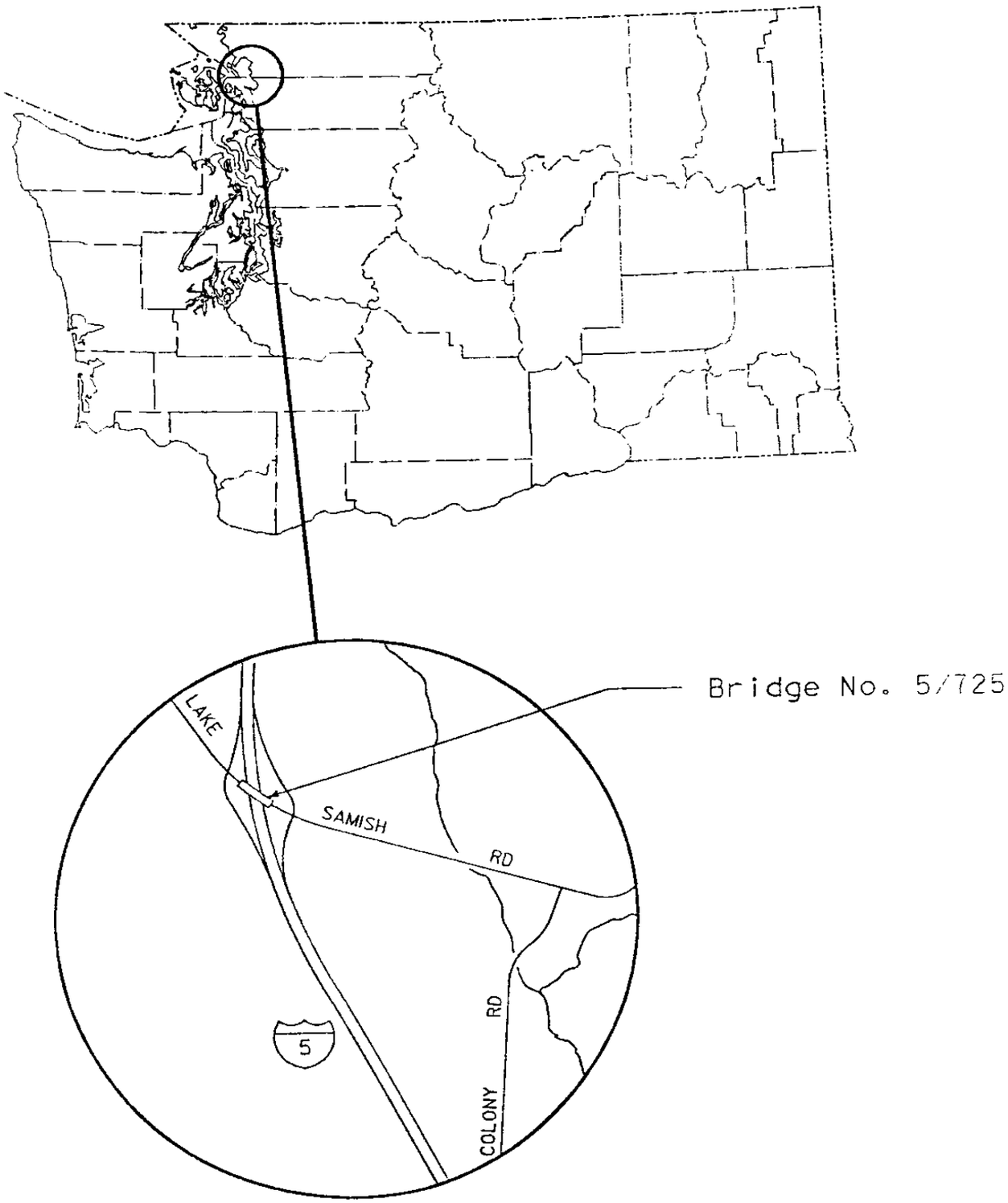
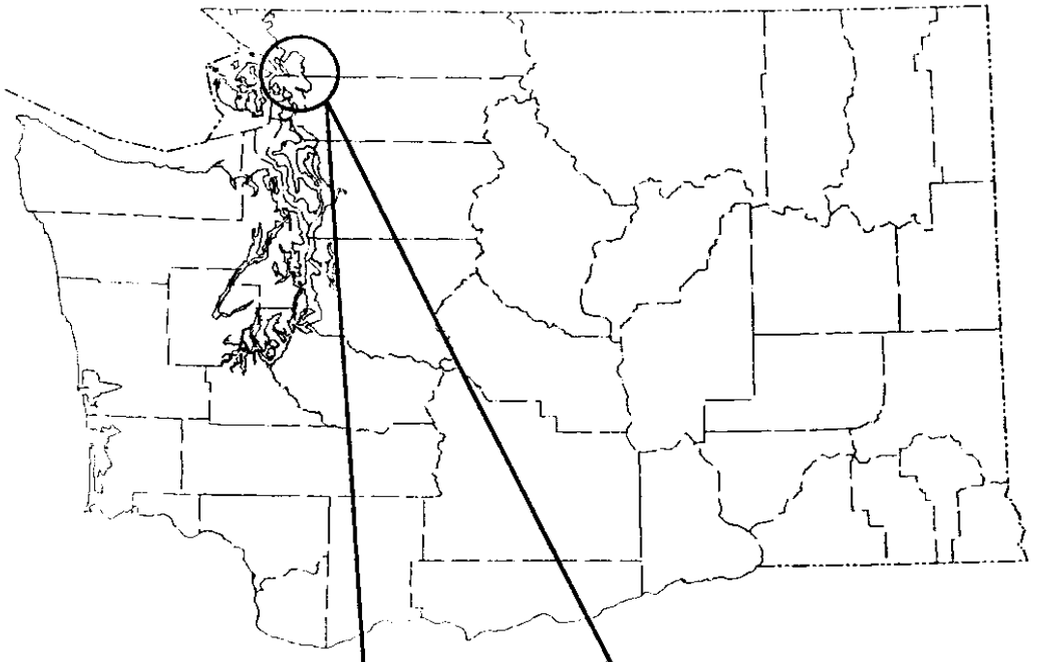


PROJECT SITE

VICINITY MAP



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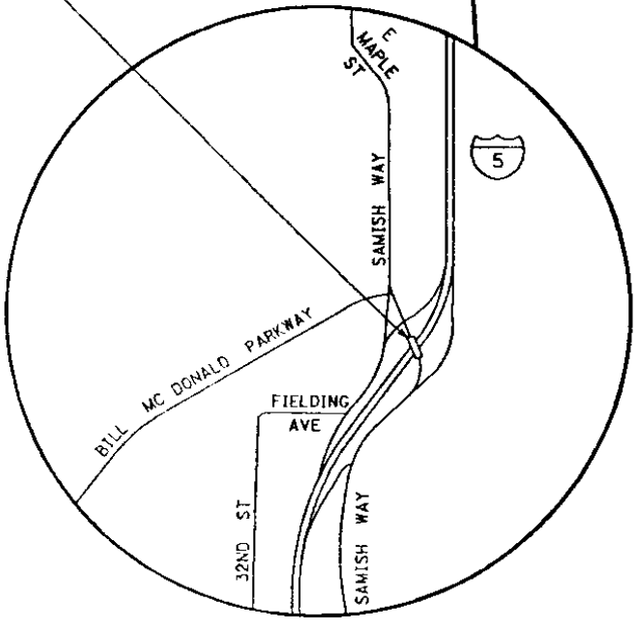

PROJECT SITE

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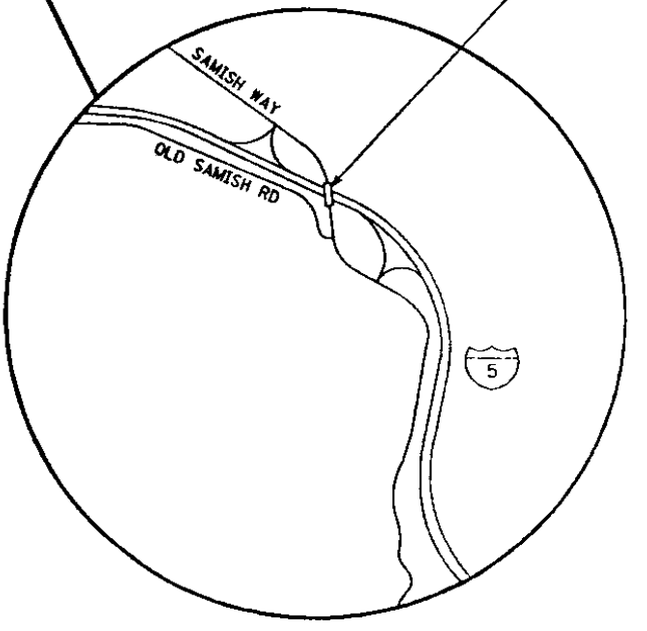

PROJECT SITE

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. Overlays of latex modified concrete (LMC) and asphalt concrete with a waterproof membrane (AC/membrane) are presently being used on existing bridge decks as the primary systems to prevent the intrusion of additional chlorides and moisture. Concrete overlays are more durable than the AC/membrane systems. LMC is used on bridge decks with high traffic volumes and high levels of chloride contamination, and on decks requiring significant rehabilitation. It is estimated that LMC may be used on an additional 700 bridge decks in Washington State over the next 12 to 15 years.

Latex is a relatively expensive concrete additive. The in-place cost is further increased by the special equipment required to construct LMC overlays. Recent studies have confirmed that LMC is more construction sensitive than conventional Portland cement concrete. In view of this, an alternative protective concrete overlay system is desirable. A system that can be mixed, placed, and finished with conventional concrete equipment should be more economical than LMC, and potentially less construction sensitive. Additional cost savings may also be realized by having a comparable system that can be bid competitively with the present LMC overlay system.

In recent years, condensed silica fume, or microsilica, has been added to concrete to obtain high strengths and very low permeability. Microsilica is a byproduct recovered during the

production of ferrosilicon and silicon metal. Microsilica, approximately 100 times finer than Portland cement, fills the voids in the concrete, making it less permeable.

Microsilica is also a highly reactive pozzolan, generally containing more than 85 percent silica. The chemical reaction between silica, water, and calcium hydroxide forms calcium silica hydrate, a major cementitious product similar to that produced by the reaction of Portland cement and water. The normal hydration of Portland cement produces 20 to 25 percent calcium hydroxide. The addition of microsilica to Portland cement and water provides for the formation of additional calcium silica hydrate, thereby improving the strength and durability of the concrete.

The results of laboratory testing indicate that the permeability of concrete containing microsilica is comparable to the permeability of LMC. Compressive strengths have reached as high as 15,000 psi in WSDOT laboratory tests.

Concrete containing microsilica can be produced in any concrete batch plant, and mixed in standard ready-mix trucks. The use of a superplasticizer is recommended with microsilica to provide a workable mix for field placement.

STUDY SITE

This project overlaid three existing bridges on SR 5 in Skagit and Whatcom Counties with 1-1/2 inches of microsilica modified concrete (MMC). The bridges involved were 5/725 Alger Road Undercrossing, 5/803 Samish Inn Undercrossing, and 5/807 South Bellingham Undercrossing. Tabulated below is the pre-overlay condition of each deck.

Bridge No.	Span Type	Deck Area Square Feet	Chloride Contamination*	Delaminations (% of Deck Area)
5/725	PCB	8944	100	33
5/803	PCB	7020	58	10
5/807	C Box	7420	60	18

*Percent of deck area containing more than 2 lbs./cu. yd. of chlorides at the level of the steel reinforcing.

All the bridges are in District No. 1 and were included in the same construction contract, Contract 3418, Samish River to 36th Street Undercrossing.

INSTALLATION PROCEDURES

The existing bridge decks were scarified with a CMI Autograder Model 375 Roto Mill as a first step. Unsound or delaminated concrete was removed with 15 pound air chipping hammers. Two different methods were used to patch the repaired areas. In some cases, the repair areas were patched with cement concrete Class M. In other cases, the repair areas were filled monolithically during placement of the microsilica deck overlay. Prior to placement of the overlays, the decks were sandblasted and flushed clean with water.

The microsilica concrete, furnished by Pacific Concrete of Bellingham, was delivered to the job site in standard ready-mix trucks. The load on each truck was limited by the contract to four cubic yards. This was done to limit the volume of concrete that had to be finished and protected with burlap at any one time. This should have decreased any shrinkage cracking problems caused by rapid surface drying of the concrete. The microsilica, water reducer, and a portion of the recommended dosage of superplasticizer were added at the batch plant.

Additional superplasticizer was added at the bridge site if the workability of the mix was a problem. One representative of the W. R. Grace Company, suppliers of the Force 10,000 microsilica, was present at the plant to give technical advice, and another was at the job site in a similar advisory capacity.

A slump test was performed on each load of concrete prior to its leaving the batch plant. WSDOT inspectors tested each load at the job site for both slump and air content. The contract specified a slump of 5 ± 1 inches, and an air content of 6 ± 1 percent. Copies of the inspector's daily reports, with the slump and air content test results, are included in Appendix B.

Hurlen Construction Company, the prime contractor, used a self propelled Bidwell, equiped with a rotating cylindrical drum screed, to finish the concrete. The fresh concrete was immediately covered with saturated burlap when the finishing and texturing process was completed. The burlap was then covered with white polyethylene sheeting to retain moisture. After 42 hours, the polyethylene sheeting was removed and the burlap again saturated and left to dry for an additional 6 hours before its removal. The table below shows the sequence in which the bridges were completed.

Date	Bridge	
7/18/88	5/807	Right Half
7/21/88	5/725	Right Half
7/26/88	5/807	Right Half
7/29/88	5/807	Left Half
8/04/88	5/803	Right Half
8/18/88	5/725	Left Half
8/24/88	5/803	Left Half

Expansion joint modification, as specified in the plans, was accomplished after the overlay was installed and cured. It was easier to construct the expansion joints after the overlay, and resulted in better grade control.

Checking the overlay for delaminations was done after the expansion joints had been chipped out in preparation for modification, so any delamination caused by the chipping process could be detected and repaired at the same time.

The bid for overlaying with the microsilica modified concrete was $32.00 per square yard.

CONSTRUCTION PROBLEMS

Because the contractor was inexperienced with bridge deck overlays, the state inspector had to train the contractor's supervisors and workers. Consequently, deck repair progressed slowly. The contractor often underestimated preparation time and was not ready when the first load of concrete reached the site. Due to inexperience, the contractor relied heavily on the expertise of the state inspector and W. R. Grace Company representatives for the installation of the microsilica modified concrete overlay. Since the contractor had no one trained to do delamination chaining for deck repair, this was performed by Department inspectors.

When large areas of unsound or delaminated concrete were removed, the exposed rebar mat was difficult to protect from construction equipment. The contractor usually provided plywood sheets to bridge over these areas. Rebar supports were used with some success

to support the mat. This problem should be addressed in the special provisions. Breaking through the deck during deck repairs was a problem. The contract plans did not provide a clearly outlined method of payment for the extra work involved to form the bottom of the deck and for traffic control.

While trying to use the mix design specified in the special provisions, the contractor was unable to produce a mix that was within specifications and workable in the field. The concrete consistently had a 0 to 1 inch slump, and the superplasticizer used to increase the slump was not effective. The W. R. Grace Company representative felt that there was not enough available water for the additives to affect the mix. The contractor asked for, and received, approval to use an eight sack mix, which was used with satisfactory results.

The microsilica modified concrete overlay for Bridge No. 5/807 exhibited an abnormal number of shrinkage cracks. The overlays for Bridges 5/725 and 5/803 also cracked, but not as much. There are no clear reasons for the overlays cracking, but there may have been several contributing factors. At times during the overlay of Bridge No. 5/807, the cement finishers had a difficult time keeping up. The resulting delays in placing the saturated burlap and polyethylene sheeting may have caused some of the cracking. The overlays were all installed during a time of unusually warm weather. Daytime temperatures, often in the high 80s, and relatively warm evening temperatures may have contributed to the cracking. Duratard 40 retarder was used on this contract, and the mix was retarded up to 30 hours. It is possible that some of the cracking of the overlay was associated with the use of this retarder. Also, problems with excessive slump probably contributed heavily to the cracking

ACCEPTANCE TESTING

Mix Design

Specifications require the concrete to be a workable mix, uniform in composition and consistency. Required mix proportions per cubic yard are:

Portland cement	658 pounds
Microsilica fume	52 pounds
Fine aggregate	1540 pounds
Coarse aggregate	1540 pounds
Air	6% ± 1%
Maximum water/cement ratio	0.33 max.

The concrete shall have a slump of 5 ± 1 inches, 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 ± 1 inches. Water reducing admixtures, air entraining admixtures, and superplasticizers were added as recommended by the supplier of the microsilica admixture.

Specifications required the slump to be 5 ± 1 inches and the air content to be 6 ± 1 percent. Variations in these values occurred at the job site. The slump ranged from 1-1/2 to 10 inches. Air content ranged from 3-1/2 to 10 percent.

Post-construction experimental testing (not required by the special provisions) was as follows: Compression strength of the microsilica concrete at 28 days was 12,000 psi. The rapid chloride permeability test showed coulomb values of 227 to 352. Friction numbers were in the acceptable range, from 35 to 54. New Portland cement concrete will typically

be between 40 and 50. Bond values ranged from 95 to 255 psi. All bond tests broke in the old concrete, which made the tests acceptable. Performance evaluation testing over the eight year period will be done on Bridge 5/725 Alger Road Undercrossing only.

CONCLUSIONS AND RECOMMENDATIONS

Having two representatives of the microsilica supplier present during the pours, one at the plant and one on the job site, proved to be very effective. This arrangement should be continued on future projects.

The special provisions required that the concrete loads be limited to 4 cu. yds. per load, and that ready-mix trucks be emptied of all wash water before rebatching. These requirements were found to be desirable and are recommended on future projects.

The problems with the slump and air content need to be resolved by the material supplier.

The following ideas, submitted by the state project inspectors, are for consideration on future bridge deck overlay projects:

1. It is desirable that the paving machine screed have the capacity to lift off the mat.

2. The contractor should be required to submit a plan outlining how the grade will be maintained in those areas not finished by the paving machine.

3. Dry runs should be done at least a few hours prior to pouring; at least before the two hour pre-pour deck soaking period begins.

4. Pre-patching of deck repair areas less than 3/4 inch in depth should not be allowed. Those areas should be poured monolithically. There are potential bonding problems when prepatched areas are very thin.

5. Pressure washing rebar, in lieu of sandblasting, should require a minimum pressure of 5,000 psi. Final acceptance should be made by the inspector.

6. The contractor should submit a plan outlining how the plastic sheeting will be kept in place without damaging the new overlay. There was a problem with knee marks in the new deck and plastic sheets blowing loose.

7. Sequential pour criteria should be specified. This will alert the contractor to the effect on contract time.

8. When cracking occurs in the new overlay, the deck in its entirety should be sealed with an approved sealer. Sealing individual cracks is not effective.

9. The contractor should supply a concrete tester at the concrete plant, so the amount of additive needed can be determined. Technical representatives from the microsilica admixture manufacturer should be required, by special provision, at both the concrete plant and the bridge site. Both the state and the contractor depend on these people to provide an acceptable concrete mix.

10. It is advisable to require an extra sequential arrow sign be available in case of sign failure.

11. Installing the expansion joint modification after the bridge deck overlay assures a better final product.

APPENDIX A

TEST PLAN

EXPERIMENTAL PROJECT
MICROSILICA-MODIFIED CONCRETE FOR BRIDGE DECK OVERLAYS
TESTING AND ANALYSIS COSTS
(Total Costs for One Bridge)

Responsible Unit	Work Item	Pre-Construction	Post Construction	YEAR[1] 1	2	4	6	8	Totals
HQML[2]	Chloride Sampling	(2 hrs) $ 244			(2 hrs) $ 294	(2 hrs) $ 356		(2 hrs) $ 524	$ 1,418
HQML	Chloride Lab Testing	(9 samples) $ 63			(9 samples) $ 76.5	(9 samples) $ 92.5		(9 samples) $ 135.5	$ 367.5
HQML	Half-Cell Testing	(2 hrs) $ 244			(2 hrs) $ 294	(2 hrs) $ 356	(2 hrs) $ 432	(2 hrs) $ 524	$ 1,850
HQML	Bond Testing		(1 hr) $ 122			(1 hr) $ 178		(1 hr) $ 262	$ 562
HQML	Delamination Testing		(1/2 hr) $ 61	(1/2 hr) $ 67	(1/2 hr) $ 73.5	(1/2 hr) $ 89	(1/2 hr) $ 108	(1/2 hr) $ 131	$ 529.5
HQML	Rapid Chloride Perm. Sampling		(2 hrs) $ 244						$ 244
HQML	Rapid Chloride Perm. Lab Testing		(2 samples) $ 330						$ 330
HQML	Air Void Analysis		(2 samples) $ 600						$ 600
HQML	Visual Inspection	(1-1/2 hrs) $ 183	(2 hrs) $ 244	(1/2 hr) $ 67	(1 hr) $ 147		(1 hr) $ 216		$ 857
HQML	Skid Resistance @ $108/hr		(1/2 hr) $ 54	(1/2 hr) $ 59.5	(1/2 hr) $ 65.5	(1/2 hr) $ 79	(1/2 hr) $ 95.5	(1/2 hr) $ 115.5	$ 469
HQML	Travel Time	(2-1/2 hrs) $ 305	(2-1/2 hrs) $ 305	(2-1/2 hrs) $ 335	(2-1/2 hrs) $ 367.5	(2-1/2 hrs) $ 445	(2-1/2 hrs) $ 540	(2-1/2 hrs) $ 655	$ 2,952.5
HQBB[3]	Analysis and Reporting		(20 hrs) $ 550	(4 hrs) $ 121	(4 hrs) $ 133	(10 hrs) $ 402.5	(4 hrs) $ 195	(20 hrs) $1,179	$ 2,580.5
Dist	Traffic Control @ $400/day	(1 day) $ 400	(1 day) $ 400	(1/2 day) $ 220	(1 day) $ 484	(1 day) $ 585.5	(1/2 day) $ 354.5	(1 day) $ 857.5	$ 3,301.5
	TOTALS	$1,439	$2,910	$ 869.5	$1,935	$2,583.5	$1,941	$4,383.5	$16,061.5
TOTAL CONTRACT FUNDING			$4,349						$-4,349
								Total Experimental Feature Funding	$11,712.5

1 10 percent annual inflation rate assumed
2 Headquarters Materials Lab time and equipment at $122/hr
3 Headquarters Bridge Branch time at $27.50/hr

APPENDIX B

TEST RESULTS

INSPECTOR'S DAILY REPORT SUPPLEMENT

Contract No. 3418 Highway 5 Date 7-18/19-88 P.E. J.M. Hayes

Page 1 Of 1

Section (Title) Samish River to 32nd Street Undercrossing

Load No.	Truck No.	Batch Time	Arrival Time	Batch Adjustments			Slump	Air	Discharge Time
				Type	Quantity	Time			
1	20	10:26 p.m.	11:01 p.m.	—	—				Rejected *
2	21	11:02 p.m.	—	Plasticizer	1 gal.		3"	6%	12:15 A.M.
3	20	12:03 A.M.	—	Plasticizer	1⅓ gal.		6½"	5%	12:49 A.M.
4	27	12:52 A.M.	—	Plasticizer	1 gal.		9½"	6½%	1:43 A.M.
5	20	1:23 A.M.	—	—	—		6½"	6½%	2:04 A.M.
6	21	1:52 A.M.	—	Plasticizer	1 gal.		4¾"	5½%	2:40 A.M.
7	20	2:14 A.M.	—	Plasticizer	2 gal.				
				Air	8 oz.		7½"	7%	3:20 A.M.
8	27	2:57 A.M.	—	—	—		3"	6½%	3:54 A.M.
9	20	3:33 A.M.	—	—	—		4"	6½%	4:25 A.M.

Remarks First Load Rejected After Exceeding 1½ Hour Time Limit From 10:26 p.m. Batch Time.

Inspector [signature]

INSPECTOR'S DAILY REPORT SUPPLEMENT

Contract No. 3418 Highway 5 Date 7-21-88 P.E. J.M. Hayes

Section (Title) Samish River to 36th St. Undercrossing (Alaska) Page 1 Of 1

Load No.	Truck No.	Batch Time	Arrival Time	Batch Adjustments			Slump	Air	Discharge Time
				Type	Quantity	Time			
1	29	7:27 pm.	7:57 pm.	—	—	—	7½"	8%	8:05 pm.
2	20	8:05 pm.	8:32 pm.	—	—	—	6½"	7½%	8:38 pm.
3	21	8:37 pm.	9:03 pm.	—	—	—	7½"	7½%	9:07 pm.
4	29	9:10 pm.	9:36 pm.	—	—	—	8"	8%	9:48 pm.

Remarks * ½ cubic yard ± used from 4th load.
No adjustments made to loads @ job site.

Inspector Richard W. Stamm

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INSPECTOR'S DAILY REPORT SUPPLEMENT

Contract No. 4-18 Highway 5 Date 7-26/27-88 P.E. J.M. Hayes Page 1 of 2

Section (Title) Samish River to 36th St. Undercrossing

Load No.	Truck No.	Batch Time	Arrival Time	On Site Batch Adjustments Type	Quantity	Time	Slump	Air	Discharge Time	Cylinders No.	Cylinders Time Made
1	29	9:42 pm	9:58 pm	—	—	—	2½"	4½%			
				Air	12 oz	10:06 pm	2¾"	6½%			
				Superplasticizer	½ gal	10:13 pm	3¾"	4 %			
				Air	12 oz	10:24 pm	3"	3½ %			
				Air	12 oz	10:30 pm	5½"	4 %	10:38 pm	1	10:39 pm
							9¾"	7%			
2	21	10:14 pm	10:35 pm				8¾"	7%			
				Additional Mix Time			7½"	5%	11:10 pm	2	11:12 pm
				Additional Mix Time			9½"	6½%			
3	27	11:16 pm	11:35 pm				9"	4½%			
				Additional Mix Time			8"	6%	11:59 pm	3	12:00 pm
				Additional Mix Time			10"	6%			
4	29	11:42 pm	12:01 pm				9"	6%			
				Additional Mix Time			5½"	6%	12:35 Am	4	12:37 Am
				Additional Mix Time			7"	7½%	12:53 Am	5	12:48 Am
5	21	12:23 Am	12:41 Am								

Remarks

Inspector Roland W. Stowe

INSPECTOR'S DAILY REPORT SUPPLEMENT

Contract No. 3418 Highway 5 Date 7-26/27-88 P.E. J.M. Hoops

Page 2 Of 2

Section (Title) Samish River to 36th St. Undercrossing

Load No.	Truck No.	Batch Time	Arrival Time	On Site Batch Adjustments Type	Quantity	Time	Slump	Air	Discharge Time	Cylinders No.	Cylinders Time Made
6	27	1:08 AM	1:25 AM				7"	7½%	1:33 AM	6	1:35 AM
7	29	1:31 AM	1:47 AM				7"	6½%	1:57 AM	7	1:55 AM
8	21	2:04 AM	2:19 AM				7½"	7%	2:26 AM	8	2:25 AM

Remarks

Inspector Richard M. Stowe

INSPECTOR'S DAILY REPORT SUPPLEMENT

Contract No. 341E Highway 5 Date 7-29/30-68 P.E. J.M. Hayes

Section (Title) Sammish River to 36th St. - Underpasses (Bridge 8/607) Page 1 Of 1

Load No.	Truck No.	Batch Time	Arrival Time	On Site Batch Adjustments Type	Quantity	Time	Slump	Air	Discharge Time	Cylinders No.	Time Made
1	29	9:28 pm	9:49 pm				3"	5%	9:56 pm	1	9:55 pm
2	21	9:52 pm	10:11 pm				1½"	4½%			
				Superplasticisor	2½ gal.	10:15 pm	6½"	4½%	10:22 pm	2	10:25 pm
3	27	10:30 pm	10:48 pm	Superplasticisor	1 gal.	10:50 pm	3¾"	4½%	11:01 pm	3	10:59 pm
4	29	10:54 pm	11:09 pm				4¾"	7½%			
				Superplasticisor	1 gal.	11:33 pm	8"	4½%	11:42 pm	4	11:45 pm
5	21	11:19 pm	11:43 pm				3¾"	6½%			
				Superplasticisor	¾ gal.	11:54 pm	4"	5%	12:02 Am	5	12:02 Am
6	27	12:10 Am	12:31 Am				1½"	5%			
				Superplasticisor	1½ gal.	12:35 Am	4½"	5%	12:40 Am	6	12:42 Am
7	29	12:41 Am	12:55 Am	Superplasticisor	1½ gal.	12:58 Am	3"	4½%			
				Superplasticisor	½ gal.	1:03 Am	4"	4½%	1:15 Am	7	1:15 Am
8	21	1:08 Am	1:25 Am	Superplasticisor	2 gal.	1:26 Am	6"	4½%	1:35 Am	8	1:37 Am
9	27	1:52 Am	2:07 Am	Superplasticisor	3½ gal.	2:09 Am	7"	4½%	2:17 Am	9	2:15 Am
10	21	2:57 Am	3:10 Am				3"	5%	3:16 Am	10	3:20 Am

Remarks *1 gallon of Superplasticisor added to increase slump after dropping from 4 3/4" to 3" while waiting to get onto bridge.

Inspector Roland Ray Stamm

INSPECTOR'S DAILY REPORT SUPPLEMENT

Contract No. 3418 Highway 5 Date 8-15-88 P.E. J. M. Hayes

Section (Title) Sumas River to 36th St. Underpasses (Bridge 5/803) Page 1 of 1

Load No.	Truck No.	Batch Time	Arrival Time	On Site Batch Adjustments			Slump	Air	Discharge Time	Cylinders	
				Type	Quantity	Time				No.	Time Made
1	21	8:04 pm	8:26 pm				9"	7½%	8:36 pm	1	8:34 pm
2	27	8:39 pm	8:54 pm				2"	6%			
				Superplasticizer	1½ gal	9:01 pm	8½"	6%	9:10 pm	2	9:14 pm
3	29	9:24 pm	9:48 pm				2¾"	7%			
				Superplasticizer	1½ gal	9:53 pm	9½"	7%	10:01 pm	3	9:59 pm
4	21	9:42 pm	10:05 pm				4"	7½%			
				Superplasticizer	1½ gal	10:16 pm	7½"	5%	10:32 pm	4	10:30 pm
5	27	10:43 pm	11:07 pm				6"	8%	11:15 pm	5	11:13 pm
6	29	11:08 pm	11:27 pm				7"	9%			
				Superplasticizer	1 gal	11:32 pm	10"	5½%	11:42 pm	6	11:40 pm
7	21	11:36 pm	11:50 pm				8"	9%			
				Additional Mix Time			7½"	6½%	12:10 Am	7	12:08 Am
8	27	12:18 am	12:41 Am				4½"	8%	12:47 Am	8	12:45 Am

Remarks

Inspector

INSPECTOR'S DAILY REPORT SUPPLEMENT

Contract No. 3418 Highway 5 Date 8-18/19-88 P.E. J.M. Hayes

Section (Title) Sammish River to 36th St. Undercrossing (Alger Bridge) Page 1 Of 2

Load No	Truck No.	Batch Time	Arrival Time	On Site Batch Adjustments			Slump	Air	Discharge Time	Cylinders	
				Type	Quantity	Time				No.	Time Made
							2 1/2"	9%			
1	71	7:47 pm	8:14 pm	Superplasticizer	2 1/4 gal	8:21 pm	8 1/2"	5 3/4%	8:31 pm	1	8:33 pm
							4"	9 1/2%			
2	20	8:12 pm	8:41 pm	Superplasticizer	1 1/2 gal	8:52 pm	7 1/2"	6%	8:59 pm	2	9:01 pm
							4 1/2"	9 1/2%			
3	27	8:46 pm	9:14 pm	Superplasticizer	1 1/2 gal	9:20 pm	10"	6 1/2%	9:27 pm	3	9:30 pm
							6"	10%			
4	25	9:20 pm	9:49 pm	Superplasticizer	3/4 gal	9:53 pm	8"	7%	10:01 pm	4	10:02 pm
							8"	7 3/4%	10:22 pm	5	10:21 pm
5	21	9:48 pm	10:12 pm				3"	6%			
6	20	10:04 pm	10:30 pm	Superplasticizer	1 1/2 gal	10:39 pm	9"	4 1/2%	10:45 pm	6	10:43 pm
							3"	7 1/2%			
7	27	10:32 pm	10:56 pm	Superplasticizer	2 gal	11:04 pm	10"	4 3/4%	11:15 pm	7	11:13
							4"	7 1/2%			
8	29	10:55 pm	11:21 pm	Superplasticizer	1 1/2 gal	11:26 pm	10"	4 3/4%	11:32 pm	8	11:35 pm

Remarks

Inspector K. Stowe

INSPECTOR'S DAILY REPORT SUPPLEMENT

Contract No. 3618 Highway 5 Date 8-18/19-88 P.E. J.M. Hayes

Section (Title) Sammish River to 32nd St. Undercrossing (Alger Bridge) Page 2 Of 2

Load No.	Truck No.	Batch Time	Arrival Time	On Site Batch Adjustments			Slump	Air	Discharge Time	Cylinders	
				Type	Quantity	Time				No.	Time Made
9	21	11:31 p.m.	11:55 p.m.				4"	7%			
				Superplasticizer	1½ gal.	12:01 A.M.	8½"	6%	12:12 A.M.	9	12:07 A.M.
10	27	12:27 A.M.	12:51 A.M.				2"	4½%			
				Superplasticizer	1½ gal.	12:55 A.M.	9"	3½%			
				Air	24 oz	1:00 A.M.	9"	4%	1:10 A.M.	10	1:05 A.M.
11	29	*	2:36				5"	6½%	2:41 A.M.		

Remarks All Loads 4 yards with exception of load # 10 with 3 yards.
* No ticket recieved from plant for load # 11.

Inspector [signature]

INSPECTOR'S DAILY REPORT SUPPLEMENT

Contract No. 3418 Highway 5 Date 8-24-88 P.E. J.M. Hayes

Page 1 Of 1

Section (Title) Samish River to 36th St. Undercrossing (North Samish U.C. 5/803)

Load No.	Truck No.	Batch Time	Arrival Time	On Site Batch Adjustments: Type	Quantity	Time	Slump	Air	Discharge Time	Cylinders: No.	Time Made
1	21	7:24 pm.	7:46 pm.				7"	7%	7:51 pm.	1	7:54 pm.
2	27	7:47 pm.	8:07 pm.				7"	8%	8:15 pm.	2	8:16 pm.
3	20	8:08 pm.	8:33 pm.				8"	8%	8:41 pm.	3	8:39 pm.
4	29	8:30 pm.	8:55 pm.				9"	7½%	9:10 pm.	4	9:08 pm.
5	21	8:47 pm.	9:12 pm.				8"	7½%	9:26 pm.	5	9:20 pm.
6	27	9:27 pm.	9:49 pm.				7"	7½%	9:55 pm.	6	9:57 pm.
7	20	9:50 pm.	10:10 pm.				7"	7¾%	10:20 pm.	7	10:18 pm.

Remarks: Load # 7 used at Alger bridge (5/725). No adjustments to loads made at job.

Inspector [signature]

MICROSILICA MODIFIED CONCRETE OVERLAY
ALGER RD U'XING
5/725
CONTRACT 3418

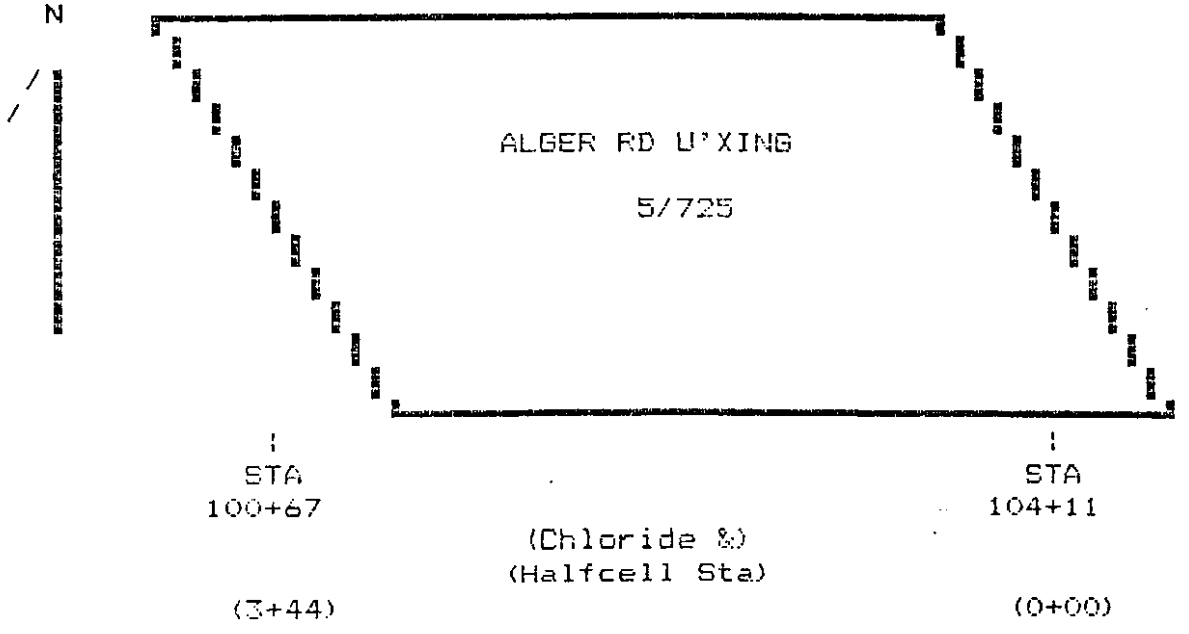
TESTING REQUIREMENTS

	Post Const 1988	1989	1990	1992	1994	1996	
FRICTION	10/88	7/89	6/90	x	x	x	x
DELAMINATION	x	7/89	7/90	x	x	x	
BOND	x	7/89		x		x	
HALF-CELL			7/90	x	x	x	
CHLORIDE			7/90	x		x	
PERMIABILITY (Cores)	x	7/89					
AIR CONTENT (Cores)	x	7/89					

x = To Be Tested

Bridge
Orientation

^ BELLINGHAM ^



DESIGN DATA
ALGER RD U'XING 5-725

SLUMP	5" +/-1"
AIR CONTENT	6% +/-1%
AIR ENTRAINING AGENT	DARAVAIR
WATER REDUCER	WRDA 79
MIX RATIO	7 SACKS CEMENT/52# SILICA
WATER/CEMENT RATIO	.33 MAX

FIELD TEST DATA

Truck #	Slump	Air	Yield	Air Temp

RAPID CHLORIDE PERMEABILITY TEST

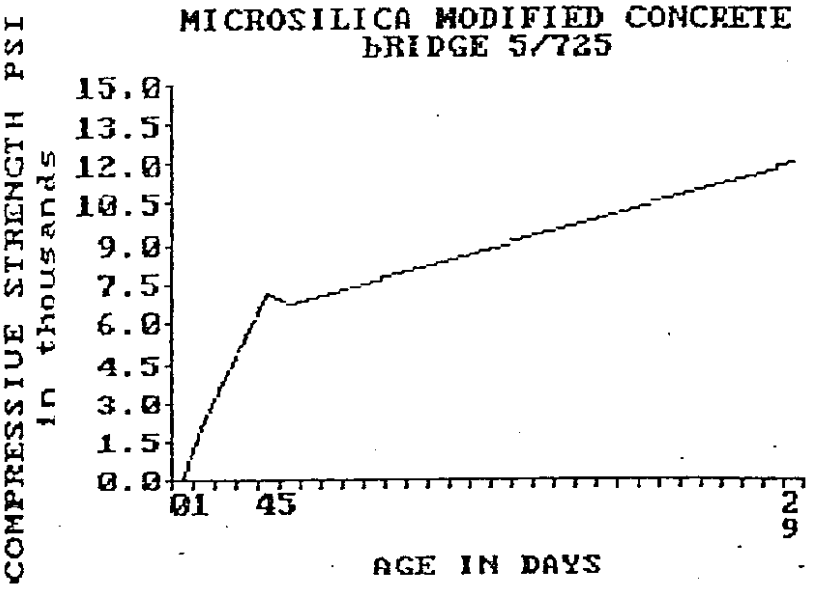
Sample	Coulombs	Depth	Date	Sample	Coulombs	Depth	Date
RP-1	352	2"	7/89				
RP-2	227	1-3/4"	7/89				
RP-3	321	1-3/4"	7/89				

AIR VOID ANALYSIS ON 6" CORE SPECIMENS

Sample #	% Air
AC-1	4.2
AC-2	3.4

COMPRESSIVE STRENGTH
ALGER RD U'XING 5/725

DATE	AGE	PSI	AVERAGE	DATE	AGE	PSI	AVERAGE
	1 DY	2310					
		2270	2290				
	4 DY	7720					
		7560					
		6090	7123				
	5 DY	6640					
		5930					
		7360	6710				
	29 DY	12010					



BOND TEST RESULTS
ALGER RD U'XING 5/725

Year	Station	Offset*	Depth	Load	PSI	Comments
1989	101+03	3 rt	1-1/2	800	255	Break in Old Conc.
	101+52	8.5 rt	1-3/4	800	255	DITTO
	102+10	3.5 rt	?			Invalid test
	102+90	9.5 rt	1-1/2	300	95	Break in Old Conc.
	103+66	3 rt	1-3/4	600	191	DITTO

*NOTE: Offset is feet left or right of centerline

FRICTION TEST RESULTS
ALGER RD U'XING 5/725

DATE	DIR	FN	AVE	RANGE
10/88	E	43		
		40		
		35		
		39		
		42		
		39	40	35-43
	W	36		
		40		
		37		
		37	38	36-40
7/89	E	51		
		50		
		54		
		51	52	50-54
	W	51		
		51		
		49		
		50		
		48	50	48-51
6/90	E	50		
		51		
		55		
		56	53	50-56
	W	53		
		52		
		52		
		52	52	52-53

DATE	DIR	FN	AVE	RANGE

CHLORIDE TEST RESULTS
ALGER RD U'XING 5/725

Year	Sample No	Station	Offset	Chloride Content 0-3/4	Chloride Content 3/4 - 1 1/2
1990	1	0+41	9	0.76	0.03
	2	0+63	5	0.13	0.27
	3	0+89	7	0.72	0.13
	4	1+15	11	0.32	0.13
	5	1+40	3	0.28	0.16
	6	1+67	8	0.37	0.17
	7	2+04	12	0.38	0.17
	8	2+41	3	1.09	0.13
	9	2+70	7	1.19	1.07
	10	3+15	12	0.95	0.34

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

HALF-CELL TEST RESULTS
ALGER RD U'XING 5/725

July, 1990

Sta	2	7	12			
0+00						
0+05		+.226	.242			
0+10	.185	.290	.275	x	x	x
0+15	.242	.282	.277	x	x	x
0+20	.250	.313	.275	x	x	x
0+25	+.263	+.159	.333	x	x	x
0+30	.268	.305	.022	x	x	x
0+35	.255	.299	+.099	x	x	x
0+40	+.152	+.224	+.150	x	x	x
0+45	+.171	+.160	+.156	x	x	x
0+50	+.195	+.163	+.218	x	x	x
0+55	.200	+.111	.283	x	x	x
0+60	.285	.360	.283	x	x	x
0+65	.306	.359	.219	x	x	x
0+70	.245	.228	.213	x	x	x
0+75	.152	.245	.205	x	x	x
0+80	.227	.252	.232	x	x	x
0+85	.191	.196	.201	x	x	x
0+90	.198	.228	.231	x	x	x
0+95	.241	.206	.215	x	x	x
1+00	.195	.243	.208	x	x	x

Values are NEGATIVE unless otherwise noted.

HALF-CELL TEST RESULTS
ALGER RD U'XING 5/725

July, 1990

Sta		2	7	12			
	2+00						
	2+05	.176	.225	.158	x	x	x
	2+10	.200	.235	.148	x	x	x
	2+15	.235	.265	.172	x	x	x
	2+20	.251	.240	.179	x	x	x
	2+25	.207	.178	.188	x	x	x
	2+30	.251	.217	.280	x	x	x
	2+35	.125	.245	.174	x	x	x
	2+40	.213	.198	.163	x	x	x
	2+45	.217	.220	.179	x	x	x
	2+50	.207	.219	.237	x	x	x
	2+55	.259	.229	.231	x	x	x
	2+60	.173	.290	.228	x	x	x
	2+65	.227	.251	.197	x	x	x
	2+70	.220	.235	.193	x	x	x
	2+75	.215	.253	.163	x	x	x
	2+80	.237	.244	.211	x	x	x
	2+85	.201	.244	.145	x	x	x
	2+90	.202	.228	.191	x	x	x
	2+95	.190	.231	.193	x	x	x
	3+00	.095	.120	.103			

Values are NEGATIVE unless otherwise noted

HALF-CELL TEST RESULTS
ALGER RD U'XING 5/725

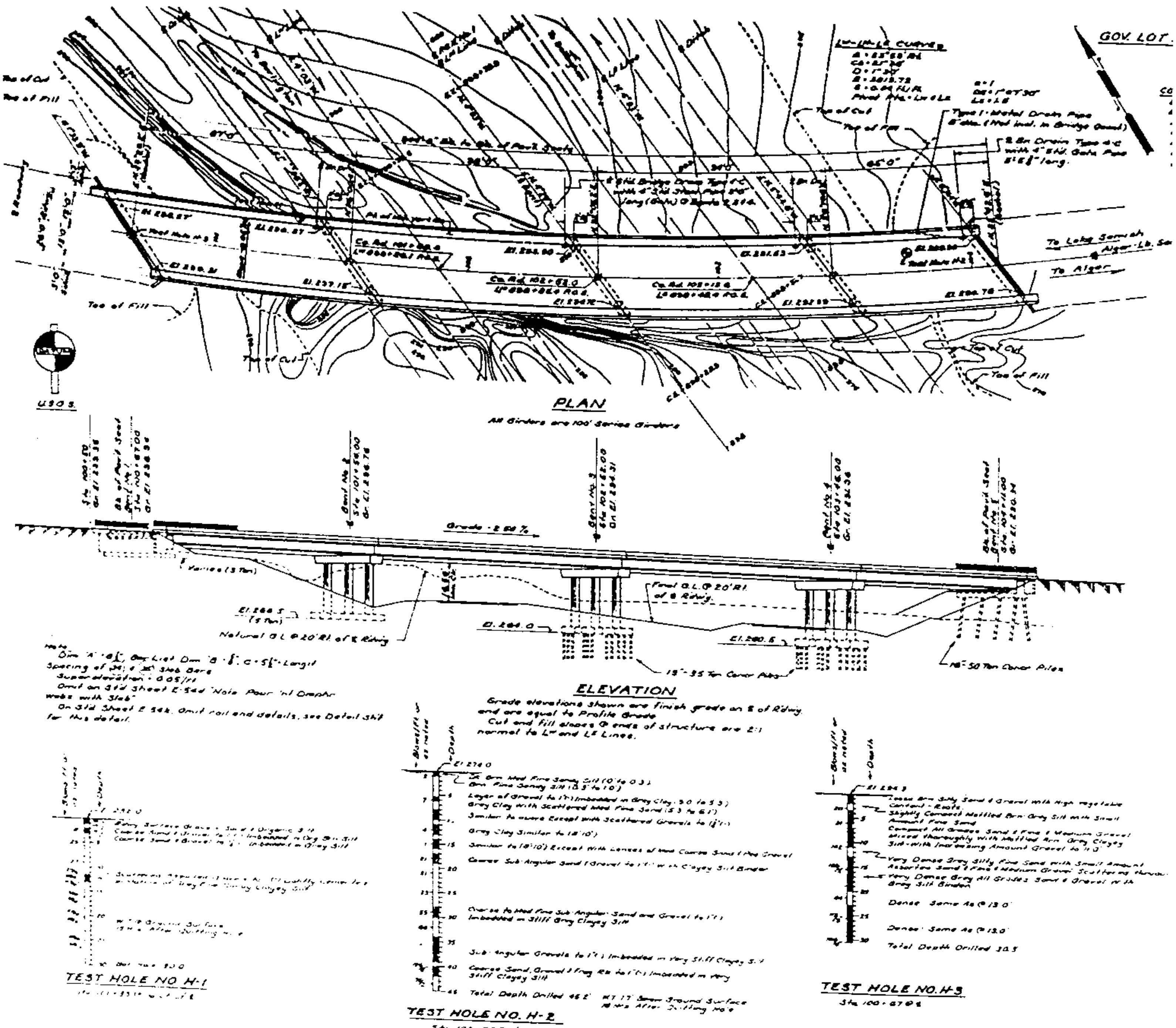
July, 1990

Sta	2	7	12			
3+00						
3+05	.195	.236	.219	x	x	x
3+10	.175	.229	.143	x	x	x
3+15	.209	.236	.157	x	x	x
3+20	.167	.148	.186	x	x	x
3+25	.198	.247	.169	x	x	x
3+30	.218	.276	.187	x	x	x
3+35	.218	.275	.190	x	x	x
3+40	.129	.237	.175			
3+44						

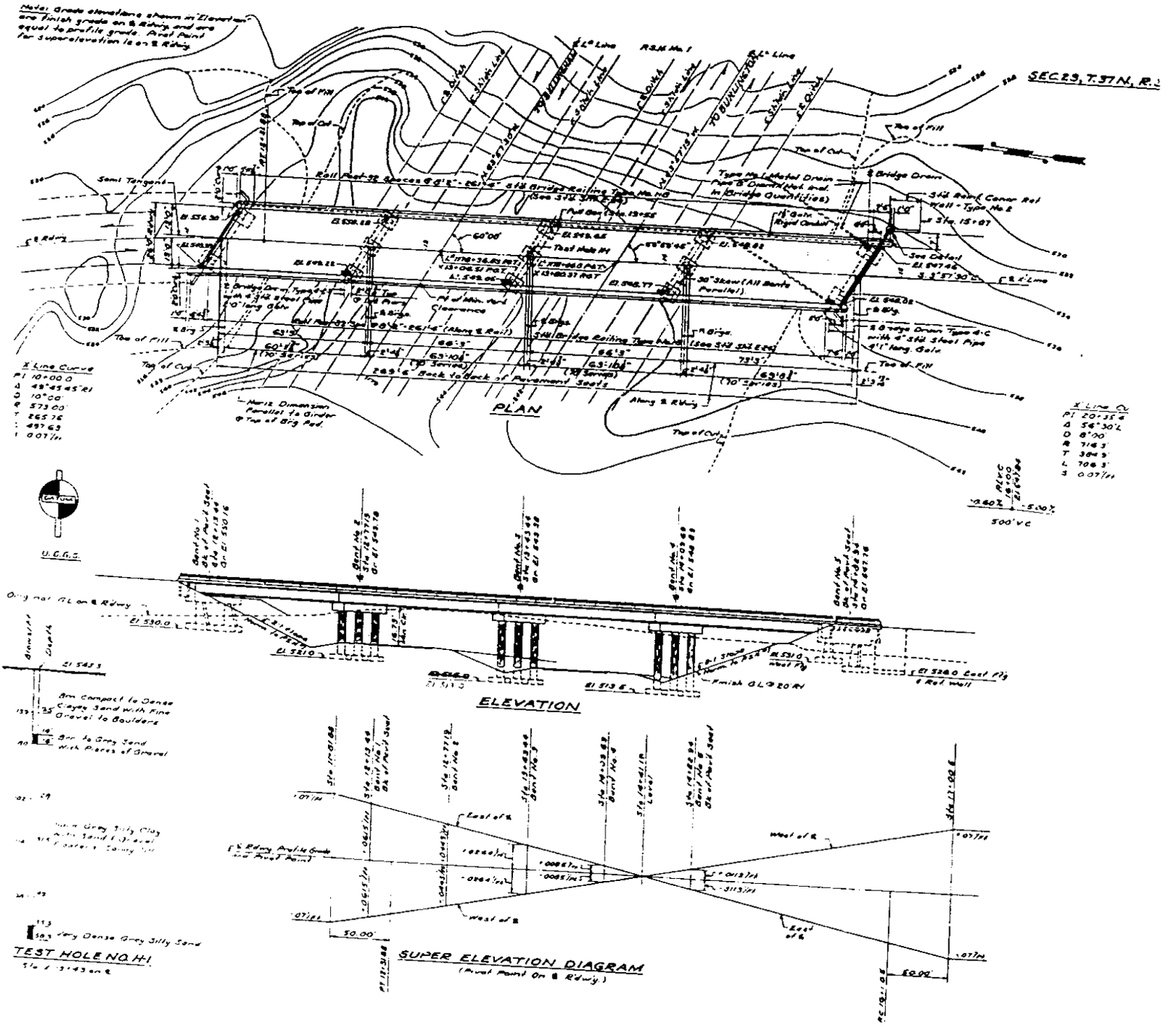
Values are NEGATIVE unless otherwise noted

APPENDIX C

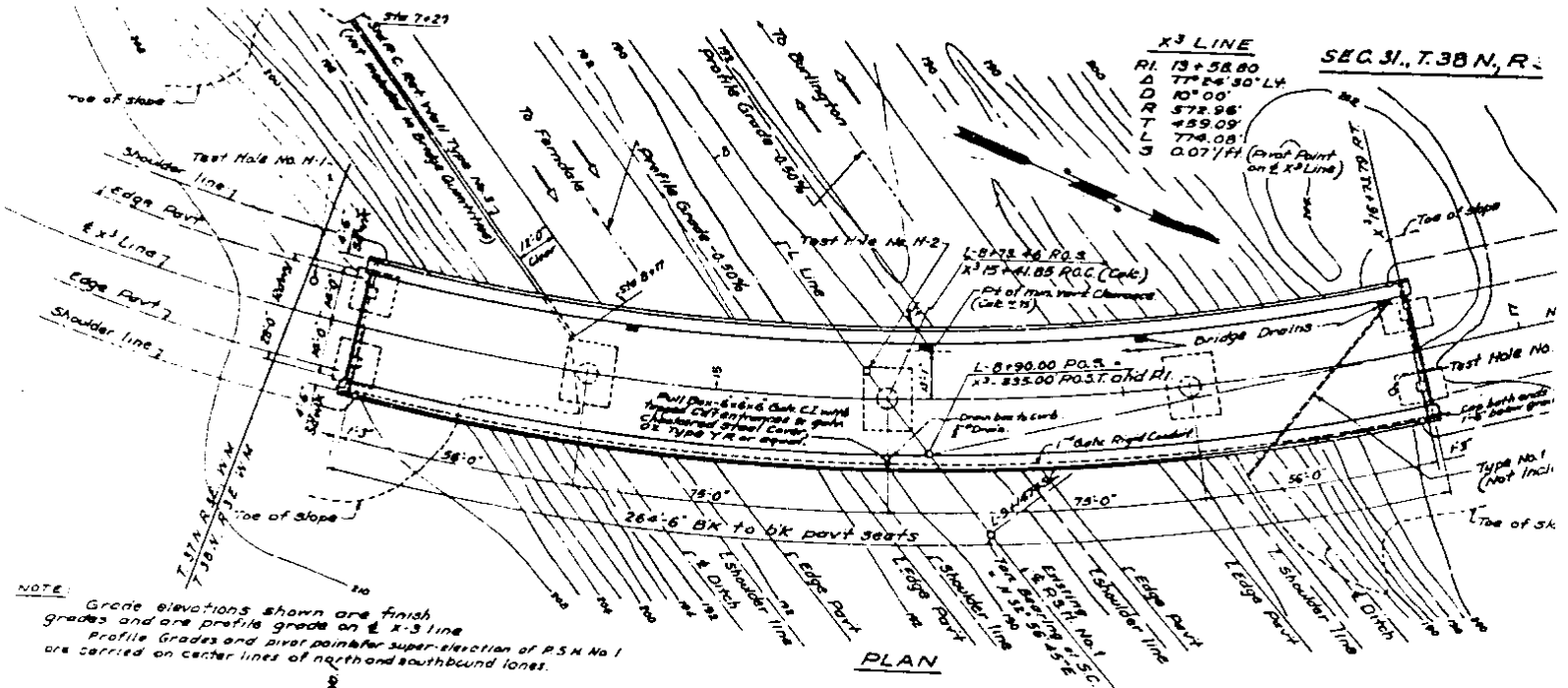
GENERAL LAYOUTS


GOV. LOT
Toe of Cut
Toe of Fill
To Alger
PLAN
All Girders are 100' Series Girders
Grade - 2.50 %
ELEVATION
Grade elevations shown are finish grade on ℄ of R'dwy and are equal to Profile Grade.
Cut and fill slopes @ ends of structure are 2:1 normal to L and L Lines.
TEST HOLE NO. H-1
TEST HOLE NO. H-2
TEST HOLE NO. H-3

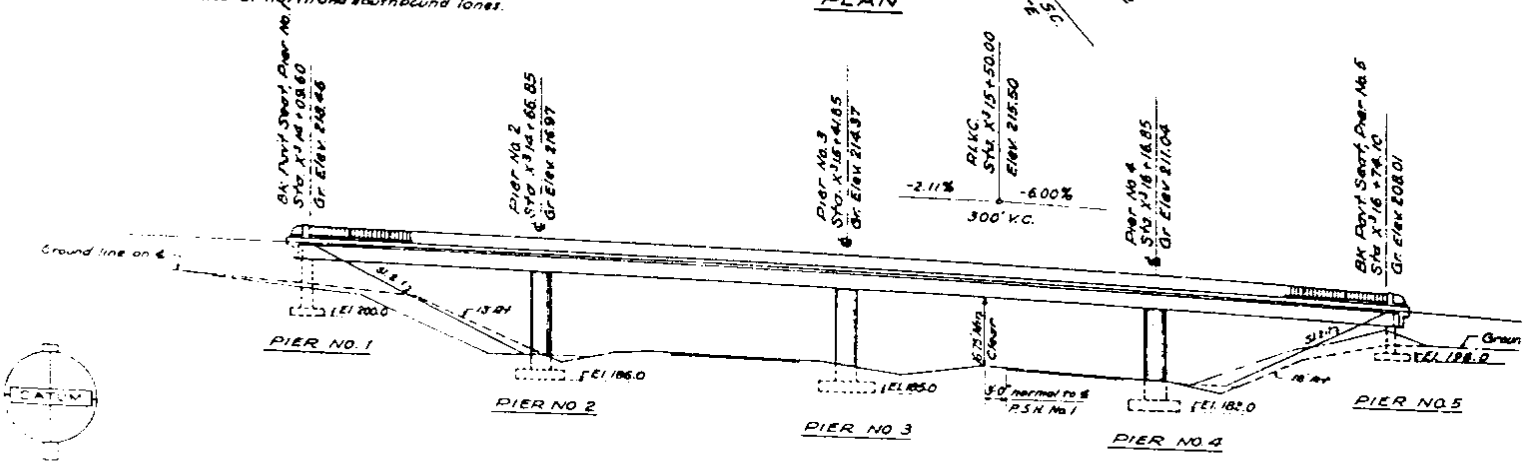
5/725


PLAN
ELEVATION
SUPER ELEVATION DIAGRAM
TEST HOLE NO. H-1
SEC 23, T. 37 N., R.

5/803



NOTE:
Grade elevations shown are finish grades and are profile grade on ℄ X-3 line.
Profile Grades and pivot points for super-elevation of P.S.H. No. 1 are carried on center lines of northbound and southbound lanes.



ELEVATION
18 Rt

Scale 1" = 5'

Depth in Ft
Ground Elev 207.9

- Stiff brown silt with scattered sand & gravel & some organic material. Sand & gravel Rounded & Sub Rounded
- Very stiff Brown silty clay with scattered all grades of Sand & gravel
- Very stiff grey clayey silt with all grades Sand & gravel thoroughly mixed
- Increasing amount sand & gravel
- Grey Soft shale
- Grey Sandstone Bedrock
- Drilling Stopped in Bedrock Samples damp thruout. Lost no water in hole Wash & Rotary TH-3 Boring

TEST HOLE NO. H-1
Sta L7+70 - 100' Rt ℄

Blows/Ft | Depth in Ft
Ground El. 189.6

Depth in Ft	
1.0	Compact brown fine silty Sand & Clay mixture
2.5	Compact grey silt with all grades Sand & fine gravel scattered thruout
5.3	Dense all grades sand & fine & medium gravel with silt Binder. Sand Sub Angular & Angular Gravel. Rounded & Sub Rounded
9.0	Soft shale
14.0	Grey sandstone Bedrock
	Drilling stopped in Bedrock Samples damp thruout Lost no water in hole Rotary TH-3 Boring

TEST HOLE NO. H-2
Sta L8+64

Blows/Ft | Depth in Ft
Ground Elev 202.1

Depth in Ft	
2	Stiff brown silt with scattered sand & gravel & organic material
7.5	Brown very stiff silty fine sand with scattered all grades sand and gravel
8.3	Casing driven to refusal at 5'8"
11.8	Grey Soft shale
14.0	Grey Sandstone Bedrock
18.0	Bedrock - Grey sandstone & grey shale layered
22.8	Drilling stopped in Bedrock. Samples damp 2.0 on. Lost no water in hole to 22.0'. At 22.0 lost all water.

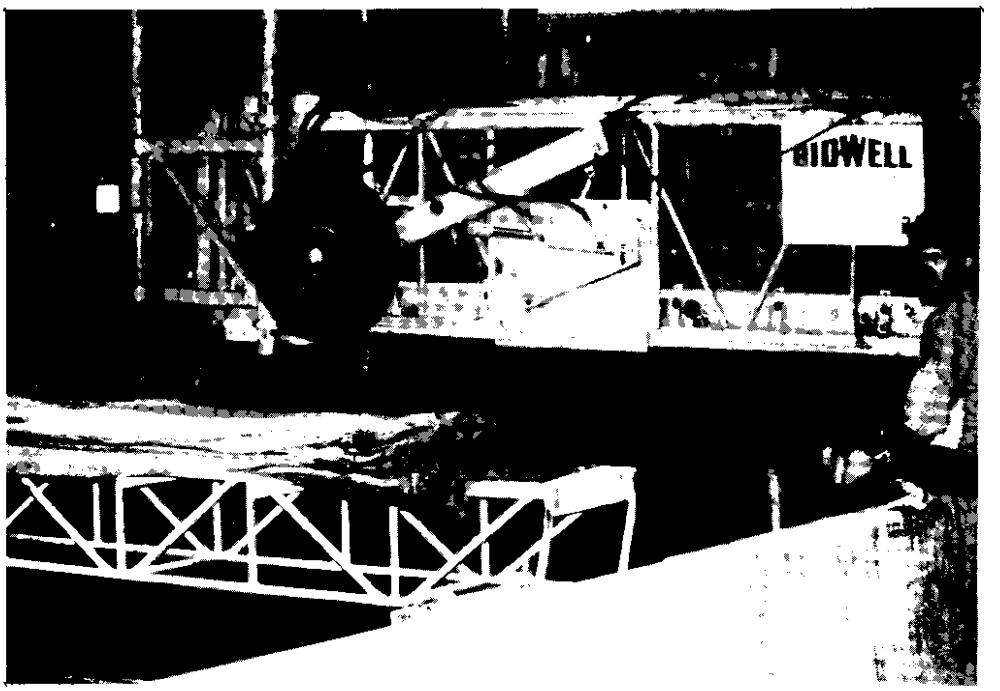
Wash & Rotary TH-3 Boring
TEST HOLE NO. H-3
Sta L9+46 - 101' left ℄

5/807

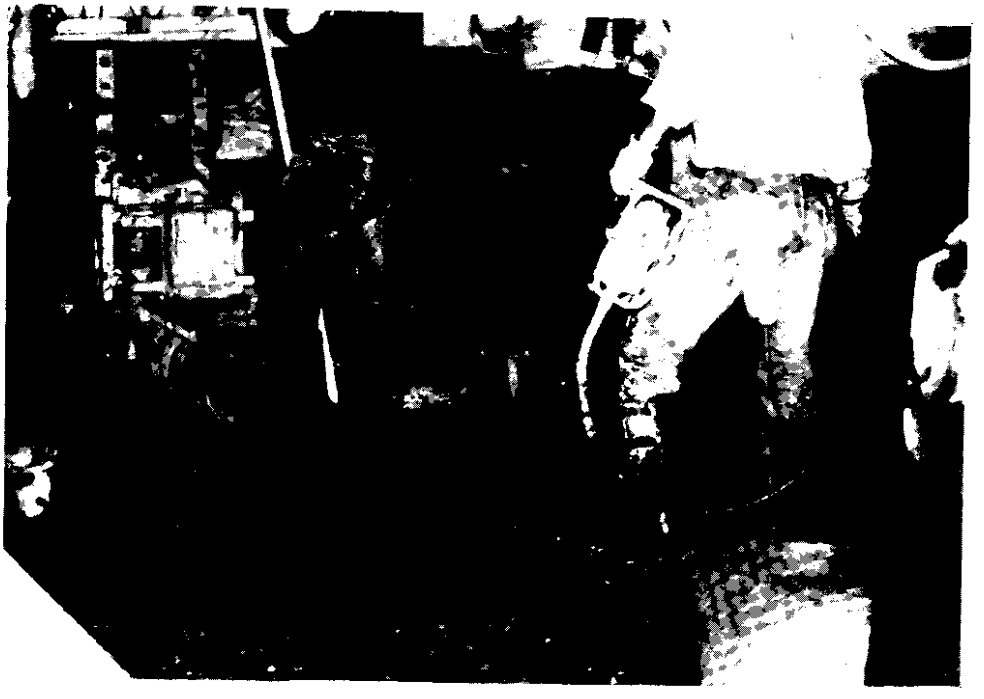
APPENDIX D

PROJECT PHOTOGRAPHS

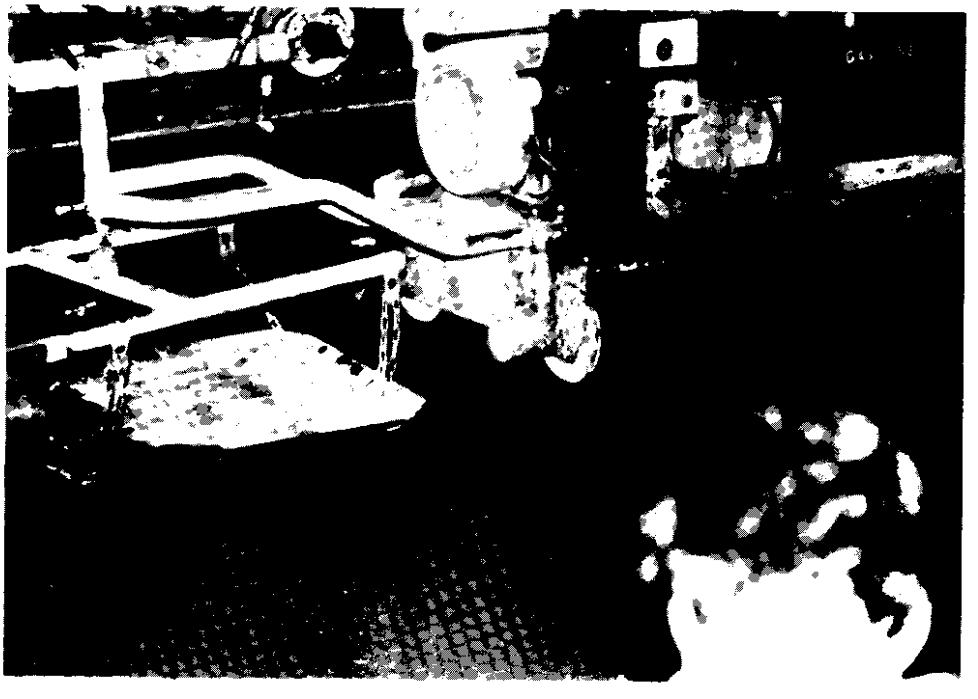
Paving Machine Guide Rail on Curb



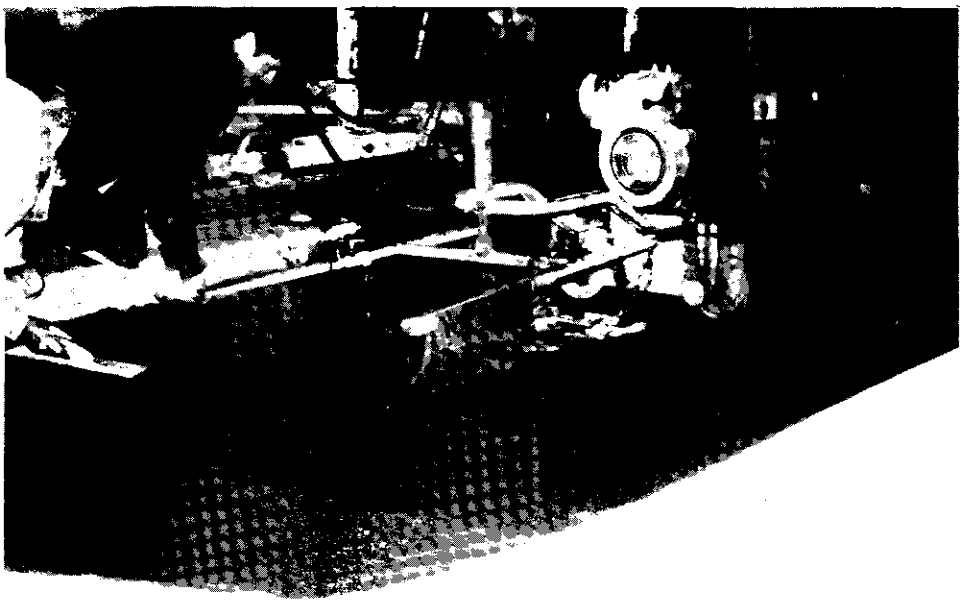
Bidwell Paving Machine



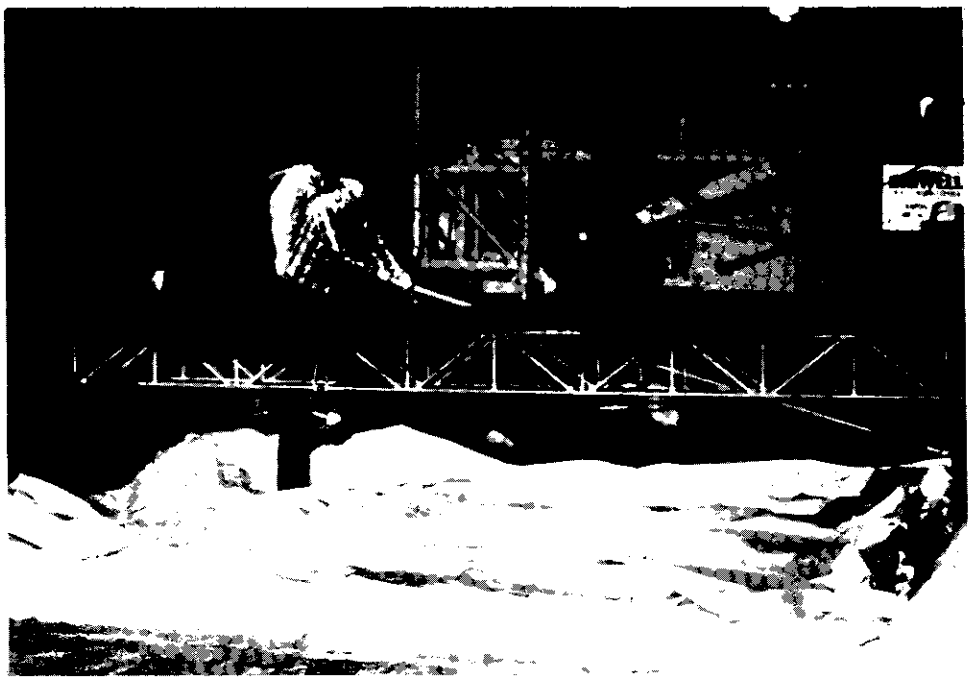
Filling Excavated Delams Monolithically with MMC Pour



Bidwell Paving Machine Finishing Equipment

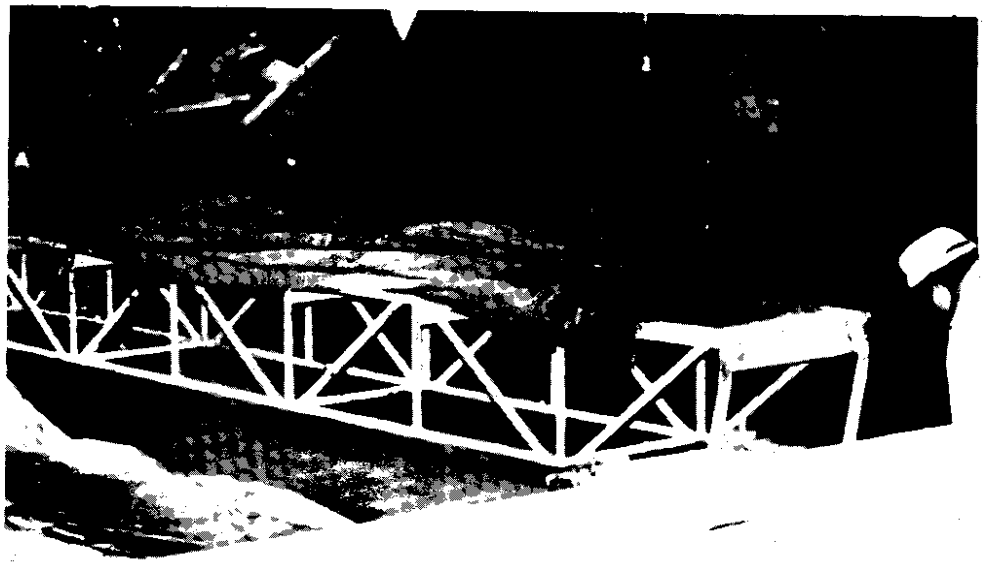


Trowelling by Hand



Float Finish in Background

Plastic Cover in Foreground



Tining Broom

Placing Wet Burlap