HIGHWAY RESEARCH REPORT

EXPERIMENTAL ASPHALT DURABILITY TEST SECTION

Road 11-Riv-10-R133.5/R149.5

72-05

STATE OF CALIFORNIA

BUSINESS AND TRANSPORTATION AGENCY

DEPARTMENT OF PUBLIC WORKS

DIVISION OF HIGHWAYS

MATERIALS AND RESEARCH DEPARTMENT

RESEARCH REPORT

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Prepared in Cooperation with the U.S. Department of Transportation, Federal Highway Administration September, 197

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STATE OF CALIFORNIA—BUSINESS AND TRANSPORTATION AGENCY

RONALD REAGAN, Governor

DEPARTMENT OF PUBLIC WORKS
DIVISION OF HIGHWAYS
MATERIALS AND RESEARCH DEPARTMENT
5900 FOLSOM BLVD., SACRAMENTO 95819

September 1971
Interim Report
M&R No. 633134

Mr. J. A. Legarra
State Highway Engineer

Dear Sir:

Submitted herewith is a research report titled:

EXPERIMENTAL ASPHALT DURABILITY TEST SECTION

ROAD 11-Riv-10-R133.5/R149.5

George B. Sherman
Principal Investigator

Glenn R. Kemp - Nelson H. Predoehl
Analysis & Report

Very truly yours,

JOHN L. BEATON
Materials and Research Engineer

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REFERENCE: Sherman, G. B., Kemp, G. R., and Predoehl, N. H., "Experimental Asphalt Test Section, Road 11-Riv-10-R133.5/R149.5," State of California, Department of Public Works, Division of Highways, Materials and Research Department, Research Report 633134, September 1971.

ABSTRACT: This is a project report for a test road which is part of a study dealing with the durability of paving grade asphalts. The test road incorporated an asphalt produced to meet a California Tentative Asphalt Specification as well as standard 85-100 and 200-300 grade asphalts. This report discusses construction details as well as test results from cores taken after six months' service. Test results from cores taken after two years' service and results of a field survey are included as appendixes.

KEY WORDS: Testing, asphalts, special asphalt, asphalt concrete, durability, laboratory studies, test section, plant reports, control section, tentative specification, mix samples, test results.

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ACKNOWLEDGMENTS

This work was done in cooperation with the U. S. Department of Transportation, Federal Highway Administration, and their cooperation is hereby acknowledged. The opinions, findings, and conclusions expressed in this publication are those of the authors and not necessarily those of the Federal Highway Administration. This is the 13th in a series of interim reports dealing with the durability of paving grade asphalts.

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INTRODUCTION

The California Division of Highways has been conducting a study on the durability of paving grade asphalts for almost ten years. This project has involved the study of various test methods and the evaluation of various test roads. For each of the test roads a project report, dealing with construction details, has been issued. This is the project report for test road 11-Riv-10-R133.5/R149.5. This particular report also discusses test results of cores taken from the project after six months service. In addition, this report includes, as appendixes, test results from cores taken approximately 2 years after construction and the findings of a field inspection conducted at approximately the same time interval.

Prior to the year 1968, all test sections incorporating the use of the California tentative specification asphalt were relatively small. The typical test section would use approximately 50 tons of the special asphalt. On Contract 11-037564, Road 11-Riv-10-R133.5/R149.5, a producer was contracted to furnish about 500 tons of the special asphalt. This special asphalt, which was manufactured to meet the California Tentative Asphalt Specifications (Table A), was placed in an approximately two mile test section in full depth on two lanes and shoulders. An additional test section using a regularly produced 85-100 asphalt was placed as a control section. The asphalt used in the remainder of the contract pavement was 200-300 grade.

While the general supervision of the test sections was by the Headquarters Materials and Research Department, the field activities were directed by the Resident Engineer and his associates. Under evaluation was (1) the ability of the producer to furnish and meet the California Tentative Asphalt Specification for the total amount contracted, (2) the ability of field crews to sample and evaluate the test sections comprehensively so as to provide all needed data for future evaluation, (3) the properties of the California Tentative Specification Asphalt in comparison with the present specification materials. Future reports will provide performance data.

FINDINGS

1. The asphalt producer was unable to consistently meet the California Tentative Asphalt Specification.

2. There was a lack of uniformity in the test results on asphalt received from the original mix. This may indicate variability in mixing and placing procedures.

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3. The tentative specification asphalt was used on the project without presenting any construction problems except for a slight early "setting" problem. However, this may have been due to cool weather conditions during paving.

4. The test results on core samples taken at approximately six months' field weathering show rapid hardening of all the asphalts, indicating possible severe weathering conditions.

5. Extensive bleeding is evident in the control 200-300 asphalt section in the travel lane after two years. The asphalt concrete was designed to use 200-300 asphalt and no change in asphalt content was made when the special asphalt and the 85-100 asphalt was used. No bleeding or other distress was visible in the special asphalt or 85-100 sections.

IMPLEMENTATION

This report, as mentioned in the Introduction, is merely a project report for one test road. Therefore, there are no recommendations for implementation. Implementation recommendations will be presented in a future interim report or in the final report for the entire research project.

DESCRIPTION OF PROJECT

The project is located in Riverside County from 1.5 miles west of Wiley's Well Road to 0.4 mile east of Route 78, about 2.6 miles west of Blythe. The project was constructed under Contract 11-037564 on Road 11-Riv-10-PM-R133.5/R149.5. Test sections are located as follows:

Asphalt No.	Grade	Paving Date	Course	Lane	Station (Eastbound)
1	Special Calif. Tent. Spec. Refinery A	11-25-68 to 12-6-68	Base Level Surface	1 & 2 Shoulder	585+00 - 697+40
2	200-300 Project Asphalt Refinery A	9-68	Base Level Surface	1 & 2 Shoulder	450+00 DR - 550+00 DR (control - also on rest of project)
3	85-100 Refinery B	1-16-69 to 2-5-69	Level Surface	1 & 2	938+75 DR - 99+00 ER

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DESCRIPTION OF THE PAVEMENT STRUCTURE

The pavement structure consists of asphalt concrete placed upon 0.60' Class 2 aggregate base. Upon this base was placed 0.25' of Type B asphalt concrete base, 1-1/4" coarse grading followed by 0.30' of asphalt concrete surfacing. The surfacing was Type B, 3/4" coarse grading which was placed in two lifts. Following all paving a layer of open-graded asphalt concrete 0.05' thick was placed as a wearing course. The paving mixture was produced by a Massey portable hot plant which delivered about 450 tons/hour. The mixture was hauled to the job in bottom dump trucks. The pavement was spread by a Barber Greene paver using a KoKal loader for picking up the mix from the windrow.

The intended asphalt content was 4.1% for the base and 4.5% for the surfacing. The same asphalt contents were specified for each of the three different type asphalts used on the project. The asphalt content was calculated using a 200-300 grade asphalt.

CONSTRUCTION OF TEST SECTIONS

The three different test sections were constructed at intervals of about two months. The section incorporating the special tentative specification asphalt was placed in late November and early December of 1968. The weather data, as obtained from plant reports for each day this asphalt was used, indicates that it was typical weather for that time of the year with fairly cool temperatures and windy conditions at times. Daytime highs ranged to about 70°F. Construction of the test section incorporating the 200-300 asphalt was during September 1968. A portion of this paving was picked to represent the project as the 200-300 control section. The 85-100 asphalt was placed during January 1969. This asphalt, which is a regular Standard Specification 85-100, was incorporated to provide a control section of an asphalt with original viscosities more similar to the special asphalt. The two control sections were constructed according to standard specification requirements concerning mixing, placing and rolling.

Some problems occurred with the special asphalt mix cooling or "setting" too quickly. The weather was windy and cool at this time. According to the plant reports, the roller operators experienced some problems with the mix sticking to the pneumatic.

LABORATORY STUDIES

A main phase of this report is the detailing of laboratory studies on the various components used in the project. Samples were taken of all of the asphalts at the hot plant and of the

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special asphalt at the refinery. Samples of the mix were taken from the windrow at the jobsite only for the special asphalt.

Following is a table showing the properties of the original mix for the Special Tentative Specification Asphalt:

Average Original Asphalt Mix Results (Normal Standard Specification for Asphalt Concrete)										
Location (No. of Samples)	Plant Asphalt Content(%)	Stab Value	Cohesion Load/ in.width	Asph. Cont. (%)	Grading (% Passing) 3/4	3/8	#4	#8	#30	#200
(Type B, 3/4" coarse) Surface Course (8 samples)	4.5	48	435	4.1	94	72	51	36	21	6
(Type B, 3/4" coarse) Level Course (5 Samples)	4.5	44	360	4.5	96	73	52	37	21	6
(Type B, coarse, 1-1/4" Max.) Base Course (6 samples)	4.1	47	289	4.3	95	59	41	31	19	5

While the test results for the mix are uniform for the "mix" test, the results on the Abson recovered "asphalt" from these same mixes indicate a variation between the days of mixing. This shows up when you note that prior to and including the mixing on December 3, 1968, the results are fairly uniform but the results of the material mixed on December 4 and 5 show a dramatic change. Following is a table showing these average results on a daily basis:

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Average Test Results of Recovered Asphalt from Original Mix (California Tentative Specification Asphalt)									
Location			Duct	Viscosity		Micro-Viscosity @77 (megapoise)			Micro-Duct
(No. of Samples) Date of Samples	Pen @77°F	S.P. (°F)	@77°F (cm)	@140°F Poise	@275°F (cs)	@0.05sec^{-1} S.R.	@0.001sec^{-1} S.R.	Shear Suscep	@77°F (mm)
Sta585-609 Ln 2 Surface Course (2 samples) 12-3-68	40	133	100+	8516	600	7.85	13.0	.13	47
Sta 609 Lane 2 Surface Sta566-577 Shrd Surface (3 samples) 12-4-68	26	144	79	24869	919	17.1	38.1	.20	22
Sta646-673 Ln 1 Surface (3 samples) 12-5-68	27	143	72	35059	1099	23.1	53.8	.22	9
Level (5 samples) 11-26,27; 12-2-68	45	129	100+	6070	513	6.12	8.6	.08	52
Base (6 samples) 11-25,26,27;-68	47	129	100+	5214	471	5.22	6.29	.05	68

Samples of the special asphalt were taken two times a day at the plant. Samples were also taken at the refinery on two separate days. These samples were all tested for their compliance to the California Tentative Asphalt Specification. The results for each sample and the average of all the samples are detailed in Table B. Samples of the two control asphalts were also procured from storage and these two asphalts were subjected to the tentative specification tests. A comparison of their test results can be observed in the following table:

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AVERAGE ORIGINAL ASPHALT TEST RESULTS

* NOT A SPECIFICATION REQUIREMENT

Test Methods →	AASHO T-73	ASTM D1328	AASHO T-51	AASHO T-202	AASHO T-201	CALIF. 348		CALIF 349	CALIF. 348	AASHO T44
				Viscosity	RTF Res.	Asphalt Durability Residue Test				
Asphalt & Refinery	Flash Pt. PMCT (°F)	Stain No. 120 (hrs)	Ductility on RTF Res. (cm)	Vacuum Cap. 140°F (poise)	Kin. Vis. at 275°F (cs)	Microviscosity at 77°F (megapoise) 0.05 Sec^{-1} SR	0.001 Sec^{-1} SR	Micro-ductility at 77°F (mm)	Shear Susceptibility	Solubility CCl_4 (%
California Tentative → Specifications	Minimum 450	Maximum 10	Minimum 75	4000 to 6000	425 to 800	Maximum 25.0	Maximum 60.0	Minimum 10	* Maximum 0.23	Minimum 99.0
Tentative Specification Asphalt 1 Refinery A	445	7.8	100+	3665	419	31.1	77.5	6.8	.23	99.89
200/300 Control Asphalt 2 Refinery A	415	9.0	100+	578	157	6.04	6.04	91	.00	99.93
85/100 Control Asphalt 3 Refinery B	440	9.0	100+	2550	321	43.8	97.5	7	.20	99.97

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Four inch and twelve inch core samples were taken at several locations in each of the specified test sections when the pavements were about six months old. Normal routine tests were run on the four inch cores, with the average results shown in the following table:

Average Results of Test on 4" Cores

Core Location (Eastbound Rt OWT)	Asphalt No. Type, Age	Air Permeability ml/min/sq.in.		Waxed Spec. Grav.		Air Voids Percent	
		Surface	Level	Surface	Level	Surface	Level
Sta 450DR - Sta 550DR (Sta468+40) (Sta501+00) (Sta523+85)	Asphalt #2 200-300 8 months	1	5	2.37	2.35	4.4	5.2
Sta 585DR - Sta 697DR (Sta596+00) (Sta608+00) (Sta620+00)	Asphalt #1 Special 6 months	3	47	2.30	2.28	7.2	8.1
Sta 938DR - Sta 99ER (Sta10+00ER) (Sta26+00ER) (Sta42+00ER)	Asphalt #3 85-100 4 months	3	31	2.31	2.30	6.9	7.2

By means of the Abson Recovery, the asphalt from the 12 inch cores was extracted. The following table gives test results on the recovered asphalt:

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Average Results on Recovered Asphalt from 12 inch Cores

Core Location (Eastbound RT OWT)	Asphalt No. Grade Age of Pvmt.	Pen. at 77°F	*	S.P. (°F)	Duct. at 77°F (cm)	Micro-Viscosity at 77°F (megapoise) $0.05 sec^{-1}$ S.R.	Micro-Viscosity at 77°F (megapoise) $0.001 sec^{-1}$ S.R.	Shear Suscep.	Micro-Ductility at 77°F (mm)
Sta 450DR to Sta 550DR (Sta468+40) (Sta501+00) (Sta523+85)	Asphalt #2 200-300 8 months	63	S	117	100+	1.74	1.93	.03	71
		64	L	117	100+	1.66	2.15	.07	69
Sta 585DR to Sta 697DR (Sta596+00) (Sta608+00) (Sta620+00)	Asphalt #1 Special 6 months	40	S	126	100+	6.1	7.72	.06	76
		41	L	129	100+	6.63	7.62	.03	73
Sta 938DR to Sta99ER (Sta10+00ER) (Sta26+00ER) (Sta42+00ER)	Asphalt #3 85-100 4 months	29	S	136	100+	11.6	11.6	.00	91
		28	L	133	100+	12.3	12.3	.00	99

*S = Surface Course = 0 to .17' depth.

L = Level Course = .17' to .34' depth.

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ANALYSIS OF DATA

In the introduction it was mentioned that three basic subjects were under evaluation.

1. The ability of the producer to furnish and meet the California Tentative Asphalt Specification for the total amount of special asphalt to be furnished.

Table B is an accounting of all of the asphalt samples submitted from the special asphalt test section. None of the samples submitted fully met all of the tentative specification tests. The "mean" of all of the samples also indicates noncompliance with over half of the requirements. Overall, the results are fairly uniform.

2. The ability of field crews to sample and evaluate the test sections comprehensively so as to provide needed data for future evaluation.

The information received from the field crew for this job included asphalt mix samples taken at regular intervals from the street and copies of plant reports for all the days on which the special tentative specification asphalt was used. No information concerning mix temperatures on the street was furnished. There were no mix samples furnished for either of the control sections as well as no original asphalt samples. Original asphalt samples were obtained by using stored samples saved from routine testing during these periods on this contract.

The variation between the results of the recovered asphalt and the original mix samples is difficult to define since there were no street temperatures available. Recovered asphalt test results from cores taken at approximately six months indicate the original mix samples may have not adequately represented the mix in the pavement.

3. Comparing the properties of specially produced asphalt to meet the California Tentative Asphalt Specification with materials currently produced to meet the California Standard Specifications.

There were some early setting problems with the tentative specification asphalt; however, this may have been due to cool weather paving conditions.

Test results on cores taken from the project after six months indicate that all asphalts are hardening rapidly.

Further comparisons of the asphalt produced to meet the tentative specifications will be judged mainly on how future field performances compare with the laboratory predictions.

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TABLE A

CALIFORNIA TENTATIVE ASPHALT SPECIFICATION

Paving Grade Asphalt Shall Conform to the Following Requirements

Test	Test Method	Specification
Flash Point, P.M.C.T. °F Min.	AASHO T 73	450
Stain Number of Original Sample Max. after 120 hrs. -140°F -50#/sq. in.	ASTM D 1328-58T	10
Rolling Thin Film Test 325°F, 75 min.	Calif. Test Method No. 346	
Duct. Residue, 77°F Min.	AASHO T 51	75
Viscosity, Residue	AASHO	
140°F, Poises	T-202	4,000 - 6,000
275°F, Centistokes	T-201	425 - 800
Durability Test	Calif. Test Method No. 347	
Viscosity of Residue after Durability Test, Megapoises at 77°F		
Shear Rate 0.05 sec^{-1} max.	Calif. Test Method No. 348	25
Shear Rate 0.001 sec^{-1} max.		60
Micro Ductility of Residue 1/2 cm./Min. 77°F, Minimum, mm	Calif. Test Method No. 349	10
Solubility, CCL_4, Orig. Sample, % Min.	AASHO T 45	99

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ORIGINAL ASPHALT TEST RESULTS TABLE B

* NOT A SPECIFICATION REQUIREMENT

Test Methods →		AASHO T-73	ASTM D1328	AASHO T-51	AASHO T-202	AASHO T-201	CALIF. 348		CALIF. 349	CALIF. 348	AASHO T44
Sample Number	Date Sampled	Flash Pt. PMCT (°F)	Stain No. 120 (hrs)	Ductility on RTF Res. (cm)	Viscosity Vacuum Cap. 140°F (poise)	RTF Res. Kin. Vis. at 275°F (cs)	Asphalt Durability Residue Test: Microviscosity at 77°F (megapoise) 0.05 Sec^{-1} SR	0.001 Sec^{-1} SR	Micro-ductility at 77°F (mm)	Shear Suscept-ibility	Solubility CCl_4 (%)
Specifications →		Minimum 450	Maximum 10	Minimum 75	4000 to 6000	425 to 800	Maximum 25.0	Maximum 60.0	Minimum 10	* Maximum 0.23	Minimum 99.0
From Refinery											
R4435	11-24-68	443	8.5	100+	3375	417	29.0	75.0	7	.24	99.84
R4436	12-2-68	465	8.5	100+	3788	429	25.0	65.0	4	.25	99.89
From Plant in 5 gal.											
R4429	11-25-68	443	8.0	100+	3603	411	30.3	90.0	10	.28	99.89
R4430	11-26-68	450	8.0	100+	3565	411	30.3	89.0	6	.28	99.88
R4431	11-27-68	480	8.0	100+	3728	417	32.0	86.0	6	.25	99.87
R4432	12-2-68	438	8.5	100+	3673	426	24.7	59.0	7	.23	99.92
R4433	12-3-68	470	9.5	100+	3735	423	26.0	60.0	7	.22	99.91
R4434	12-5-68	470	9.5	100+	3865	426	31.2	82.5	10	.25	99.87
Regular Asph. Sampling											
90360	11-25-68	430	5.0	100+	3731	408	39.5	71.5	8	.16	99.88
90361	11-25-68	435		100+	3620	416	35.5	85.0	6	.23	
90362	11-26-68	428		100+	3682	414	37.8	82.0	6	.21	
90363	11-27-68	440		100+	3703	410	33.9	82.0	8	.23	
90364	11-27-68	410		100+	3593	405	42.8	125.5	6	.25	
90365	12-2-68	412		100+	3558	428	33.0	80.5	6	.23	
90366	12-2-68	455		100+	3593	417	27.1	63.0	7	.22	
90367	12-3-68	475		100+	3695	429	28.0	80.0	6	.26	
90368	12-4-68	433		100+	3627	424	27.0	59.3	6	.20	
90369	12-5-68	435	5.0	100+	3828	436	27.5	59.3	6	.20	99.97
Mean		445.1	7.8	100+	3664.6	419.3	31.1	77.5	6.8	.23	99.89

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APPENDIX A

Test Results and Comments on Samples Recovered from Cores Taken at Approximately 24 Months (November 1970)

Cores were removed from the Blythe Test Section in November 1970 at which time the ages of the test areas were Control 200-300: 25 months, California Tentative Specification Asphalt: 24 months, and the 85-100 asphalt: 22 months. Abson recoveries were performed on the twelve inch cores and air permeabilities and specific gravities on the four inch cores. Test results are recorded on Table A.

The penetration and viscosity results indicate a rapid hardening of the asphalt. Figures 1 and 2 illustrate this trend. The test results for the 85-100 asphalt indicate that this material has become quite hard and non-ductile. Failure of this section is possible with the asphalt in this condition. The special tentative specification asphalt has also hardened significantly. It will be interesting to see if this hardening rate will flatten out at about this stage of weathering as the special asphalts have in the other test sections.

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TABLE A

Test Results on Cores After 25, 24, 22, Months

Tests on 4" Cores

Asphalt Section	Pavement Age (Months)	Depth	Air Perm. ml/min/in.^{2}	Specific Gravity (Waxed)	% Air Voids
Control 200/300 Asphalt #2	25	Surf.	1	2.41	2.8
		Level	5	2.37	4.4
Asphalt #3 85/100	22	Surf.	1	2.35	5.2
		Level	18	2.32	6.5
Special Tentative Spec. Asphalt #1	24 Travel Lane	Surf.	2	2.34	5.6
		Level	77	2.31	6.9
	Passing Ln.	Surf.	3	2.32	6.5
		Level	41	2.28	8.1
	Average	Surf.	3	2.33	6.1
		Level	59	2.30	7.5

Tests on Abson Recovered Asphalt

Asphalt Section	Pavt. Age (Mos.)	Depth	Pen. at 77°F	S.P. (°F)	Duct. 77°F (cm)	Micro-Viscosity (Megapoise) .05s^{-1} S.R.	Micro-Viscosity (Megapoise) .001s^{-1} S.R.	Shear Susp.	Micro-Duct. 77°F (mm)
Asphalt #2 Control 200-300	25	Surf.	44	125	150+	4.78	6.1	.05	70
		Level	35	129	150+	8.12	10.1	.04	70
Asphalt #3 85/100	22	Surf.	11	150	23	102.0	205.0	.18	2
		Level	11	150	26	100.0	193.0	.17	1
Special Tent. Spec. Asphalt #1	24 (T.L.)	Surf.	21	141	134	27.2	67.7	.23	12
		Level	19	144	45	34.8	92.0	.25	10
	(P.L.)	Surf.	19	146	71	31.2	84.7	.26	10
		Level	21	144	78	25.9	72.8	.26	10
	Average	Surf.	20	144	103	29.2	76.2	.25	11
		Level	20	144	62	30.4	82.4	.26	10

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Figure 1

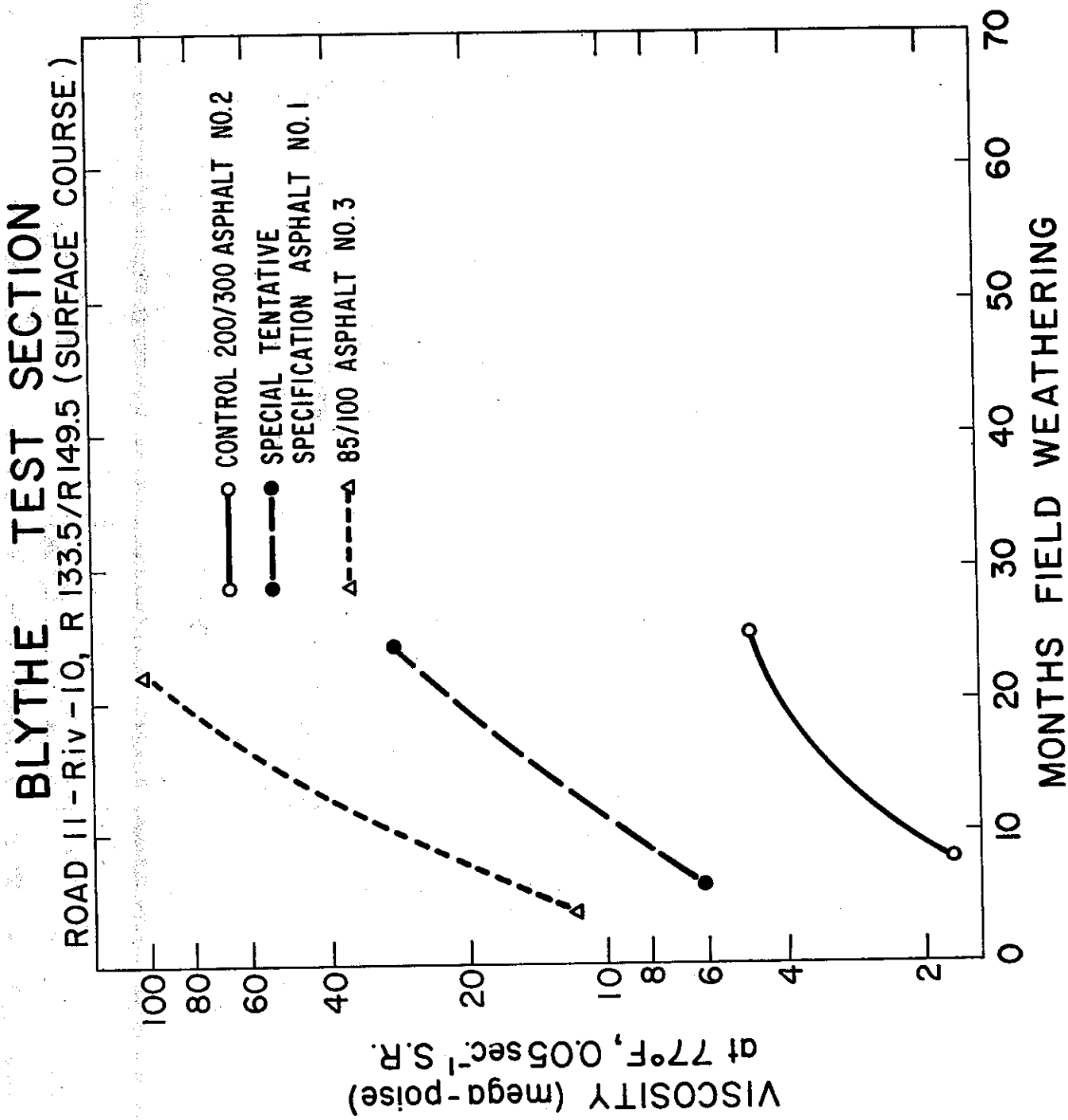

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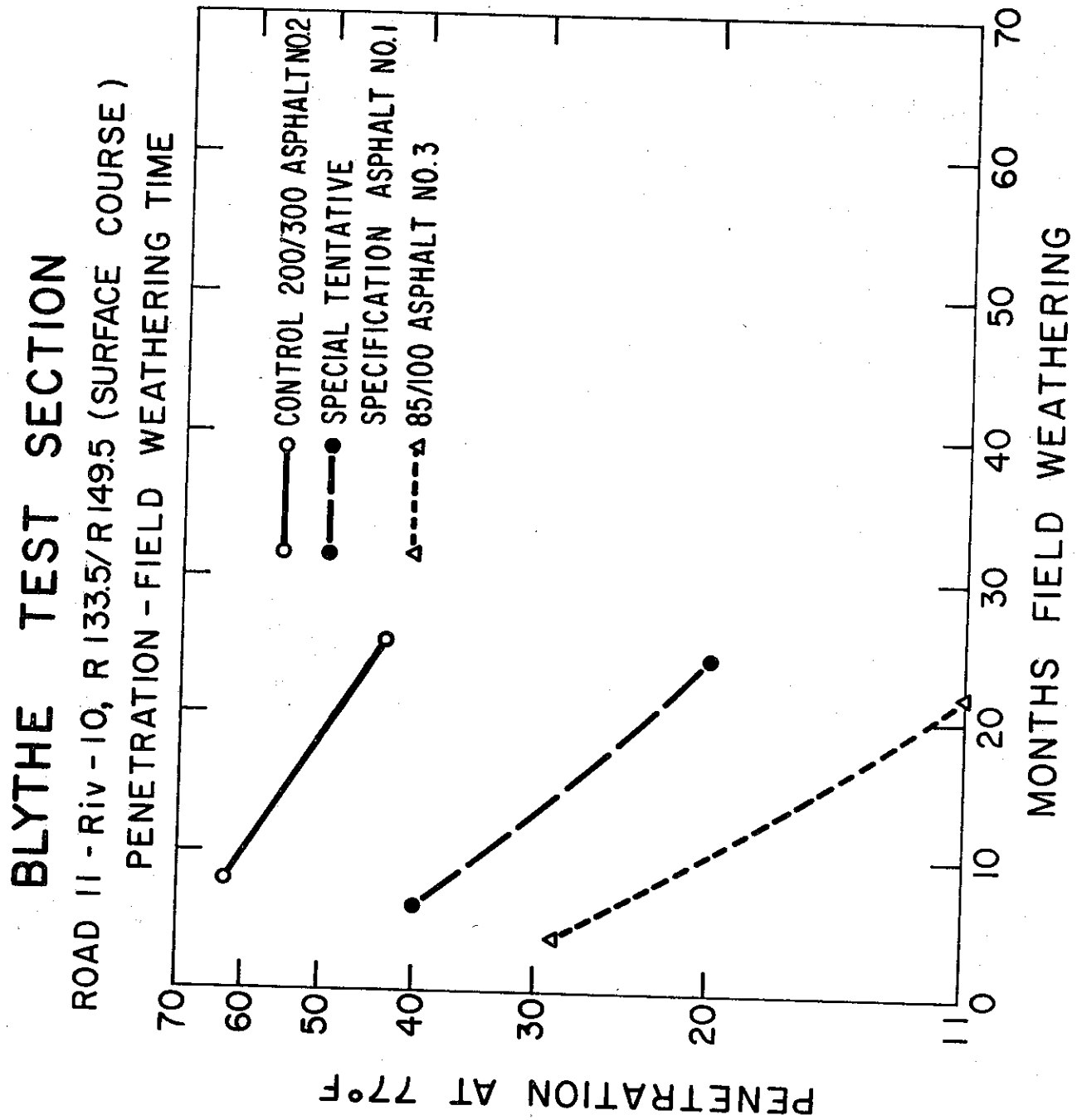
Figure 2



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APPENDIX B

Field Inspection January 1971

A field inspection was conducted by personnel of the Materials and Research laboratory in January 1971 of the Blythe Test Section. Each of the test areas were observed at all core location points as well as a general observation of the whole job. There was no sign of distress at the surface of the tentative specification asphalt or the 85-100 control asphalt. On the control 200-300 asphalt there was varied amounts of bleeding at varied locations throughout the job primarily in the travel lane wheel tracks. Some bleeding was also evident in the passing lane wheel tracks. Figures 1 and 2 show two different locations and intensities of bleeding in the 200-300 section.

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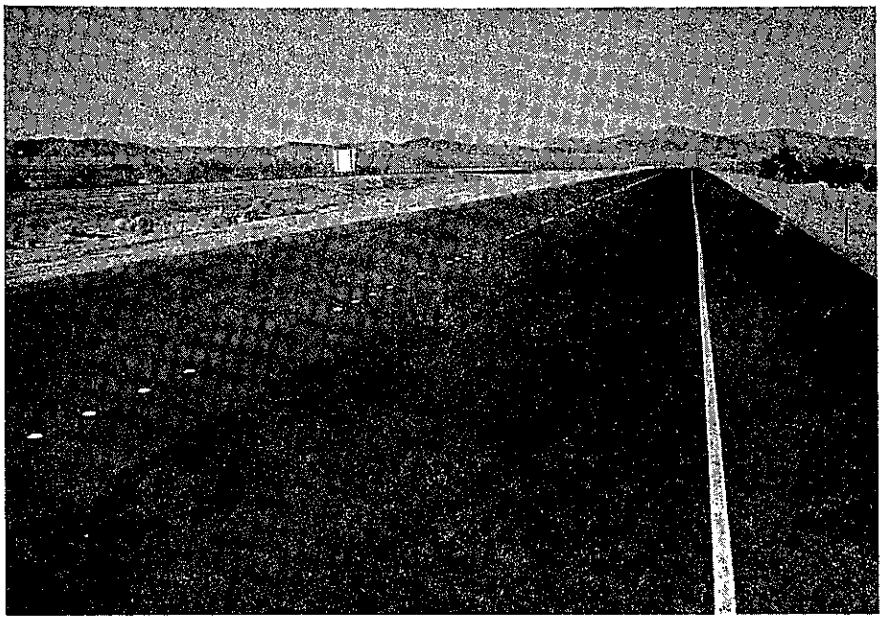
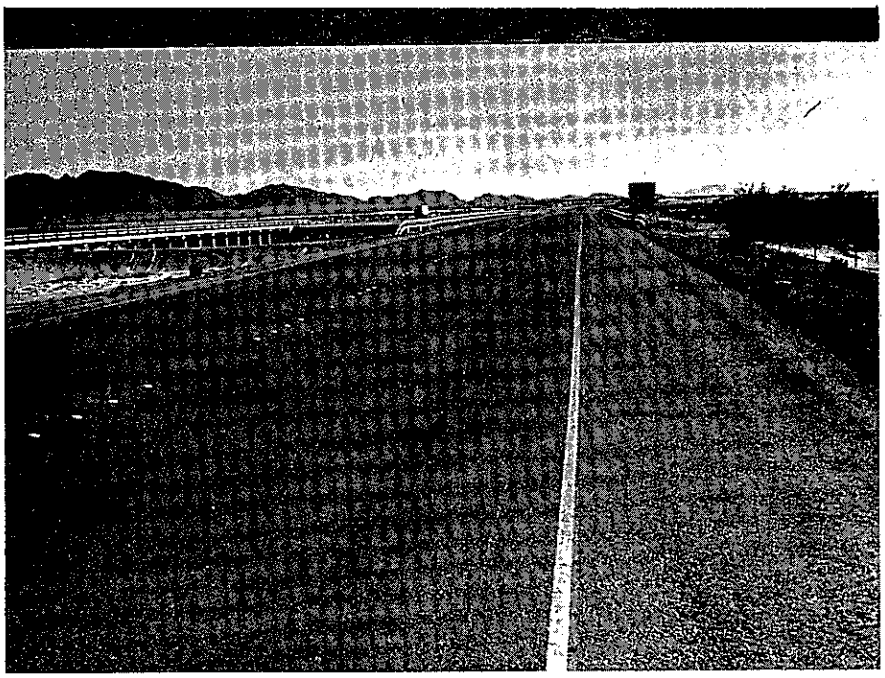


Control 200-300 Section - extensive bleeding

Figure 1



Control 200-300 Section - slight bleeding

Figure 2

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